AN EMPIRICAL INVESTIGATION OF THE CAUSES AND CONSEQUENCES OF INERTIA IN WAGES AND PRICES

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ABSTRACT

The thesis considers the process of adjustment in the supply side of the economy, discussing factors which might influence (nominal and real) wage and price responsiveness, and investigating these empirically using data for the UK. This contributes to the analysis of the macroeconomic consequences of supply side inflexibilities, and policy implications are drawn out.

Two themes recur throughout the thesis. The first is an emphasis on the institutional detail of the supply side which suggests reasonable sources of adjustment costs and explanations for rigidities. The second is an emphasis on disaggregation in the analysis. It is argued that the interactions and interdependencies between sectors of the economy play a central role in determining the responsiveness of the supply side to shocks. In order to investigate these ideas, the empirical work makes use of data available at the industrial level.

Econometric analysis of the variability of wage growth across industrial sectors and of the frequency of wage negotiations over time provides clear evidence that the speed of adjustment of nominal wages is influenced systematically by supply side conditions. Comparison of price responsiveness across industries in the UK demonstrates that the extent of product market competition is an important determinant of the speed of price adjustment. A model of the UK supply side is also described, modelling employment, price, wage and output determination in each of 38 industrial sectors plus their interactions. The model provides insights on the theoretical debate on supply side behaviour, and, through simulation methods, shows the importance of inter-sectoral feedbacks in the determination of the speed and direction of adjustment in wages and prices in the face of shocks. In particular, the simulations emphasise the role of expectation formation in supply side adjustment, illustrate the presence of unemployment hysteresis, and highlight the structural implications of wage and price rigidities.

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CHAPTER 1

The Scope of the Investigation

One of the remarkable features of the past decade has been the very rapid rise in unemployment throughout the industrial world. This increase has been especially marked for the countries of the European Community, with the United Kingdom finding itself among those that have been particularly badly affected. The emergence of widespread unemployment in the UK and elsewhere, has, in turn, excited considerable interest among economists as to the causes of the problem, and a great deal of research effort has been devoted to a study of the functioning of labour markets and the supply side in general.

Much of this research built on the debate of the 1970's on the effectiveness of government policy in influencing real events. This debate caused a shift in emphasis in many European governments' economic programmes away from direct intervention in the economy and towards liberalisation of market mechanisms. In the UK this shift in emphasis meant that the defeat of inflation was given priority over other policy objectives, while the government advocated, and remains strongly committed to, policies designed to facilitate the free adjustment of the labour market in order to reduce the problem of unemployment. Although unemployment rates in the UK fell towards the end of the 1980's, after almost a decade in which unemployment has been in excess of two million, it is clear that the process of free market adjustment is at best a slow one. Moreover, this process has turned out to be rather more complicated than might have been thought in the mid-1970's. Despite high levels of unemployment, the UK experienced a strong rate of growth in real wages during the 1980's, so that fears of inflationary pressure in the labour market continue to be expressed in the arguments against expansionary economic policies. The coexistence of high unemployment and strong real wage growth represents a scenario which simply was not envisaged in the policy prescriptions of the mid-1970's, and the search for an explanation of this phenomenon has become one of the key areas of research among economists in recent years.

The work presented in this thesis provides some empirical evidence on the process of adjustment in the supply side of the economy, aiming to develop further some of the insights that have been made recently in this field of research. More specifically, the work focusses on the advances made in our understanding of the institutions involved in wage and price determination, and the explanations these provide for less-than-instantaneous adjustment of wages and prices to changes in their determinants. These advances are investigated empirically using data available for the UK, providing insights on the extent to which governments may be able to influence the causes of inertia, and to moderate its consequences in the UK.

It should be stated at the outset of the thesis that "inertia" is a phenomenon which is only ambiguously defined. Clearly, inertia in a variable cannot be identified if there is no change in the circumstances determining the size of the variable. A useful working definition of the concept might therefore be *a lack of responsiveness of a variable in the face of changes which would warrant a response.* So, for example, while the concepts of inflation and price level inertia are clearly related, they are quite distinct: the price level could increase at 5%, 10%, or 20% per annum with no price inertia if there is a one-to-one correspondence between prices and some other variable also growing at 5%, 10% or 20% per annum. Inertia would exist if the one-to-one correspondence were to break down over some period so that the price level response is less than that warranted by changes in the influential variable. Of course, this means that any definition or measure of inertia requires as a base some model (either theoretical or empirical) of the process determining the "warranted" level, and the definition or measure cannot be seen independently of the model. Similar comments apply to the related idea of "rigidities", although a distinction can be made between the two concepts in terms of the time span involved in adjustment: the presence of a "rigidity" implies that a warranted response may never occur, while "inertia" implies that the response will take place, but with a delay. (In fact, inertia can be thought of as a particular class of rigidity in which the speed of adjustment is emphasised. Given that this is question of emphasis, however, the two terms can be used interchangeably in many circumstances). In this work, I shall consider a variety of means of measuring and defining the extent of inertia and rigidities in prices and wages, and on each occasion I shall make explicit the model underlying the analysis. However, while the models chosen for this purpose will be as general as is possible, and have been supported both theoretically and empirically in the literature, it is recognised that alternative theories or econometric specifications may suggest alternative measures and definitions to those employed here.

The labour market models underlying the macroeconomic debates of the 1970's and before were highly stylised, generally based on a one-good economy with instantaneous price adjustment. It is this latter assumption which I shall primarily wish to investigate, looking at the causes of less than instantaneous adjustment in prices and nominal wages, and the macroeconomic implications of any inertias or rigidities that are found. However, such an investigation will also need to consider the possibility of many sectors since the interactions and interdependencies between different sectors of the economy will clearly play an important part in determining the responsiveness of the economy as a whole to any exogenous shocks. Throughout the thesis, therefore, I shall emphasise the importance of disaggregation in looking at supply side adjustments, and the empirical work will make use of data available at the industrial level. Working at this level of disaggregation means that we are closer to the level at which decisions are actually made, so that it may be possible to capture aspects of labour market behaviour which are lost in a more aggregated study. Moreover, this level of disaggregation allows a comprehensive coverage of the whole economy, so that I can undertake to study the interactions between sectors.

The choice to work with disaggregated data illustrates a belief that inertia and rigidity may be generated in a number of stages. As we shall see in the next section, the justifications for inertia and rigidity are generally presented at the level of the decision-maker, based around particular views of the wage-setting, pricing and employment decision of the individual firm. So, for example, it might be argued that there are adjustment costs incurred by the firm in changing nominal wages or prices which directly inhibit their flexibility. However, in this work it is recognised that beyond these influences, there may be information lags and uncertainties generated by the inter-play between sectors which also result in less-than-instantaneous adjustment. Further, inflexibilities generated in these ways in any one sector could have cumulative effects on the economy as a whole as price responses are passed along the production chain, and as agents look to wage settlements outside their sector in deciding on their own wage claims. The structure of the thesis reflects this view of the build-up of inertia and rigidity, with the first chapters concentrating on the inflexibilities generated at the individual level, and the later work taking up the possibility of interactions between sectors.

Specifically, the thesis continues in the next chapter with a review of the literature in this area, discussing in more detail the macroeconomic debate on the consequences of inertia, and considering in turn the possible sources of inertia in prices, in nominal wages, and in real wages. Much of this discussion focusses on the institutional framework of the supply side; for example, we look at the internal organisation of the parties to wage negotiations, at the wage bargaining framework, and at the structure of product markets in order to provide an explanation for inflexibilities in wage and price setting. We also consider in this chapter the significance of allowing for more than one sector for our understanding of (nominal) wage and price inertia, and illustrate this through an algebraic model of wage setting in a two sector economy. Although highly stylised, this algebraic model captures some important features of a multisectoral model with less-than-instantaneous adjustment in prices, and provides a useful focus for many of the ideas that are subsequentlty investigated. In particular, the model illustrates some of the arguments for government activism, both directly through the manipulation of wage- and price-setting procedures, and indirectly, in the area of demand management.

Chapters Three and Four exclusively consider nominal wage inertia, providing empirical evidence on the extent and causes of the phenomenon in the UK. Both chapters focus on the fact that in reality wages are re-set at discrete intervals, and explore the possibility of modelling this fact through 'renegotiation probabilities' which may be less than one in any period. This method of modelling inertia is precisely that incorporated in the algebraic model in Chapter Two, and in so far as the empirical work of chapters Three and Four provides evidence to support the method, this gives an additional resonance to the properties of the algegraic model, and the policy prescriptions suggested by it.

Chapter Five broadens the discussion by presenting a comprehensive model of the supply side of the UK economy based around 38 industrial sectors. This model aims to examine the process of wage and price formation in a general macroeconomic context, and is able to investigate the possibility of there being different degrees of inertia in different sectors of the economy. In so doing, the model provides evidence on the empirical reasonableness of various theoretical views of wage and price formation and the explanations of rigidities that are associated with them.

Chapters Six and Seven take up the results of the disaggregated supply side model and makes use of the industrial dimension to investigate the causes and consequences of rigidities in prices and wages. In the analysis of Chapter Six, estimated price equations are used to obtain measures of price inertia in the different industries. These are then incorporated in further statistical analysis in an attempt to identify the industrial characteristics associated with price inertia. In the analysis of Chapter Seven, the entire model estimated in Chapter Five is employed in simulation exercises in an attempt to identify the interactions between industries that are important in affecting the time paths, and speed of adjustment, of prices and wages to an exogenous shock. More specifically, three simulation experiments are considered in this chapter: in the first, the highly complex nature of intersectoral interactions are elaborated, with particular emphasis placed on the formation in each industry of expectations of wage and price movements taking place elsewhere in the economy; in the second, attention concentrates on the (lack of) responsiveness of wages and prices to unemployment rates, and considers what is meant by a 'Natural' rate of unemployment in the context of a multisectoral dynamic model of the type estimated in Chapter Five; and in the third simulation experiment, we consider some of the structural implications of wage and price rigidities, noting the usefulness of a coordinated industrial strategy on pay and employment, and the difficulties involved in constructing such a policy in the face of wage and price rigidities.

Finally, in Chapter Eight, we draw together some of the conclusions derived from the preceding chapters, focussing in particular on the implications of the analysis for government policy.

CHAPTER 2

A Review of the Literature

In this chapter I will review some of the work carried out in the study of rigidities in the pricing and wage-setting processes, and in particular I will discuss some of the proposed explanations for the existence of these rigidities and the problems that these create in the functioning of the macroeconomy. For this, I will consider in turn the nature and causes of price inertia, of inertia in nominal wages, and of real wage rigidities. Finally, I will note how the existence of more than one sector has been accommodated into this work, and discuss the implications that this has for econometric analysis, and for the design of macroeconomic policy. However, in order to elaborate on the significance of nominal and real rigidities, and to put these studies into context, I first briefly note some of the recent developments in macroeconomic debate in which the issue of wage and price rigidities have played a role.

2.1 The macroeconomic background

The macroeconomic significance of rigidities

The experience of accelerating inflation alongside rising unemployment in the late 1960's began a round of debate which profoundly influenced the way in which economists thought about the labour market. The Phillips curve, which had formed the basis for analysis upto that time, had been seen to break down, so that new concepts were explored in an attempt to find theories of the labour market which could accommodate the experience of stagflation. In these efforts, Friedman's (1968) presidential address to the AEA was particularly influential, and raised many of the ideas which occupy labour economists today. The 'Natural Rate Hypothesis' (NRH)[1] set out in the paper became widely accepted as a reasonable description of the functioning of the labour market, at least in the long run, and the important themes of this description were quickly recognised and became the centre-piece of macroeconomic debate in the 1970's. In particular, questions on how agents form their expectations, on the information that is available to them, and on the extent to which markets are able to clear in each period were widely debated.

The policy implications of Friedman's view of the labour market were made most strongly in a series of papers by Lucas (1975), Sargent and Wallace (1975,1976), (LSW), and Barro (1976) in which it is further assumed that expectations are formed "rationally", in the sense of Muth (1961). This assumption has the result that Friedman's long run view comes to pass immediately: with agents forming expectations rationally, systematic government policy becomes ineffective even in the short run as agents, knowing the government's policy rules and the structure of the economy, react to offset the effects of such policy as soon as it is conceived. Since (only) unanticipated policy can influence real magnitudes in these circumstances, these commentators argued in favour of constant "x%" money growth rate rules on the grounds that this would reduce uncertainty and any undesirable variability around the economy's natural level of activity and employment.

Some empirical support was provided for these arguments, first by Lucas (1973) and then by Barro (1977,1978) for the US, and by Attfield, Demery and Duck (1981a, 1981b) for the UK.(2) These arguments did not go unchallenged, however, as policy-activists looked for theoretic and empirical evidence to counter the LSW policy prescriptions.(3) Perhaps the most convincing argument against the LSW models was that which challenged the assumption that prices adjust to clear markets at every point in time. Early papers on the importance of nominal wage and price rigidities in the functioning of the supply side have developed into a more complete research programme in which the microfoundations of wage and price setting decisions have been considered, and the "policy-is-ineffective" proposition attacked from this base (see, for example the recent survey article by Rotemberg (1987)). In particular, it has been noted that the dynamic effects of policy-induced aggregate demand shifts on output are influenced both by nominal wage and price rigidities, and by the responsiveness of wage and price setting to output change. Blanchard (1988) provides the following simple illustrative model to make the point:

$$p = \mu p(-1) + (1-\mu)w + \alpha y \tag{2.1}$$

$$w = \eta w(-1) + (1-\eta)p + \beta y \tag{2.2}$$

$$y = m - p \tag{2.3}$$

Variable are in logarithms, with y, p, w, and m representing output, prices, nominal wages, and nominal money supply respectively. The price equation at (2.1) gives the price level as a function of its own lagged value, of wages, and of output. The wage equation is expressed similarly at (2.2), while (2.3) gives aggregate demand as a simple function of real money balances. In this model, nominal inertia in prices and wages are represented by (non-zero) values for μ and η respectively. Parameters α and β capture the responsiveness of price setters and wage setters to demand, and represent in Blanchard's term "real" rigidities. Hence, a low value for α implies that the markup of prices over wages remains unchanged over the cycle, while a low value for β means that real wages are unresponsive to demand change.

Clearly, in the absence of any nominal inertia ($\mu = \eta = 0$), prices, nominal wages, and money supply move in parallel, and money supply manipulation leaves output unaffected. More generally, however, the speed of adjustment of nominal wages and prices to a change in the money supply depends (negatively) on μ and η, while such effects are compounded by high values for α and β.(4) So long as prices lag behind the money supply, output in this model is expanded through the real balance effect. As Blanchard points out, standard neoclassical assumptions assert that μ and η are both zero, while α and β would be positive and large. One element of the policy activist's research programme can therefore be viewed as providing evidence and theoretical support for non-zero values for μ and η, and for low values of α and β.

The earliest papers in this line of attack concentrated primarily on nominal inertia. Papers by Phelps and Taylor (1977), Fischer (1977), Taylor (1980), Canzoneri (1980), Buiter and Jewitt (1981), Rotemberg (1982), and Parkin (1986), among others, have each questioned the assumption of nominal flexibility, and demonstrated how the introduction of nominal wage/price inertia can generate a path through which government policy can influence real magnitudes. A variety of justifications for the existence of inertia in these models have been put forward. In some, inertia is simply imposed on the grounds of the observed real-world phenomenon of multi-period, staggered contracts, while in others the frequency of wage or price change is endogenously determined within the model, deriving inertia from (unspecified) costs of adjustment. In the models, the effectiveness of policy is established on the basis of two complementary elements. On the one hand, there is an "information-based" argument, put forward in the Phelps and Taylor paper for example, in which prices and wages are sticky in the sense of being predetermined from period to period. In this paper, it is assumed that firms set their prices one period in advance of the period over which they will apply, on the grounds that "there are disadvantages in too-frequent or too-precipitate revisions of price lists or wage schedules" (op.cit., p166). In this case, the government has an information advantage over individuals, and is able to use its broader information set to react to disturbances as they arise, thereby reducing fluctuations of output around its normal level. The second strand to the inertia argument is based on the presence of long-term contracts, as in the Fischer paper for example. Here, although workers are aware that the government will be able to respond to news every period, they enter contracts which limit their own responsiveness over a number of periods. Here there is no asymmetry in the availability of information between workers and government, but again, the extra flexibility in response to change provides government policy with its potency.

Empirical evidence on the importance of allowing for slow adjustment has also been presented. Leiderman (1980) and Mishkin (1982a,b) both provide methodologies which can be used to test the two component hypotheses of the LSW models, i.e. the Natural Rate Hypothesis and the Rational Expectations Hypothesis, jointly and separately to find the contribution each makes to the joint result. Both Leiderman and Mishkin (1982a) take Barro's (1977) analysis as a base, but while the former finds that both the components are jointly and separately supported by the data, Mishkin finds that the joint hypothesis fails to hold, with there being little contribution to this rejection from the rationality constraints. The major difference between the two studies is in the choice of lag length, Leiderman choosing to enter money growth into the unemployment equation lagged upto five quarters, following Barro's work, while Mishkin finds that coefficients on lags as far back as twenty quarters make a significant contribution and are therefore included. Mishkin's results not only provides encouragement for those interventionists who accept rational expectations as a reasonable assumption, but also highlights the length of time over which any policy may take effect, raising doubts on the empirical validity of the assumption of instantaneous market adjustment made in the LSW models.

Gordon (1982a) and Demery (1984) provide further empirical evidence on the importance of price inertia in the macroeconomic debate, estimating for the US and UK respectively a model which allows for the long run neutrality of money, as expressed in the NRH, but which also accommodates a gradual adjustment of prices (GAP). The empirical work involved the two-stage procedure developed in the Barro papers, obtaining explicit estimates of the anticipated and unanticipated components of nominal income growth and then using these in a second regression analysis, this time explaining deviations of output from its normal level. The relationship that is estimated in the Gordon paper in this second stage includes a series of lagged price terms in addition to the standard LSW explanatory variables, so that the NRH-GAP model encompasses the instantaneous-adjustment model. Analysis not only shows that these lagged price terms contribute to the estimated fit, so that the inclusion of a GAP process provides a statistically superior model, but also demonstrates that both unanticipated and anticipated nominal income growth influence output significantly when these terms are included.

However, despite the literature documenting the theoretical implications of nominal wage and price inertia, and the empirical evidence given to establish its practical relevance, there has been, and remains, an aversion to the incorporation of wage/price stickiness into macromodels by some economists. This aversion is often justified on the grounds that if nominal inertia causes significant real costs, then agents would have the incentive to reset wages and prices more frequently to eliminate the inertia and the associated costs (the "Barro critique"). Despite the widespread acceptance of the fact that wages and prices do not adjust instantaneously, there still remained a need for interventionists to establish theoretic explanations for the existence of nominal price and wage stickiness. In sections 2.2 and 2.3, I turn to some of the attempts that have been made in the literature to establish such explanations.

The role of wage-setting institutions

The second front on which policy activists have progressed in the debate on the effectiveness of government policy is through the analysis of the causes of **real** rigidities that may exist in pricing and wage setting behaviour. Theoretic explanations for a lack of responsiveness in the markup of prices over wages and in wage level determination for a given price in the face of output fluctuations provide further support for the contention that policy can have significant real effects (these relate to low values of α and β in the Blanchard illustration above). The literature in this area has also developed rapidly in recent years, especially on the explanations for real rigidities in wage setting (low β).(5)

Much of this interest developed through the seventies as economists searched for an explanation for the observed fact that, following the oil shocks, some economies suffered more in terms of higher unemployment and higher inflation than others. Attention focussed on the flexibility of the labour markets, and the differences that exist between the supply-side institutions of the different countries. In this way, economists hoped to identify the means by which the consequences of recession were incorporated into decisions in some countries to ensure supply side adjustment could take place relatively painlessly. A good example of this approach is provided by Gordon (1982b, 1983) in which a comparison of the macroeconomic performance of Britain, Japan, and the US is made in the light of the historical development and institutions of the countries. This comparison emphasises the dual role of wage setting in the achievement of macroeconomic efficiency and the resolution of conflict over income shares; while highly responsive wages are conducive to efficiency, they can also result in high negotiation and strike costs. A variety of sociological and historical differences are presented to explain the differing extents to which one of these objectives is subordinated to the other in the three countries. It is argued that the greater degree of equality, the tradition of hierarchical social relations, the homogeneity of the workforce, and the degree of integration of economic and social life has enabled Japan to develop institutions geared to efficiency rather than the resolution of disputes, in contrast to Britain and the US. Gordon also considers the development of unionism to be important; the gradual formation of many small craft unions in the UK contrasts with the US experience in which intensive unionisation (after the 1935 Wagner Act) generated large industrial unions in key industries. Gordon argues that this process has contributed to higher perceived costs of negotiation in the US and the development of three-year contracts, resulting in slower wage adjustment in the US than either Japan or Britain.

Similar themes are to be found in Flanagan, Soskice, and Ullman (1983), McCallum (1983), Bruno and Sachs (1985), Newell and Symons (1986), Bean, Layard and Nickell (1986), Calmfors and Driffill (1988) and in Freeman (1988). In these, it is argued that the institutional setting of wage negotiations can magnify or dissipate the conflict caused by the pursuit of different objectives by different groups. In turn, this will influence the structure and the intensity of bargaining experienced across the economies, and this feeds through to their overall economic performance. From these studies, it is also clear that it is the inter-relations between different institutions within each economy which are important in determining the macroeconomic performance of the countries. For example, while strong labour organisations are frequently cited as a contributory factor in the relative economic success of Austria and West Germany, economies such as the Netherlands and the UK performed less well despite the existence of strong unions in these countries also. In fact, it is the interaction of this strength with employers' power, the degree of centralisation, the extent of political and social consensus, and so on, which has resulted in the diversity in the economies' achievements. Clearly then, labour market institutions which contribute to the successful macroeconomic performance of one country may not be helpful if exported in isolation to another. However, the literature does serve to focus attention on aspects of the labour market which contribute to real rigidities, and may suggest areas in which governments can improve the resilience of the economy to shocks, through the establishment of formal or informal lines of communication, through labour relations legislation, and so on.

In section 2.4 below, I review some of the recent work on wage setting, concentrating on union-based models of the labour market since these seem particularly pertinent to the UK. These models have been used in the literature to illustrate a number of potential sources for real rigidities in the UK, and these are also described. Section 2.5 then turns attention to the issue of disaggregation and notes the impact of decentralisation in wage and price setting decisions on nominal rigidity. The related issue of expectations and inter-sectoral communication is also addressed in this section, while the significance of corporatism and the coordination of decisions is discussed once more in the concluding comments of section 2.6. Together, the literature in these areas provide a useful insight into the features and institutions of the labour market which might generate real inflexibilities in the UK, and perhaps suggest a combination of supply side policies which would help to eliminate them. First however, in the following two sections, I return attention to the causes of nominal inertia in prices and then in wages.

2.2 On the nature and causes of price inertia

As mentioned above, many of the macroeconomic analyses carried out involving nominal inertia have simply imposed the phenomenon on the grounds that empirically agents are not observed resetting prices or renegotiating wages at every instant. In others, the inertia is derived endogenously, assuming there to be costs involved in adjusting prices. In this section, I consider in more detail the possible sources of price inertia suggested in the literature. To begin, I shall look at the inertia generated by adjustment costs, noting how these might affect price responsiveness and the possible sources of such costs. Next, I shall turn to some alternative sources of price inertia not based around adjustment costs. In each case, I shall comment on the extent to which governments can influence inertia generated in these ways.

Modelling firms' response to adjustment costs

Barro (1972), and Sheshinski and Weiss (1977) (BSW) provide clear illustrations as to how adjustment costs (of whatever source) make instantaneous adjustment of prices sub-optimal and reduce responsiveness. In the Barro paper, price adjustments, of whatever size, incur a lump-sum cost, perhaps corresponding to the simplest notion of adjustment costs in which there is a fixed administrative cost in changing price lists and catalogues, informing dealers, etc. Assuming that the firm adopts the strategy of adjusting prices when demand achieves chosen "ceiling" or "floor" levels (termed the "(s,S) rule"), Barro demonstrates that, in the face of random demand shocks, the expected value of price change is proportional to any shock, with the coefficient of proportionality (inversely) related to the size of the adjustment cost. Sheshinski and Weiss extend these ideas to the case where there is general price inflation which is fully anticipated. In this paper, the firm chooses both the timing of price change and the price level through the maximisation of an objective function involving the (discounted) stream of future real profits. Real profits are themselves dependent on the price of the firm's output relative to the aggregate price level (which rises according to the known constant rate of inflation), and on a fixed (real) lump sum cost of adjustment incurred whenever prices are altered. The optimal strategy for the firm in these circumstances is again of the "(s,S)" variety, with the firm raising the real price to S whenever it falls to the floor of s. Given that the general price level is rising at a constant rate, price adjustment occurs at regular but discrete intervals, following finite periods during which price is held constant. Again the size of the adjustment cost is shown to be (inversely) related to the frequency of price adjustment, while changes in the rate of inflation are seen to have an ambiguous effect on the frequency. (An example is provided to illustrate how higher levels of inflation can be associated with reduced price adjustment, although it is noted that a positive association, which is perhaps more intuitively reasonable, might be more likely in practice).(6) As we shall see in Chapter 4 (section 4.2), the optimality of the (s,S) rules for price adjustment can also be established in a stochastic framework; see, for example, Sheshinski amd Weiss (1982) or Danziger (1984). Although the mathematics of the analysis become more complicated in these circumstances, this generalisation provides the model with more practical relevence. Indeed, it is precisely this model which underlies the empirical analysis of nominal wage adjustments in chapter 4.

The assumption of lump-sum adjustment costs is realistic in the sense that their presence can explain the discrete jumps in prices (and wages) that are seen to occur in practice. However, some economists may prefer to incorporate adjustment costs in a more tractable way through the use of a quadratic cost function. Here, a firm is penalised by both deviations of actual levels from target levels, and by rapid adjustment. The popularity of this form is based on the fact that, although the desirable property of discrete price movements is lost, the standard Partial Adjustment Mechanism (PAM) can be derived from this base. In this, the size of the influence of the (one) lagged dependent variable (ldv) will depend on the cost of adjustment relative to the cost of being out of equilibrium.(7) Pagan (1985) provides an interesting review of the usefulness of the PAM, and in particular considers the relevance of the ordinary (one ldv) PAM when the target variable itself exhibits growth. Working from an alternative quadratic cost function in which adjustment of the control variable is penalised when it deviates from a given rate of growth, Pagan argues that the ordinary PAM will often need to be augmented by a term reflecting this trend growth, and goes on to consider various options for doing this. As an illustration, it might be argued that an industry which experiences frequent price change might set up institutions which facilitate these changes, so that costs of adjustment will be incurred only when extraordinary price adjustments have to be made. If we imagine that mechanisms are installed progressively to keep adjustment costs low as increasingly larger shocks are experienced (in times of rising inflation, say), then it might be sensible to model the rate of price change over which costs are incurred as that which was experienced last period. In this case, the cost of adjustment, C, are given by

$$C = a(p_t-p_t^*)^2 + b(p_t-p_{t-1}-g_t)^2$$

where p_t^* is the target level of the control variable, p_t, and g_t = trend growth = $(p_{t-1}-p_{t-2})$. Minimising C with respect to p_t gives

$$p_t = (a/(a+b)).p_t^* + (2b/(a+b)).p_{t-1} - (b/(a+b)).p_{t-2}$$

Here it is clear that the relative size of the adjustment costs (given by b/(a+b)) is still important in determining the extent of inertia, but that a second ldv must also be included to capture the complete dynamics of adjustment. This follows from firms' recognition that they can set up institutions to reduce the cost of successive price adjustments, and therefore shift the burden of adjustment to earlier periods. This shift introduces a cyclical element to the time-path of prices which would be picked up only with two lagged dependent variables in applied work. In the empirical work of chapter 6, we use the size of the estimated coefficients of price equations estimated for 39 industries to obtain measures of price inertia in those industries in exactly this way. As the discussion above indicates, although the PAM approach to modelling costs and dynamics can be justified at the level of the firm through the firm's desire to minimise quadratic adjustment costs, its main advantage is in its tractability. Moreover, when working with more aggregated data, this approach seems more reasonable than the (s,S) approach, which perhaps models the decision making of an individual firm more realistically. Certainly the PAM approach provides a very reasonable interpretation of the coefficients which can be obtained in industrial analysis, however, and it is for this reason that it is employed in the analysis of industrial price inertia in chapter 6.

These papers not only provide a rationale for less-than-instantaneous price adjustment, then, but also suggest that complicated dynamic time-paths can be generated by these costs, according to the (algebraic) form in which costs are incurred.(8) Moreover, the extent to which these costs are firm- or industry-specific may provide a possible justification for desynchronisation of price-setting (giving a justification for staggered price- or wage-setting, as in the wage contract papers noted earlier). To understand which of these algebraic forms is most likely to be true in the real-world, and whether costs are predominantly sector-specific, it is clearly necessary to know the source of the adjustment costs, and it is to this that I now turn.

The source of price adjustment costs

The idea that price rigidities can adversely influence macroeconomic performance is not original to the "policy-effectiveness" debate of the 1970's. The discussion on the importance of "administered" prices, associated with the US economist Gardiner Means, centered around exactly the same argument applied to the recession of the 1930's. The precise nature of "administered" prices has been only ambiguously defined, although they have frequently been contrasted with prices determined by the forces of supply and demand, so that administered pricing has been generally linked with less than perfect competition, and specifically oligopoly, in the product market.

This possible link between price responsiveness and the degree of market power enjoyed by price-setters has been widely discussed, although the form of this relationship remains to be fully explored. So, for example, Okun's (1981) description of the administered price hypothesis explains price unresponsiveness in terms of an informational system among oligopolists that allows them to engage in tacit collusion. Here, competitors want to maintain some degree of profitability over the pure-competition level, and make an implicit agreement not to react to demand change with price responses. The more competitors that there are in a market, the more likely this arrangement is to break down, so that under this description we expect there to be a positive relation between market power and price inertia. Domberger (1983), on the other hand, considers the degree of inertia to be dictated by the costs of being in disequilibrium set against the costs of price change (as described above to obtain a (one ldv) PAM). He argues that the most important element of the adjustment costs is the subjective evaluation made by the firm of the consequences of adjusting its price, and that this element will be lower for firms operating in highly-concentrated industries than those competing against many rivals. The idea here is that firms in highly-concentrated industries are likely to enjoy higher profitability,and that such industries are therefore more likely to exhibit price-leadership than more fragmented ones. Equally, firms in tightly oligopolistic industries will be better able to inform competitors of their pricing policies by means of pre-notification schemes and press announcements. These characteristics of oligopolistic industry represent institutionalised modes of behaviour which reduce the subjective costs of price adjustment to the firms in that industry because of the ease of disseminating information on prices, and the associated reduction in uncertainty. Hence Domberger suggests that price response might be expected to be more rapid in highly-concentrated industry than in industries with many competitors.

In fact, Domberger (1979) provides some empirical support for his view of the way in which industrial concentration effects price responsiveness in an investigation of pricing in twenty-one manufacturing sectors of the UK economy. In this study, price equations containing one lagged dependent variable are estimated for each of the sectors, and the estimated coefficient on the lagged dependent variable used as a measure of price inertia in that sector. A second regression analysis is then undertaken to investigate the association between price inertia and the level of industrial concentration in these sectors, and a significantly negative relation between these factors is identified. Some discussion on the appropriate econometric methodology to be employed in a two-stage analysis of this kind followed in Winters (1981) and Domberger (1981), but the main conclusion of the study was upheld, thereby confirming Domberger's view of the (positive) impact of concentration on price responsiveness. It is noted that Mean's advice to the US government to implement strong anti-trust legislation in order to increase the responsiveness of prices would, according to Domberger's results, have had quite the opposite effect.

While the administered price hypothesis, and the associated link between market power and price inertia, have been historically important, the contribution of Okun (1981) has probably been most influential in raising the question of the determinants of price inertia at the microeconomic level in recent years. In this book, many price-setting practices, observed in the real-world but often abstracted in economic theorising, are explicitly noted, and a theory of price-setting put forward to accommodate them. For example, Okun explicitly notes the effects of the firm's internal structure on the price-setting decision, recognising that many of the elements involved in this process are simplified and mechanised so that they can be "monitored and enforced by top executives and taught and delegated to subordinates" (p. 170). These considerations are used to explain a variety of observed behaviours, such as the use of backward-looking information in the construction of cost measures or the use of a "normal cost" yardstick, which appear anomalous in models which do not take Okun's more global view as "pricing as the product of an information system". More importantly here, this view also provides insights into the causes of price unresponsiveness. In the market, Okun's view emphasises the extent of heterogeneity in goods and services, and notes the complex nature of the purchase of many goods, often involving a variety of delivery, repair, and other post-sale servicing arrangements. Okun notes that there are some commodities that are traded in markets which can be subjected to "standard" economic analysis: goods for which there are many buyers and sellers, which are homogeneous or easily-gradable, and which can be stored at low cost are frequently traded in "auction" markets in which agents take the price set by a market-clearing auctioneer. But much more prevalent are goods whose prices are set by the seller, and which are sold to the buyer after some sort of shopping process. In these "customer" markets, the heterogeneity of products and the costs incurred by the buyer become most important, so that some means of reducing search and information costs will be introduced. Okun argues that, in a situation where many purchases are likely to be repeated subsequently, firms will have an incentive to keep prices unchanged, even in the face of variations in demand, in order to encourage repeat customers. The high search and information costs involved in shopping, and the information obtained from previous purchases, mean that repeat purchasers are likely to have a discontinuous elasticity of demand for a firm's product, so that firms will rationally maintain price levels in the face of demand change. Moreover, by pledging continuity of an offer, sellers encourage buyers to become more reliant on the information contained in previous purchases. Through this reliance, repeat shoppers become more common and sales become more predictable, thereby reducing difficulties in production

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scheduling and minimising inventory costs for the firm. Such a view of the sale and purchase of products provides a rational for a variety of observed behaviour in which firms simply attempt to convince consumers of their dependability and reliability. Examples of such behaviour include the widespread use of after-sales service arrangements, fixed-time price scheduling, pre-notification of price change, commitments to "match" competitors prices, and the setting of prices as a mark-up over costs. Moreover, this view suggests that the prevalence of price unresponsiveness is widespread, and generated by the very process of shopping for goods. This means of course that there is little scope for government intervention for its reduction.

Alternative causes of price inertia

The ideas suggested in the paragraphs above provide an explanation for rigidities in a wide range of industries based on realistically-described adjustment costs, but explanations also exist which are not based on these costs. These explanations can be grouped into three broad categories, all of which call on the fact that output is not homogeneous and is produced by many uncoordinated units. The first group of explanations takes up this fact to note that individual firms' decisions are made against a background determined by an aggregation of outcomes of other firms' decisions. These feedbacks constitute what many economists would consider the effects of disaggregation, and the inertias generated in this way are considered in section 2.5. The second group of explanations is closely related to the first, but concentrates on the **uncertainty** associated with disaggregation, while the third group emphasises the interrelations that exist between firms in the **process of production** and the inertia that results from here. I elaborate on the latter two groups in the paragraphs below.

The importance of uncertainty in price inertia is well described in Gordon (1982, 1983). Here it is noted that, in an economy with many heterogeneous products, there may be difficulties simply in interpreting economic "news". The heterogeneity of products, and the resultant multiplicity of markets, means that information on any shocks will be imperfect. An individual firm will be unable to perfectly distinguish between aggregate and local shocks, but will have some information available to them in the form of changes in input prices and changes in the demand for its output. Gordon demonstrates, using an analysis similar to that of Lucas (1973), that in such a situation the responsiveness of a monopolist to any observed demand shift will depend on the ratio of the variance of past local demand shifts to the sum of the variances of past local and aggregate demand shifts, and on the equivalent ratio for cost shifts. This argument emphasises the ease with which information can be extracted from observable shocks and incorporated into pricing decisions when there is uncertainty; relatively high uncertainty will be associated with relatively sluggish price adjustment. Similar arguments are found in Nishimura (1986) where the problem of incomplete information is compounded in a monopolistically competitive market, where "erroneous" price responses are further penalised by a loss of demand to competitors. Here, it is shown that prices will become more unresponsive as the elasticity of demand becomes more elastic. Gordon argues that this source of inertia complements that suggested by Okun, providing an explanation for the existence of different degrees of inertia at different times for the same economic agents. Hence, the price responsiveness of firms in Israel or in various Latin American economies has been seen to rise rapidly during recent experiences of hyperinflation, and this Gordon explains with the idea that firms increasingly interpret observed nominal demand increases as the result of economy-wide shocks.

Clearly related to the difficulties involved in interpreting "news" are the difficulties involved in planning production to meet uncertain future demand. On this issue, Blinder (1982) recognises the importance of inventories as another possible source of price inertia. Here it is noted that when output can be stored, firms make a joint decision on how much to produce for inventories, and how much to sell out of inventories. In these circumstances, a negative sales shock can be met partly by reduced production and partly by accumulating stocks; prices will remain unchanged according to the extent to which output is storable, and to which the shock is expected to be only transitory.

Another group of explanations for price inertia which are not reliant on costs of adjustment involves the interaction between firms in the production process. So, for example, Gordon (1981) also comments on the possible influence on price responsiveness of an industry's position in the chain of production. In this he argues that the producers of final goods will obtain information relevant to price-setting (eg. expansionary policy) first, and that these will therefore be more responsive than others earlier in the production chain, who learn about events only with a delay as the information filters down the production chain. Equally, those sectors which directly supply goods and services demanded by the government sector might be expected to respond most quickly to government policy; so, for example, an expansionary fiscal policy aimed at improving the economy's infra-structure might be expected to show first in the price responses of the construction industry. This suggestion is in contrast to that presented in Blanchard (1987) where the price equation of the output of the final stage of a production chain is shown to exhibit considerable inertia, as the individual lags at each stage of the process accumulate. As an illustration, Blanchard considers a process where the price of output from each stage of production is related to the current and lagged price of output from the last stage. In this set-up, although adjustment is complete within two periods in any single step of the chain, the price of final output will depend on the cost of inputs to the first stage from many periods previous, with the mean lag linearly dependent on the number of links in the production chain. These suggestions do not provide an explanation for the original source of the inertia (introduced through the lag term), although if the period in question lasts just one month, say, then the fact that production takes time may help justify this assumption. However, the paper does make clear the fact that small degrees of inertia generated by the individual decision-maker can result in significant and long lags in adjustment in the economy as a whole.

Similar conclusions are derived in a related model in Blanchard (1982). Here, prices from each stage of production are dependent on the current price of output from the previous stage. However, it is also assumed that all prices are fixed for two period, with firms in alternate links in the production chain resetting prices at the same time (i.e. firms at stages 1, 3, 5,... reset prices at time t+1, t+3, t+5,..., while firms at stages 2, 4, 6,... reset at t+2, t+4, t+6,...). Inertia here is imposed on the model through this mechanical structure, although Blanchard argues informally in his (1983) paper that the presence of many sector-specific shocks (relative to the number of aggregate shocks) could justify a structure of this sort in a world such as that described by Sheshinski and Weiss (see earlier). The solution to this model is very similar in form to those to be discussed in section 2.5 below in which firms interact indirectly via economy-wide aggregates rather than directly through the provision of intermediate inputs as here. This solution shows that in these circumstances even small departures from perfect synchronisation can generate substantial price level inertia. Further, given the timing decisions of others, no agent has an incentive to change his own timing decisions. In this sense then, the mechanical desynchronised structure imposed on the model is a stable one, and the conclusions reached are therefore more robust.

These explanations of price unresponsiveness are again based very much on the characteristics of the production and of the selling process. Like the earlier justifications for adjustment costs, there seems to be little scope for direct government action to influence the degree of price inertia generated from these sources. Given that price inertia appears to be an economic fact of life then, it is natural to ask whether governments can influence nominal inertia through wages? It is to the sources of this type of inertia, and to the answer to this question, that I now turn.

2.3 On the nature and causes of nominal wage inertia

In many ways the following discussion on the causes of nominal wage inertia mirrors that of the previous section and many of the arguments related to price level inertia are applicable here too. So, for example, I begin this section with a brief description of the literature examining the process of wage bargaining and the costs involved in adjusting nominal wage levels. This is followed by a comment on the institution of open-ended contracts in which it is argued that the (s,S) framework discussed above is relevent also to nominal wage adjustment. These two subsections raise again the idea of adjustment costs, the former concentrating on lump-sum costs, and the latter emphasising the costs of being out of equilibrium, showing the introductory comments of section 2.2 to be equally valid here. Finally I note the potential impact of uncertainty on wage adjustment as described in the literature on wage indexation, and again parallels with the price adjustment literature can be drawn.

Sources of costs in adjusting nominal wages

To understand the nature of adjustment costs incurred when wages are reset, we need to have some understanding of the process of wage-setting and pay negotiation. Clearly, wage negotiations, whatever the type of bargaining arrangement, will involve the collection of relevant data, the co-ordination of representatives of all the parties to the negotiation, and the general maintenance of a bargaining machinery, all of which will generate costs according to the frequency with which negotiations take place. Further, whenever new settlements are made, the dissemination of the news, the adjustment of the payroll, and the effort expended in implementing the changes will generate additional costs. The resources consumed in the negotiation process, and the administrative costs associated with implementing a new settlement described above are relatively clearly defined. More ambiguous, however, are the issues which relate to the bargaining process itself, and which centre around the fear of, and the expected costs involved in, negotiation breakdown and the possible deterioration of industrial relations incurred through resetting wages.

A basic requirement for a bargaining process to occur is a lack of knowledge on the part of one or both of the parties; perfect knowledge means that both parties will immediately choose their optimum positions, and no bargaining need actually take place at all. Some insights on how economists have attempted to approximate reality in the introduction of imperfections in information collection and processing is given in the literature on strike activity. For example, Turk (1984) recognises two main approaches to the explanation of strikes: the "bargaining approach" and the "institutional approach". In the bargaining approach, associated with Zeuthen (1930), Nash (1950), and Cross (1965, 1969), there is explicit consideration of the bargaining process as agents form wage claims in successive rounds of negotiation according to the (discounted) value of utility over the contract. This utility depends on the size of the eventual settlement, the financial cost of each new round of negotiations, expected concession rates, and the financial cost of a strike to each party. From such a framework, conditions can be derived under which one or both of the parties believe it to be in their interest to call a stoppage, via a strike or a lock-out. These conditions emphasise the importance of differences of opinion between the parties about the variables relevant to the wage bargain, arguing that stoppages will occur more often when the degree of uncertainty about these variables rises. In addition, those variables affecting the size of the bargaining zone and the rate at which each party expects the other to concede will also be influential.

The above approach develops stoppage behaviour from an information structure which treats the parties symmetrically; in contrast the "institutional approach", associated with Ashenfelter and Johnson (1969), works from an information structure which sacrifices symmetry to incorporate features into the theory which its proponents believe to be more realistic. Here, an initial aspiration wage is set down by the rank and file members of the union at the beginning of negotiations, based on a less-than-full information set. Both the union leadership and the management face a full information set, so that both recognise the extent to which the initial aspiration wage diverges from the optimum wage. Of course, the union leadership can try to persuade the rank and file to alter their aspiration wage, but if persuasion fails, then rather than risk a decline in their political appeal and power by signing an agreement at odds with the aspiration wage, the union leadership will incur a strike. The effect of the strike, according to this approach is to lower the rank and file's expectations, a process which will continue until the leadership feels that the aspiration wage has fallen sufficiently close to the optimum, when an agreement can be signed and the strike ended. From the management's point of view, negotiation involves a simple choice at the beginning of the process: accept the initial aspiration wage and avoid a strike, or reject this wage, thereby incurring strike costs, but lowering the eventual wage settlement. Assuming that the management makes this choice according to the principle of profit maximisation, the propensity to strike will be positively related to the gap between the initial aspiration wage and the optimum wage, and to the rate at which rank and file expectations decline, but negatively related to the costs of a strike to the management.

The two descriptions of the bargaining process explained above suggest a wide range of possible influences on the costs of wage setting. So, for example, given the above discussion we might expect the internal characteristics of an industry to influence the financial costs of negotiation and the expected breakdown costs. Features such as the use of payments-by-results, the operation of shift work, the recognition of unions in bargaining, the number of trade unions involved, the use of formal agreements or joint consultative committees in agreements, the existence of a closed shop, and the size of the work unit will all be important, affecting communication between bargaining parties and the size of the bargaining zone.(9)

Factors affecting the union's propensity to strike, through their effect on the union's concession rate during the bargaining process or on the rank and file's initial aspiration wage, for example, might include the availability of job opportunities elsewhere in the economy, as illustrated by the unemployment rate, the level of unemployment benefits, or the level of strike funds (measured, for example, through trade union membership). Despite reservations as to the feasibility of a strategy of leaving a firm to become unemployed (see Binmore, Rubenstein and Wolinskey (1985)), it seems reasonable that high unemployment rates, low levels of benefit, or small strike funds could reduce unions' desires to negotiate.

Also, the extent of recent strike action elsewhere in the economy may affect a union's propensity to strike in any one industry. The "institutional" view of negotiations stressed the importance of political appeal to the union leadership; union officials may not want to be seen as less active than those in other industries, so that during periods of militancy they may be more inclined to respond to differences between the rank and file's aspirations and the optimum wage by calling a strike, rather than by attempting to persuade members to alter their aspirations. The effect that this would have on negotiation frequency is ambiguous, however, because while the leadership may feel that it also ought to be more active in wage negotiations at these times, it may take the attitude that negotiations should be avoided so as not to put itself into the position of having to call a strike to maintain prestige.

The cost of a strike to the employer will be well described by profit levels, so that unions may engage in more negotiations when profit levels are high and the employer is least inclined to incur a strike. In a similar way, we may expect inventories (as a proportion of sales, say) to be influential too, with low inventories raising the cost of a strike to employers, and reducing the expected cost of a strike to unions, while variation in the demand for the industry's output over the year (and indeed in worker's expenditure commitments) will introduce seasonality to negotiation costs.

Finally, the importance of incomes policies in affecting the frequency of wage settlements should be noted. Accommodating the type of incomes policy used in the UK over the last twenty to thirty years within the context of the bargaining process described above is not difficult. The fear of losing government contracts during voluntary "twelve-month", or "freeze" policies, or the direct costs involved in breaking the law during compulsory policies raises the cost of negotiation during periods of policy directly. Perhaps more interesting, however, is the idea put forward in Turk (1984) that "ceiling" incomes policies, insofar as they are successful, may work to reduce the bargaining zone, and thereby reduce expected strike costs, increase negotiation frequency, and improve wage responsiveness. If this is true, it is clear that incomes policy may serve to coordinate wage setting across different sectors of the economy and, to the extent that the success of corporatist economies described in section 2.1 is associated with coordination of wage settlements, this point highlights one of the potential gains to be achieved from an active government policy on incomes. We return to this issue in section 2.5, and subsequently in the empirical work of chapter 4.

Open-ended contracts

The above considerations on wage setting describe the possible sources of lump-sum adjustment costs in negotiations over pay, but equally relevant to the decision to renegotiate are the costs involved in being out of equilibrium. As the conditions under which the previous wage was negotiated change, it is likely that the wage achieved in the negotiations may become increasingly inappropriate. As we saw in the previous section, control theory tells us that in these circumstances, a state-contignet rule should be followed in which the contract expires when relevent variables reach a critical limit (the (s,S) rule). If these relevent variables change stochastically over time, then contract lengths will also be stochastic, and wages will be set in a system of open-ended contracts. Once more we refer to chapter 4 for more details of this framework, but here we note that this approach is well illustrated in a paper by Pencavel (1982). In this, micro-data on the frequency and the size of wage change in the British coal industry from 1948 to 1975, is used in an attempt to first explain the probability that wages will change in any period, and then, given that change occurs, to explain the magnitude of the change. The methodology employed by Pencavel was to estimate the probability of wage change taking place through a Probit equation, and then to insert the reciprocal of the Hill's ratio, obtained from the Probit estimation, into a standard regression of the rate of change of wages on a set on regressors over those periods when wages were negotiated.(10) No theoretical explanation is given over the choice of regressors (namely, the percentage change in retail prices, the unemployment rate, some incomes policy dummies, the percentage change in coal prices, and percentage change in coal output per man shift) except that these represent "the variables most often used to account for wage changes at the aggregate level,..... augmented with two industry-specific variables" (p.151).

In fact, while the methodology employed here constitutes a significant advance on previous work, the results obtained are a little disappointing. Of the variables used, only inflation and the dummy relating to "wage-freeze" incomes policies were shown to significantly influence the probability of renegotiation, although it is shown that the omission of the Hill's ratio from the wage equation noticeably altered the other estimated coefficients. Possibly by limiting analysis to just one industry, and especially a nationalised industry, the explanatory power of the model is lost beneath industry-specific factors. Alternatively, the choice of a relatively unsophisticated set of explanatory variables may be the problem. In either case, while these specific results are not heartening, Pencavel's paper does highlight the simultaneous nature of the decision to enter negotiations over wages and the choice of a wage bid. Further, the method is able to accommodate (indeed, is based around) the notion of wage-setting through open-ended contracts, and given the widespread use of such contracts, in the UK at least, this will provide a useful base for future empirical investigations.

The influence of uncertainty

Finally, mirroring the arguments presented on the causes of price inertia, it is noted that the difficulties involved in wage setting decisions when faced with imperfect information may also generate unresponsiveness. Many of the efforts in this strand of the literature have been inspired by Gray's (1976, 1978) papers on indexation and contract length. In these a simple macroeconomic model is developed incorporating a labour market in which employment is demand determined and in which wage rates are set in contracts alongside an indexing parameter and a termination date for the contract. Working on the assumption that agents will want to minimise a loss function dependent on a fixed (and unspecified) cost of recontracting and the (squared) deviation of output from the level obtained in a frictionless economy, Gray establishes that, for a given degree of wage indexation, increased variability in either real or monetary shocks will reduce the optimal contract length. This "variability in shocks" is interpreted as uncertainty. In addition, increases in the costs of negotiation will increase contract length, while increased use of wage indexation will reduce the need to renegotiate and lengthen contract duration.

A variety of papers have appeared in which Gray's model has been modified, and her conclusions on the effects of indexation updated (see, for example, Cukierman (1980), or Blanchard (1979)), but the results on contract length have generally been accepted. One exception to this is the work by Fethke and Policano (1982, 1984) in which Gray's analysis is taken further, describing the determination of contract length in a model in which the extent to which contracts in different sectors will be staggered over time is also examined. Gray's conclusion that the variability of monetary or real shocks, the degree of indexation, and the costs of negotiation all influence the optimal contract length is supported, although here sector-specific shocks between sectors are also seen to be influential (an increase in the variability of these shocks again reduces contract length.) Further, it is demonstrated that while these conclusions hold whether or not staggering of negotiations occurs, when staggering is present, then the optimal contract length will be positively related to the degree of desynchronisation that exists.

As pointed out in Canzoneri (1980) and McCallum (1983), the effect of uncertainty on contract length, and hence, wage flexibility, will feed back into the policy-effectiveness arguments noted earlier: with the existence of wage inertia, the government is able to stabilise output around its natural level via appropriate policy; however, this policy will also stabilise prices and encourage longer contracts to be drawn. On choosing between policy options, therefore, the stabilisation of output must be weighed against the introduction of further wage inertia to the system.

These first attempts at a theoretical explanation of negotiation frequencies have received some empirical validation in the work of Christofides and Wilton (1983), and Christofides (1985). In these, data on the length of contracts struck by a sample of bargaining groups in Canada is analysed from the mid-sixties and through the seventies. Uncertainty over prices, measured on the base of sliding regressions on the rate of inflation and on the rate of change of M1, is entered into (linear) regression equations explaining these contract lengths, and is shown to have a significantly negative effect, providing "clear and convincing evidence that contract lengths shorten as inflation uncertainty increases." (1983, p.319) Certainly these results demonstrate that there are systematic movements in the length of contracts to be explained, and I shall return to this empirical work later, in chapter 4, to ask whether the methodology employed could be improved, and whether the conclusions reached are justified.

To summarise then, in the literature there have been three relatively distinct approaches to explaining the frequency of wage negotiation (and hence the extent of nominal wage inertia). The first emphasises the perceived costs of negotiation, the second highlights the simultaneity of the decisions of when to alter wages and by how much, and the third emphasises the importance of uncertainty. In fact, all three of the approaches have the concept of cost minimisation at their core, and later in the work (in chapter 4), I hope to demonstrate that these "distinct" approaches can be accommodated within a single theoretical framework. First, however, I complete my overview of the causes of inertia at the level of the decision-maker by considering what we mean by inertia in real wages, and what might cause this phenomenon.

2.4 Labour market models and real wage rigidity

In section 2.1, it was noted that the effectiveness of policy that can be derived in simple macromodels involving nominal wage and price inertia would be enhanced if there were also **real** rigidities in pricing and wage setting decisions. Specifically, in the simple model set out in expressions (2.1)-(2.3), policy is more effective for given nominal wage and price rigidities as α and β become smaller. These represent respectively circumstances where the price markup over wages is unresponsive to demand change, and where real wages, set in bargains over nominal wages for a given price level, are unaffected by demand. The significance of these issues is made particularly clear in Blanchard (1983, 1986), where a model of a similar structure to that at (2.1)-(2.3) is derived, but with inertia introduced mechanically through staggered wage setting and pricing decisions (so that wages are set in t, t+2, t+4,... and prices at t+1, t+3, t+5,...). In this, an increase in money supply generates a desire in price setters to raise the markup. Equally, however, wage setters desire a higher real wage. Both of these desires can be fulfilled in Blanchard's framework, as the average markup and the average real wage are higher in turn as the decision taking alternates between the two groups with a stagger. Nominal prices and wages are pushed up in turn, in a wage price spiral, until they have both increased in proportion to nominal money, so that real money balances, and output, are back to their previous level. The adjustment process is quicker the more responsive pricing and wage setting decisions are to the increased demand at each stage.

As the above description makes clear, rigidities in pricing and wage setting decisions can be treated symmetrically, both helping to explain adjustment speeds and, hence, the extent of policy effectiveness. Much of the recent literature on the supply side has concentrated on labour market issues, however, not least because there appears to be more scope for policy manipulation here than in the product market. For these reasons, I shall also concentrate on the causes of real inflexibilities, or rigidities, in wage setting, leaving discussion of the effects of demand on prices until the empirical work of chapters 5 and 6.

Sources of pressure on the real wage

Many of the labour market models underlying the macroeconomic debates of the 1970's had relatively unsophisticated micro-foundations, with the market for labour often treated like a commodity market, and the equilibrium real wage given by the intersection of the demand and supply curves for labour, assumed to be of normal shape. In looking at the causes of real wage inertia, we clearly require more realistic models of the labour market, and in recent years, there has been a great deal of research effort invested into just this area. It is to this literature that I now turn, noting some of the recent developments before looking at the ideas that they suggest on the causes of real wage rigidities.

Nickell (1984) observes that "work on wages has been dominated by the Phillips curve paradigm with the labour market firmly in the background", and argues that in fact wages, and the forces that influence them, can only be sensibly considered with their "natural market partner", employment, and in a framework based around the workings of the labour market. Of course, Lipsey (1960) had given some theoretical backing to the Phillips curve relationship, and Lucas and Rapping (1969) set out an analysis in which labour market relations are derived from individuals' optimising behaviour. Equally, efforts to model explicitly the microeconomics of the labour market were made in the "implicit contracts" literature of the mid-1970's, and further insights were obtained through the "search" literature and the "efficiency wage" models of the labour market. (11) However, the absence of a central role for unions in these approaches continued to raise doubts in some economists' minds over their relevance, at least in Europe, to the observed developments in wages and unemployment. Prompted by the rapid growth in unemployment levels, a body of literature has now developed to meet Nickell's criticisms, and raised the optimising behaviour of agents in the labour market, and specifically of unions, to the fore in establishing models of employment and wage determination. Of course, the description of the labour market provided by these union-based models is not exclusive, and elements of the earlier theories are found in many parts of the labour market. Nevertheless, these models seem particularly pertinent to the UK, and it is for this reason that I concentrate attention on them.

The work on union-based models has been well documented in Oswald (1985, 1986) and Pencavel (1985), so I shall only briefly mention some of the issues raised in this literature here in order to clarify the determinants of real wage pressures, and the sources of unresponsiveness, suggested by this literature. In this work, unions are characterised by means of a utility function in which real wage and employment levels, usually expressed relative to some fallback level, are factors. Justification for this characterisation ranges from simple intuition to more formal interpretations in which individual workers' preferences are aggregated in some sense .(12)

One broad area of debate has concentrated on the distinction between models in which firms locate on their labour demand curve, and "efficient bargain" models, and there has been some first attempts to identify which of these is empirically most relevant (see Ashenfelter and Brown (1987), and MaCurdy and Pencavel (1987), for example). In the former set of models, employers choose employment levels unilaterally, so that they always locate on the labour demand curve, while wages are set either by unions alone (the "monopoly-union" model) or in bargains between unions and employers (the "right-to-manage" model). While these models have the advantage that, in practice, employers do indeed appear to retain the right to set employment levels, it has the disadvantage that such combinations are generally inefficient. In McDonald and Solow (1981), for example, a firm's objectives are represented by iso-profit contours, so that the locus of points of tangency between these and the union's indifference curves in fact trace out the efficient "bargaining contract curve" in employment/real wage space. Only in special circumstances will this contract curve coincide with the labour demand curve (as in, for example, Oswald's (1986) seniority model), so that in general gains can be made by both parties by moving off the labour demand curve.

Clearly, in the efficient bargain models, and indeed in the "right-to-manage" models, we require some additional labour market institution to determine precisely the choice of the wage-employment combination from the available alternatives. This institution is usually interpreted in terms of relative bargaining strength, or militancy, as in de Menil (1971), Newell and Symons (1986), or Svejnar (1987) for example, but equally the institution can be based on concepts of equity, such as that in McDonald and Solow (1981) in which the concept of "fair shares" means that wages are a fixed proportion of the average revenue product of labour. Whatever, the incorporation of labour market institutions which are in some sense "uneconomic" clearly provides these models with a justification for an extremely broad range of possible influences on wage and employment determination even beyond the many economic variables that will directly affect these magnitudes through their inclusion in the firm's or the union's objective functions.

The translation of these very broad model guidelines into an empirically useful form, as in Nickell and Andrews (1983) for example, generates three broad categories of influence on the real wage set in this framework. First, there are all of the potential influences on the firm's demand for labour, which might be termed "internal" pressures, such as productivity changes or exogenous demand shocks, which alter the position of the constraints imposed by the firm and faced by unions in their wage setting decisions. Second are the components of the "wedge" between the producer price, which is the deflator of interest to the firm, and the consumer price, which is of importance to the worker. Elements affecting this wedge include taxes and the price of imports. Finally, there are the variables which affect wage rates either through their inclusion in the union objective function, such as those which affect the level of the fallback wage over which utility is derived, for example, or through their influence on the imposed institution necessary to determine wages and employment in the efficient bargain or right-to-manage models as described above. These might be termed "external" influences. Of particular interest in this final category, given the historical significance of the Phillips curve, is the influence of the unemployment rate. In this framework, as is shown in Nickell (1982), one possible path of influence of the unemployed on real wages, which are set here in the main by decision makers who are themselves employed, is through their (depressing) effect on the opportunities available to these "insiders" should they choose, or be forced, to leave the firm. This is of course just one possible means by which the level of unemployment can influence wage setting, but the fact that a realistic justification of a Phillips curve-type relationship can be accommodated within the framework of the union-based model provides a good illustration of the flexibility of this framework.

Given the model we have used to describe the process of wage setting, there are clearly a number of ways in which aggregate demand expansion might generate upward pressure on the real wage in any sector (and hence in the aggregate). First, aggregate demand expansion will raise the demand for industrial output, and hence the demand for labour in each sector, generating "internal" pressures on the real wage. Further, as employment rises, there may be "external" pressures on real wages due to the effect of falling unemployment on the fallback wage of each union. Alternatively, demand expansion may influence inflationary expectations, either directly as agents recognise expansionary policy or indirectly as the (un)employment consequences of the policy are observed. Such expectations may also raise the fallback wage and create upward pressure on real wages. In studying the responsiveness of the macroeconomy, we are interested in whether these paths of influence are relevant in practice, or whether in fact labour market institutions and conventions serve to close down these paths and thereby generate real wage rigidities. The theoretical issues involved in the determination of this responsiveness are discussed below, while the empirical validity of these suggestions are examined in the empirical work of chapters 5 and 7.

Explanations of real wage rigidity

As is clear from the discussion above, in this analysis it is extremely difficult to distinguish between model properties and any mechanisms which might cause wages to be unresponsive to pressure (this being our definition of inertia). For example, if a union's preferences are sufficiently well defined, and are known to be completely unaffected by the unemployment rate, then we should not expect the unemployment rate to influence the real wage, and the lack of responsiveness of wages to unemployment would not constitute real wage inertia as I have defined it. In this analysis then, I take a less restrictive view of inertia, concentrating on the elasticity of the real wage with respect to the various potential pressures described above. This merges the effects of the labour market model employed (describing which developments warrant a change in wages) and the influence of inertia-generating mechanisms (which reduce the responsiveness of wages to the warranted pressures). Given the difficulties involved in choosing the "correct" model of the labour market, this seems the best we can do.(13) Moreover, in the light of Blanchard's (1986) paper described above, it is precisely these inflexibilities in which we are interested since both "internal" and "external" pressures, and indeed those operating through the wedge, reflect the impact of demand change on the labour market. The responsiveness of the real wage to these pressures indicates the extent to which demand shifts feed into real wage setters' decisions (to give a large value for β in (2.2)), and hence determine the magnitude of real responses.

One type of mechanism which might exist to generate real wage rigidities in the face of the "internal" pressures mentioned above is described in McDonald and Solow (1981). Here, as explained earlier, it is noted that one possible institution for choosing between wage-employment combinations on the efficient bargaining contract curve is that of "fair shares". In this case, if the labour demand curve has constant wage elasticity, then the wage set in the bargain is shown to be insensitive to demand fluctuations: an increase in demand shifts the contract curve and the "fair shares" loci to the right in wage-employment space by exactly equal amounts, increasing employment but leaving wages unaltered. While this explanation clearly relies on fairly restrictive assumptions, the fact that labour demand institutions, such as the equity requirement of the fair shares rule or the influence of relative bargaining strength, may react to offset the impact of the cycle on wages remains a possible base for the generation of some degree of rigidity; certainly the cyclic responsiveness of these institutions warrants further attention.

A second mechanism, raised in Oswald (1986), is the possibility of "kinked" indifference curves. If utility is derived according to the gap between actual real wages and some aspiration real wage (set at a "fair" or "normal" level on the basis of past experience perhaps), and if there is an asymmetry between responses to under-payment and overpayment, then a (representative) individual's indifference curves would be kinked at this aspiration wage. In these circumstances, increases in demand, unless very large, will be associated with employment responses only, with the real wage constant at the aspiration level. Oswald argues that there is some support among psychologists for this view of the formation of attitudes towards pay. Of course, this is not a new idea and is closely related to the Keynesian notion of a "wage floor". Wages not only provide a means of allocating resources but also greatly influence the distribution of income, and to the extent that Keynes provided a behavioural justification for the wage floor, it is around this latter function of wages that it is based. Downward movements in the wage level of one group in isolation will generate for them an impoverishment relative to other groups, and it was the effort to avoid these distributional losses on which Keynes based his justification for the wage floor. Such an argument might be extended into areas beyond the scope of economics, involving questions of ethics and morality.(14) However, it is clear that the possibility that the aspiration wage may be based on other workers' pay again raises the potential importance of relativities and the interplay between wage-setting decisions across sectors of the economy. Certainly, the "kinked" indifference map appears to be a potentially significant source of real-wage inertia.

A third, and perhaps the most frequently cited, set of explanations for real wage rigidities follows from the idea that "insiders" who influence the wage-employment decision are in some way insulated from the employment consequences of their wage-setting actions, and therefore do not respond appropriately to pressures exerted on the firm and the workers as a whole.(15) This immediately raises the question of what provides these agents with their insider power, for which some ideas are given in Lindbeck and Snower (1986). In this, the "insiders" are employees on whom the full range of hiring and training costs have been expended, and whose dismissal would incur significant firing costs. These are contrasted with "outsiders", who are untrained and unemployed, and an intermediate group of "entrants". In this framework, it is demonstrated how the existence of these costs may make it unprofitable for a firm to replace insiders with entrants even though they are offering their labour services at lower wages (indeed, it is possible that this will be true even if wage differentials are greater than the corresponding productivity differentials). Moreover, it is noted that insiders may themselves be able to influence the firm's attitude towards taking on entrants or outsiders by being unfriendly or uncooperative to entrants (which would work to raise the entrants' reservation wage), and by being unhelpful with on-the-job training (thereby reducing entrants' productivity). Further, it is argued that this influence will be amplified if individual insiders are organised within a trade union.

This union/non-union distinction is used in an explanation of wage rigidity described in Carruth and Oswald (1986b) in which a utilitarian union becomes indifferent to increases in employment once everyone in the union has a job. Experiments with various functional forms for individuals' utility functions, and with different profit function properties, showed there to be a number of scenarios in which wages would be unresponsive to changes in product demand for at least some ranges of employment. While it is noted that the reliance of the results on specific functional forms and restrictive assumptions reduces the impact of the results, these experiments serve to formalise the intuitive explanations often put forward to explain inertia, and to illustrate their likely practical relevance.

The possibility of insider power generated through the accumulation of on-the-job experience and training may be compounded by the internal workings of a union. Certainly, young workers are less likely to become members of a trade union, and if they do, they are less likely to become involved in union activities, so that more senior workers may derive some further insider power from this source. Such arguments may underlie the widespread use of the "last-in, first-out" (LIFO) rule for redundancy, which has also frequently been cited as a possible source of rigidities. Again the idea is that the median voter, whose job is unlikely to be threatened in all but the most severe recession, will not respond to a reduction in product demand by lowering wages, rather allowing less senior members to bear the burden of adjustment through job losses. Oswald (1986) points out that there are gains to be made by both the firm <u>and the median voter</u> in sharing the profits and risks involved in cyclic variation, so that seniority in a world where all of the employed are paid the same wage may not provide a convincing explanation of wage inertia. On the other hand, as is argued in Borooah and Lee (1987), a situation in which the more senior workers are able to positively discriminate against less senior workers may provide an explanation for rigidities. Again the possibility that more senior workers might be uncooperative in providing training is noted, but a still more direct influence would be through the setting of youth wage rates. By raising the wages of youths relative to adults, unions may be able to insulate its adult members (who it might value more highly) from the worse employment and wage consequences of a demand shock using young workers as a buffer. Certainly, given the fact that youth wages rose steadily during the 1970's and have now stabilised at relatively high levels in the face of extremely high rates of youth unemployment, even relative to that of adults, this explanation might be able to provide some insights into recent experiences.

Of course, many of these ideas have also been raised in the recent "hysteresis" debate (see, for example, Blanchard and Summers (1986), or Jenkinson (1987)), where attention is specifically concentrated on the pressures exerted on the real wage by the unemployment rate. The discussion here is based on the idea that, working in a wide variety of labour market models incorporating the concept of the natural rate, rises in the level of unemployment would be expected to be temporary, offset through market pressures on the real wage which would fall to reestablish equilibrium in the labour market at its previous level in the long run. Historically, however, this scenario does not appear to conform with the facts; rises in the unemployment level persist over long periods, as though the natural rate of unemployment, beyond which the real wage adjustments might be expected to be initiated, has risen itself, following (and being determined by) the time path of actual unemployment rates (hence the term "hysteresis"). The lack of responsiveness of the labour market, and specifically the real wage, to high unemployment is clearly central to this debate, and the comments made above on the sources of real wage rigidities are obviously relevant in this discussion. For example, the Blanchard and Summers paper provides a clear description of the hysteresis concept employing the insider-outsider ideas raised above; here in one illustration, it is assumed that outsiders exert no influence on the decision-making of the employed, and that workers lose all of their insider power the instant they cease to be employed in a firm. In these circumstances, as any workers lose their jobs, the insiders set the wage to ensure that they retain their own jobs at the new, permanently lower, level of employment; there exists no mechanism by which the previously employed can encourage wages to be set at a level low enough for them to be reemployed, and the level of employment follows a simple random walk process over time. These ideas are expanded in a more realistic setting in the paper, but the potential importance of insider power is clearly established once again.

A second explanation for the hysteresis effect has been strongly advocated in Nickell (1987), and follows from the comments made earlier when discussing the way in which the unemployed might be expected to influence wage-setting in the union-based models of the labour market. Here it was noted that this influence might be exerted through the effect of higher unemployment rates on the opportunities available to insiders should they choose or be forced to leave their current positions. However, this effect will be different for different groups of the unemployed, so that the total number of unemployed might not adequately reflect the extent of the downward pressure on wages from this source. Specifically, Nickell argues that the long-term unemployed gradually become less attached to the labour market, and therefore exert less downward pressure on the wage than a corresponding number who have been unemployed for a short time. This effect comes from two sources: first, it is possible that the long-term unemployed become less desirable to employers as they get out of the habit of working, and as their skills and knowledge become out-of-date; and second, there is the possibility that these workers become less enthusiastic in their search for work as unemployment effects their morale. Clearly in these circumstances, only those members of the unemployed who have recently lost their jobs will exert a downward influence on wages, and to the extent that we do not account for the (lack of) influence of the long-term unemployed, the real wage will appear unresponsive to the unemployment rate. (16)

To conclude then, we note that the recent interest in union-based models of the labour market has not only provided an insight into the pressures that might influence real wage determination, but has also provided a framework that enables real world labour market institutions to be incorporated into the analysis. Armed with these tools of analysis, economists have been in a better position to identify the potentially important paths of influence from demand and supply shocks to real wage setting, and the labour market institutions that facilitate or impede responsiveness in real wages to these shocks. While there have recently been some efforts to make use of this taxonomy empirically (see Blanchflower and Oswald's (1987) survey evidence on the relative importance of internal and external influences on pay settlements, or Nickell and Wadhwani's (1989) analysis of insider forces in firm-level settlements, for example), this work is still in its infancy. It is hoped that the industrially-disaggregated analysis of the supply-side of the UK economy presented later (in chapters 5, 6 and 7) may shed light on some of these issues.

2.5 The contribution of disaggregation

In this final section of the chapter, I shall consider explicitly the role that intersectoral interactions play in wage and price movements. Although the discussion so far has concentrated in the main on nominal and real rigidities generated by individual firm/union decisions taken in isolation, I have already mentioned various paths of influence through which such decisions may interact. In section 2.3, for example, I noted the significance of the direct contact established between firms in the same chain of production and the inertia that this could generate in prices at the aggregate level. Also, in section 2.4, it was noted that real wage aspirations, around which union indifference curves might be "kinked", could be important in real wage determination. The "going rate" in settlements achieved elsewhere in the economy may well help establish such aspirations, so that wage comparabilities would enter union utility functions directly.

In this section, however, I shall concentrate on the indirect interactions that take place between firm/union units as each unit makes its decisions against a background formed by the aggregation of the decisions of all other units. These interactions were at the heart of the early papers on nominal inertia and its consequences for the effectiveness of policy, and a model of the type promoted in this early literature is set out below to illustrate some of its properties. As we shall see, the solution to these models leads naturally to a discussion of the process of expectations formation under decentralised decision making. The section concludes with a brief comment on the form of information imperfections that characterise the supply side in the real world, and the expectation formation processes and wage setting institutions that these encourage. This provides some insights for policy formulation and these are described in the concluding comments of section 2.6.

Modelling the time paths of aggregate prices and wages

The model presented here is an adaptation of that in Jackman (1983) in which there are two industries in the economy, each consisting of many firms operating under perfect competition. All workers in each industry belong to a single union, and wages in the industry are determined by the union and common to all firms. Labour is the only factor, and is homogeneous. Production takes place under constant returns so that, by choice of units, output from an industry is equated with employment in the industry (i.e. $y_{at} = l_{at}$ in industry A), and product price equated with money wage. We define the average money wage (w_t) and general price level (p_t) as a geometric average of the (logarithm) of the money wage in the two industries, w_{at} and w_{bt}, and the (logarithm) of the product price in the two industries, p_{at} and p_{bt}, respectively. Hence,

$$w_t \quad = \tfrac{1}{2}(p_{at} + p_{bt}) = p_t \qquad (2.4)$$

The demand schedule for each sector is similar to that suggested by Rotemberg (1982), with demand dependent on real aggregate demand and the price elasticity of demand for the product. Hence,

$$y_{at} = \bar{a} + (m_t + \bar{v} + \sigma_t - p_t) - \gamma(p_{at} - p_t)$$
$$= (m_t + \sigma_t) - p_t - \gamma(p_{at} - p_t) \quad (2.5)$$
by choice of units.

where m_t = (logarithm) of the nominal money supply, and σ_t is a measure of exogenous demand common to both sectors. Equation (2.5), under our simplifying assumptions, can be written as the following labour demand equation:

$$l_{at} = m_t + \sigma_t - w_t - \gamma(w_{at} - w_t)$$
$$= m_t + \sigma_t - \tfrac{1}{2}(1+\gamma)w_{at} - \tfrac{1}{2}(1-\gamma)w_{bt} \quad (2.6)$$

While obviously a very simple model of the demand side, this formulation enables us to generate a labour demand equation for each industry which highlights the dependence of employment in one industry on negotiated wages elsewhere in the economy; the aggregate price level, substituted out in (2.6), acts as the transmission mechanism.

The model differs to that of Jackman in its approach to the timing of negotiations. Here, rather than impose the institution of staggered two-period contracts, we assume that both industries are able to renegotiate in every period, although they do not have to take up this option. Rather, for each industry, i, there is a probability of negotiation occurring in each period, π_{it}. In this way, inertia is introduced in a less mechanical way than through fixed contract lengths, and one that may represent reality more closely, in the UK at least. Later, in chapter 4, we will consider what might affect the size of the π_{it}, but here we simply note that: (1) contract negotiation will be desynchronised if any of the factors influential in the determination of π_{it} are industry-specific; (2) since the π_{it} can change over time, the (expected) period of time between negotiations, and hence the degree of inertia, can also alter over time; and (3) if $\pi_{it} = 1 \ \forall$ i, t, then we have the case of instantaneous adjustment and zero inertia.

It is important to make explicit the information held by the unions when deciding on whether to negotiate in each period; in particular, we recognise that unless union A commits itself to a decision before knowing B's decision, and vice versa, then decisions can be coordinated and the two sector structure of the model is unnecessary. Here then we assume that the decision to set a new wage in period t is made at the instant at which the values of m_t and σ_t are known, but neither union knows the outcome of the other union's decision on negotiation; instead, each union has to form expectations about the behaviour of the other.

On the supply side, we assume that each union, when striking a bargain, aims to maximise a function of the real wage and the employment levels that it expects to experience before its next negotiation. The specific functional form chosen to represent the unions' objective functions is the Stone-Geary form, as in the Jackman paper. Hence, when renegotiating in period t, A will maximise u_{at} where

$$u_{at} = [E(x_{at}-x_o)^{\theta}\, E(l_{at}-l_o)^{1-\theta}] \quad \text{s.t. (2.6)} \qquad (2.7)$$

where $E(x_{at}-x_o)$ = excess of real wages over fallback level x_o expected to be obtained over the period before renegotiation, and $E(l_{at}-l_o)$ = excess of employment over fallback level l_o over the same period.

Now consider industry A at time t. In what follows we shall distinguish between w_{at} = actual money wage paid to union A in time t, and z_{at}= money wage that union A could negotiate if it enters into negotiation in time t ($w_{at} = z_{at}$ only in periods when negotiations take place). The real wage obtained by union A in any period, x_{at}, depends positively on its own nominal wage and negatively on the money wage obtained in industry B since $x_{at} = w_{at} - p_t = w_{at} - \frac{1}{2}(w_{at}+w_{bt}) = \frac{1}{2}(w_{at}-w_{bt})$. Hence, assuming that union A negotiates in time t, the real wage expected to be obtained over the period before it next negotiates over wages will depend on the wage expected to be obtained in industry B over all future periods as follows:

$$\begin{aligned} E(x_{at} - x_o) = {} & \tfrac{1}{2}(z_{at} - w^e_{bt}) \\ & + \tfrac{1}{2}(z_{at} - w^e_{bt}+1) \text{ x (expected probability A does not negotiate in t+1)} \\ & + \tfrac{1}{2}(z_{at} - w^e_{bt+2}) \text{ x (expected probability A does not negotiate in t+2)} \\ & + \ldots\ldots - x_o \\ = {} & \tfrac{1}{2}(z_{at} - w^e_{bt}) + \tfrac{1}{2}(z_{at} - w^e_{bt+1})(1-\pi^e_{at+1}) + \tfrac{1}{2}(z_{at} - w^e_{bt}+2)(1-\pi^e_{at+2}) \\ & + \ldots\ldots - x_o \end{aligned}$$

where the "e" superscript denotes expectations formed by A at time t, and where π^e_{at+j} denotes the expected probability that A negotiates in time t+j. Of course, union B has the choice of whether or not to renegotiate wages at any time (t+s), (s=0,1,2,...), so that union A's expectation of wage paid in industry B at time t+s is given by

$$w^e_{bt+s} = w^e_{bt+s-1}(1-\pi^e_{bt+s}) + z^e_{bt+s}\pi^e_{bt+s}$$

Taken together, these expressions illustrate the idea that the real wage to be obtained in A over the period before renegotiation depends on the negotiated nominal wage in industry A, of course, but also on the wage observed in B last period and the expected negotiable wages in B for the current and all future periods. The relative weight given to the wage in B at different times depends on the π^e_{at+j} and π^e_{bt+j} which determine the relevance of the future periods to union A's current wage negotiation. For example, if A knows with certainty that it will renegotiate every period, then $\pi^e_{at+j} = 1$, (j = 0, 1, 2, ...), and $x^e_{at} = \frac{1}{2}(z_{at} - (1-\pi^e_{bt})w_{bt-1} - \pi^e_{bt}z^e_{bt})$. The wage that is negotiable in B at time t+1 and beyond are given zero weight in union A's current wage settlement since union A will negotiate next period, while the observed wage in B at time t-1, w_{bt-1} and the negotiable wage, z^e_{bt} are given weights according to the likelihood that union B leaves its wage unchanged at time t or enters into renegotiation.

A similar expression can be derived for $E(l_{at} - l_o)$, using (2.6), in which the level of employment determined over the period depends (negatively) on z^e_{at} and (positively) on w_{bt-1} and z^e_{bt+j} (j = 0, 1, 2,...), with weights again attached to these according to the relevance of the future periods to union A's current negotiation (i.e. depending on the π^e_{at+j} and π^e_{bt+j}). The precise form of the expressions for $E(x_{at}-x_o)$ and $E(l_{at}-l_o)$ are provided in the Appendix. Here we simply note that maximisation of u_{at} with respect to w_{at} subject to the labour demand schedule at (2.6) gives us the following expression for z_{at}:

$$\begin{aligned} z_{at} &= \frac{2(1-\theta)(1+\gamma)x_o - 2\theta l_o}{(1+\gamma)} \\ &+ \frac{2\theta}{(1+\gamma)P(1)}\left[(m_t + \sigma_t) + (1 - \pi^e_{at+1})(m^e_{t+1} + \sigma^e_{t+1}) + \dots \right] \\ &+ \frac{(1 - 2\theta + \gamma)}{(1+\gamma)P(1)}\left[P(2)w_{bt-1} + P(3)z^e_{bt} + P(4)z^e_{bt+1} + \dots \right] \end{aligned} \tag{2.8}$$

where

$$P(1) = \{ 1 + (1 - \pi^e_{at+1}) + (1 - \pi^e_{at+1})(1 - \pi^e_{at+2}) + \dots \}$$

$$P(2) = \{ (1 - \pi^e_{bt}) + (1 - \pi^e_{bt})(1 - \pi^e_{at+1})(1 - \pi^e_{bt+1}) + \dots \}$$

$$P(3) = \{ \pi^e_{bt} + \pi^e_{bt}(1 - \pi^e_{at+1})(1 - \pi^e_{bt+1}) + \dots \}$$

and so on.

The negotiable wage in union A therefore depends positively on current and expected future values of the level of aggregate demand and on the lagged level of wages and the expected current and future negotiable wage in B. Growth in aggregate demand increases demand for labour, as does a rise in industry B's wage (through its impact on the aggregate price level and the demand for A's output), and some part of this improvement in demand conditions is taken by the union in terms of wage improvements. Increases in wages in B have the further effect of reducing real wages in A through their impact on the aggregate price level, and this engenders further rises in nominal wages in A.

The weight given to the terms in (2.8), summarised in P(1), P(2), P(3),..., capture their relevance to union A's current wage negotiation, and illustrate clearly the way in which wage inertia is introduced through the inclusion of renegotiation probabilities: directly, if $\pi_{at+i} \neq 1 \ \forall \ i$, as union A is faced with a positive probability of not renegotiating in each period; and indirectly as unions recognise that it may not be to their advantage to adjust wages fully in response to a nominal shock even when negotiations are entered into (since (2.8) shows that even if $\pi_{at+i} = 1 \ \forall \ i$, so that A enters negotiations every period, and P(4) = P(5) = P(6) = 0, there will be a backward-looking element in its wage determination if there is any possibility that B will not also renegotiate in the current period).

The form at (2.8) also illustrates the fact that wage change at the aggregate level will depend on both the proportion of industries currently altering their wages and on the proportion expected to renegotiate in the future. If these proportions are changing over time then so too are the relationships between the wage level and its explanatory variables, and in these circumstances econometric work becomes very difficult and estimated relations must be interpreted with care. These difficulties are succinctly put by Pencavel (1986), who writes that, under circumstances when the timing of collective agreements in different sectors is not synchronised "there is no reason to expect any stability in the parameters of the sort of macro wage equation that is invariably specified" (p. 214). Other economists have also noted the problem: Hamermesh (1970), Johnston and Tumbrell (1973), Ashenfelter and Pencavel (1975), and Smith and Wilton (1978) have each in their turn pointed out the inadequacies of using the aggregate rate of change in wages as the dependent variable in a wage equation without making some adjustment to take into account the proportion of workers who are, or will be, negotiating a new wage over some relevant future time horizon. These authors recognised that the rate of change in the aggregate wage will underestimate the rate of change of wages actually negotiated in each period as any such changes are distributed over all workers, including those who have not altered their wage. This will become important if the proportion of workers negotiating in any quarter varies over time, in which case the extent of the underestimation will also vary. Moreover, the papers also note that any changes negotiated by a particular industry should be scaled according to the time span over which the newly negotiated wage will hold, so that the frequency of future wage change is also influential in the specification of a wage equation. These are precisely the issues raised in the solution to our model presented at (2.8).

In order to investigate the macroeconomic properties of the model, we need to analyse the evolution of economy-wide wages, and we have to aggregate over the two sectors therefore. For this, we first note that there will be an expression for the negotiable wage in industry B of exactly the same form as (2.8) (with expectations derived on the basis of union B's information set at t). Next, we make the simplifying assumption that $\pi^e_{at+j} = \pi^e_{bt+j}$, j = 0, 1, 2,..., (i.e. the expected probability that negotiation occurs in industry A in time t+j is equal to the expected probability that negotiation occurs in industry B in t+j for all future periods), where expectations are formed on the basis of the relatively impoverished information set in which the outcome of neither union's decision on whether to negotiate in the current period is known (we shall call this the government's information set). Such a simplification allows aggregation over the sectors to take place, and is not unreasonable given the symmetry of the model.(17) In particular, if the decision on whether to negotiate in each industry depends only on aggregate parameters, such as the aggregate inflation rate, for example, then this assumption is easily justified. With details of the aggregation relegated to the Appendix, (2.8) and its equivalent expression for B, can be used under these assumptions to derive the following aggregate wage equation:

$$w^e_{t+1} = Ew_{t-1} + Fw^e_t + G(m_t + \sigma_t - [\, l_o - (1 - \theta)\theta^{-1}(1 + \gamma)\, x_o\,]) \qquad (2.9)$$

where

$$F = \frac{\pi^e_{at+1}}{P(1)-1} \left\{ \frac{P(1)}{\pi^e_{at}} + \frac{(1-\pi^e_{at+1})(P(1)-1)}{\pi^e_{at+1}} - \frac{(1-2\theta+\gamma)}{1+\gamma} \right\}$$

$$E = \frac{-\pi^e_{at+1}}{P(1)-1} \left\{ \frac{(1-\pi^e_{at})P(1)}{\pi^e_{at}} \right\} \quad \text{and} \quad G = - \frac{\pi^e_{at+1} 2\theta}{(P(1)-1)\,(1+\gamma)}$$

and where expectations are again formed on the basis of the government's information set.

In view of the earlier discussion, in section 2.1, it is of some interest to examine the responsiveness of (aggregate) wages to money growth in this situation. Specifically we have already established in (2.8), that there is a backward-looking element in wage setting so long as π_{at+j} or $\pi_{bt+j} \neq 1 \ \forall\, j = 0, 1, 2,...$; i.e. there is some inertia. Hence, in view of (2.4)-(2.6), there will be a role for government policy as wages fail to respond instanteously and equiproportionately to changes in m_t and σ_t if there is inertia in either of the sectors of the economy. Moreover, if there is inertia in both sectors, then this inertia accumulates to effect wage/price movements in the economy as a whole.[18] It remains of interest, however, to consider the macroeconomic implications of the model if we endogenise the decision to negotiate, allowing the π_{it} to vary over time and to be influenced by the development of the macroeconomy. In particular, we noted in section 2.2 some of the causes of inertia in wages and prices, and we specifically recognised the potential impact of wage inflation on the frequency of wage negotiations. In what follows therefore we shall assume that at time t the expected probability of negotiation in time t+j, π^e_{at+j} , is given by

$$\pi(\Delta w^e_t) = \pi^e_{at+j} = \frac{\exp(a + b\Delta w^e_t)}{1 + \exp(a + b\Delta w^e_t)}, \qquad j = 0, 1, 2,... \qquad (2.10)$$

Obviously, the assumption that $\pi^e_{at} = \pi^e_{at+1} = \pi^e_{at+2} = ...$ is a simplification, and contradicts reality in the sense that, under this assumption, the majority of negotiations are expected to occur one period after the previous one (with probability π), with a geometrically declining proportion expected to negotiate in subsequent periods (the proportion expected to negotiate for the first time s periods after the previous negotiation is $\pi(1-\pi)^{s-1}$). On the other hand, this assumption accommodates the notion that the expected probability of negotiation (in the current and all future periods) relates to current wage inflation. Clearly π lies in the interval [0,1], and increases as Δw^e_t increases if $b > 0$.

Incorporating (2.10) into (2.9) provides an extremely non-linear difference equation in aggregate wages, which is difficult to work with. However, a Taylor series expansion of this non-linear difference equation around a fixed point $\bar{w}$ provides a linearised version of (2.9) with the following parameter values [details of the expansion are given in the Appendix]:

$$F = 2\left(1 + \frac{\theta e^{2a}}{(1+\gamma)(1+e^a)} + \frac{\theta b\, e^{2a}(2+e^a)}{(1+\gamma)(1+e^a)^2} \{\bar{w}-m_t-\sigma_t+[\, l_0 - (1-\theta)\theta^{-1}(1+\gamma)\, x_0 \,]\} \right)$$

$$E = -1 - \frac{2\theta b\, e^{2a}(2+e^a)\{\bar{w}-m_t-\sigma_t+[\, l_0 - (1-\theta)\theta^{-1}(1+\gamma)\, x_0 \,]\})}{(1+\gamma)(1+e^a)^2}$$

and $$G = -\frac{\theta e^{2a}}{(1+\gamma)(1+e^a)} \qquad (2.11)$$

The general solution for w_t of this difference equation depends on the expected evolution of m_t over all future periods, with the speed of response of w_t to changes in m_t dependent on λ_1 and λ_2, the roots to the characteristic equation of (2.9); i.e. $\lambda_1, \lambda_2 = \frac{1}{2}$ (

$F +/- \surd(F^2 + 4E)$). The derivation of the unique solution to the difference equation in the presence of a general process determining m_t is provided in the Appendix, and shows that the time path of wages may be extremely complicated when this forward-looking element of wage determination is taken into account. In order to highlight the macroeconomic properties of the model, however, we assume here that the money supply grows at a constant rate, g, per period and that σ_t is constant. Further, we assume that at time t_0, there is a once and for all reduction in the money stock so that an alternative trajectory of prices is appropriate. Denoting the change in the money stock by 'Δm', we find that for reasonably small values of Δm and b (19), the general solution for w_t is given by

$$w_t = g(t-t_0+1) - [\, l_o - (1-\theta)\theta^{-1}(1+\gamma)\, x_o \,] + m_{t_0-1} + \Delta m\, (1 - \lambda_1^{t-t_0+1}) \qquad (2.12)$$
$$t = t_0,\ t_0+1,\ t_0+2, \ldots,$$

where $\lambda_1 = \frac{1}{2}\,(F - \surd(F^2 + 4E))$, and where we linearise around the level of wages that would have occurred in the absence of the unexpected increase in money growth, that is, $\bar{w} = g_1 t_0 - [\, l_o - (1-\theta)\theta^{-1}(1+\gamma)\, x_o \,]$.

In Figures 2.1-2.2 we illustrate the features of wage dynamics in this context. Money is assumed to grow at 2.5% per period throughout, but in period 10 there is a 10% fall in the money stock (if we consider these to be quarterly observations, the annual growth rate is 10% pa, and the money stock reduction constitutes a reasonable, if significant shock). Values for γ, the price elasticity of demand, and for θ, the relative weight of wages and employment in union utility, are arbitrarily set at 0.8 and 0.5 respectively. In Figure 2.1.1-2.1.3, the parameter 'a' is set to -1.22 and the parameter 'b' is set to 5, so that the probability of negotiation is 0.25 (and the expected length of time between negotiations is 4 periods) at the original (and ultimate) rate of wage inflation. Setting the parameter 'b' to 5 provides a moderate positive feedback from wage inflation to renegotiation probabilities. In this case, the time path of wages is given in Figure 2.1.1; wage inflation runs at 10% pa up to period 9, but decreases with a jump in period 10 (to an annualised rate of around 3.5% pa) and converges to its ultimate trajectory (growing at 10% pa, but at a level 0.1 lower than previously) by about period 25. Note that convergence takes around 15 periods which is well in excess of the average length of any single contract. This illustrates clearly, therefore, the buildup of inertia that ensues from the disaggregated nature of the model and establishes again the possibility of effective government policy in this framework. Figure 2.1.2 illustrates the effects of these developments in wages on renegotiation probabilities. Here, given the choice of parameter values and given wage inflation of 10% pa, the negotiation probability is constant at around 0.25 up to period 9. There is a jump in negotiation probability in period 10, down to around 0.235, matching the jump in wage inflation, and then a gradual increase back to

0.25 by period 25. Finally, Figure 2.1.3 shows the inflationary effects of endogenous negotiation probabilities by plotting the difference between the wage level shown in Figure 2.1.1 and that which would be obtained if a = -1.1 and b = 0 (so that there is no feedback from wage inflation to negotiation probabilities, which remain fixed at 0.25). As is clear from the Figure, the ultimate effect of the unexpected reduction in the money supply is the same in both cases, as one would expect. However, in the initial periods following the shock, wage inflation is higher in the presence of endogenous negotiation probabilities, as the reduced frequency of renegotiation slows down the adjustment process.

Figure 2.2.1-2.2.3 illustrate the same features of wage dynamics, but with parameters 'a' and 'b' set equal to -1.47 and 15 respectively. Here the probability of renegotiation is still 0.25 at the initial rate of wage inflation, but these probabilities are more sensitive to the rate of aggregate wage inflation than previously. As is to be expected, convergence of the wage to its equilibrium rate of growth is less rapid in this case (now having taken place by about period 35 in Figure 2.2.1), while renegotiation probabilities fall more dramatically (to around 0.22 in period 10) in Figure 2.2.2. The inflationary effects of endogenising negotiation probabilities are again illustrated in 2.2.3, with wages running approximately 1% higher over the periods 14-22 than would be observed if there were no feedbacks from wage inflation to negotiation probabilities. Hence, the increased sensitivity of renegotiation probabilities to wage inflation reduces the speed of adjustment of wages to the unexpected shock, with relatively small changes taking place immediately following the shock. The results shown in Figure 2.2 are more extreme than those of Figure 2.1, although even with b set equal to 15, the frequency of renegotiation is not unreasonably sensitive to changes in wage inflation (since the expected length of time between wage settlements immediately following the shock still only stretches to 4.5 quarters in this case). However, while the results are qualitatively unchanged from those in Figure 2.1, there is an even clearer role for effective government policy in this case, as the duration of the adjustment period for the economy as a whole is considerably extended.

To conclude the discussion of the model, let me summarise the points that it has helped to illustrate. First, we noted that in a world with less than instantaneous wage adjustment, the inertia generated directly as individual unions fail to negotiate each period is compounded by an indirect influence as unions fail to adjust fully even when they do enter negotiations as each recognises the inflexibility of wages elsewhere in the economy. This means that wage adjustment in the fact of shocks may take substantially longer than any single wage settlement lasts, providing the potential for relatively long-lasting effective government intervention. Note that the government is assumed to know no more than either industry at any time, so that policy effectiveness derives from their relative

Figure 2.1 Impact of a 10% reduction in the money stock (a=-1.22, b=5)

Fig. 2.1.1; Time path of wages

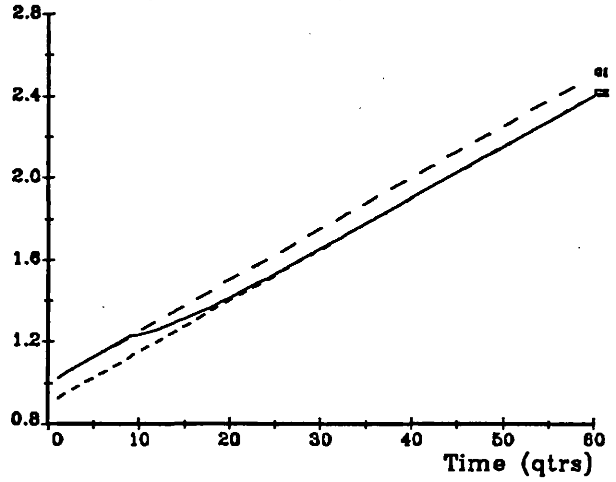


Fig. 2.1.2; Probability of negotiation

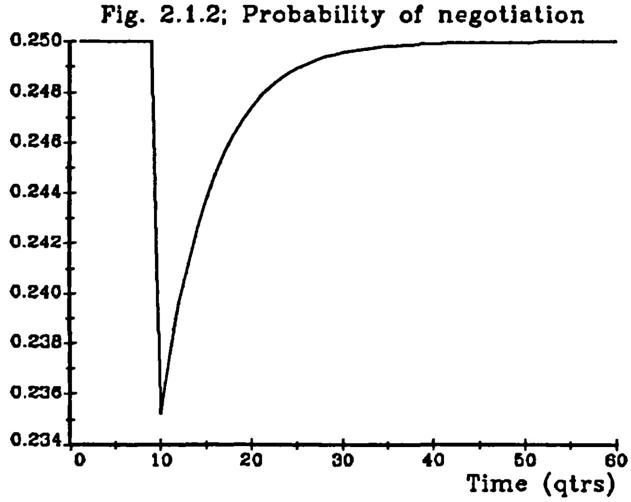


Fig. 2.1.3; Inflationary effect of endogenous probs.

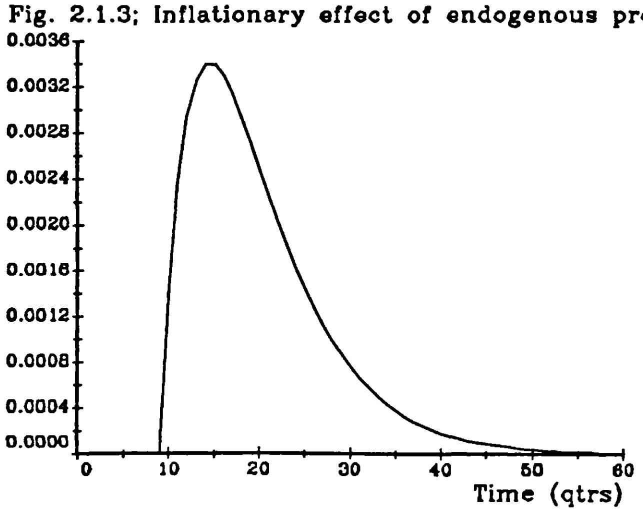
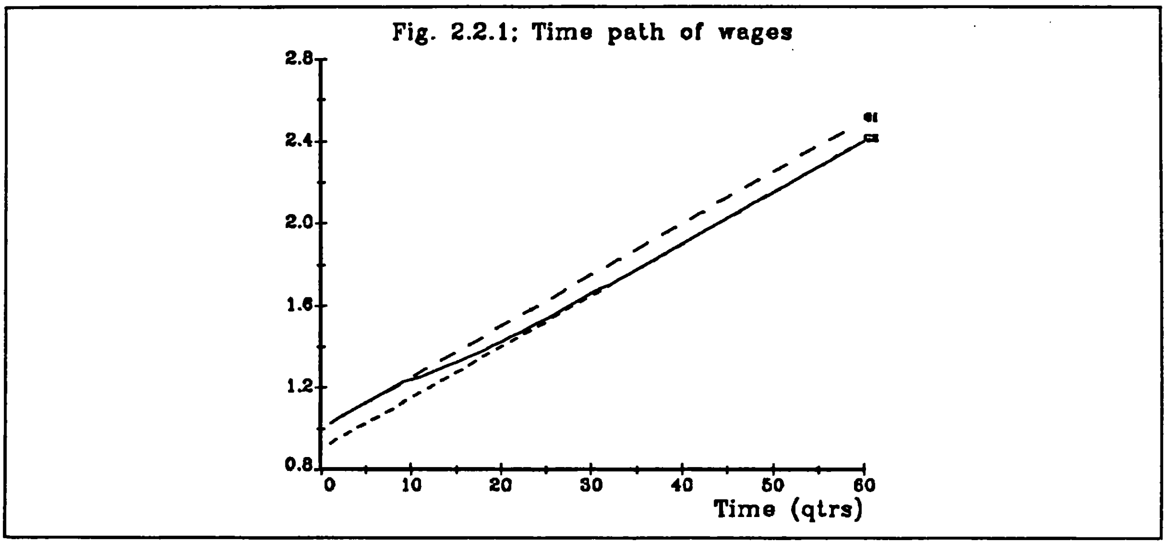
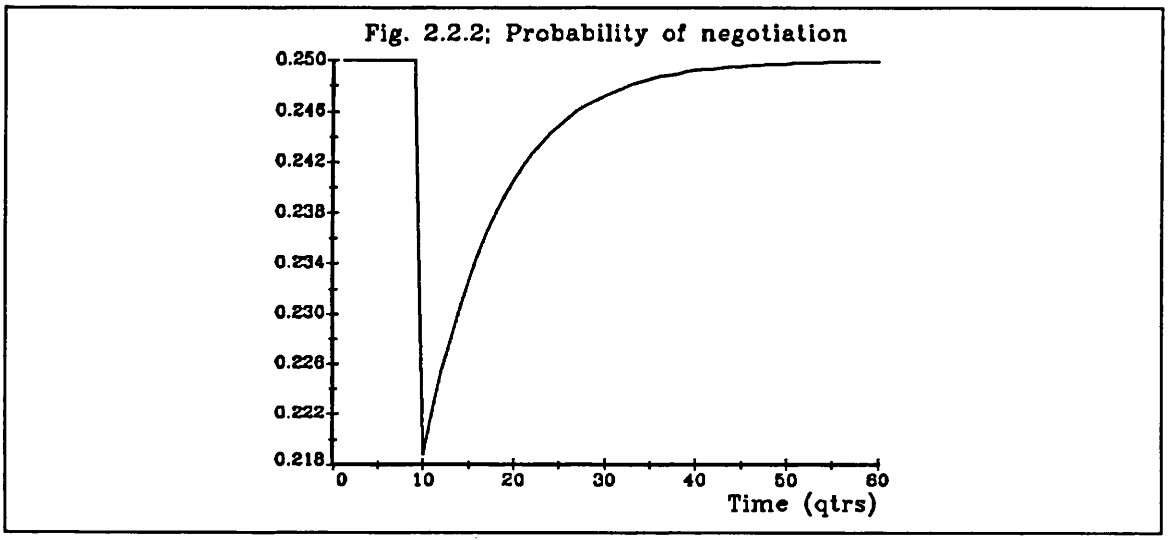
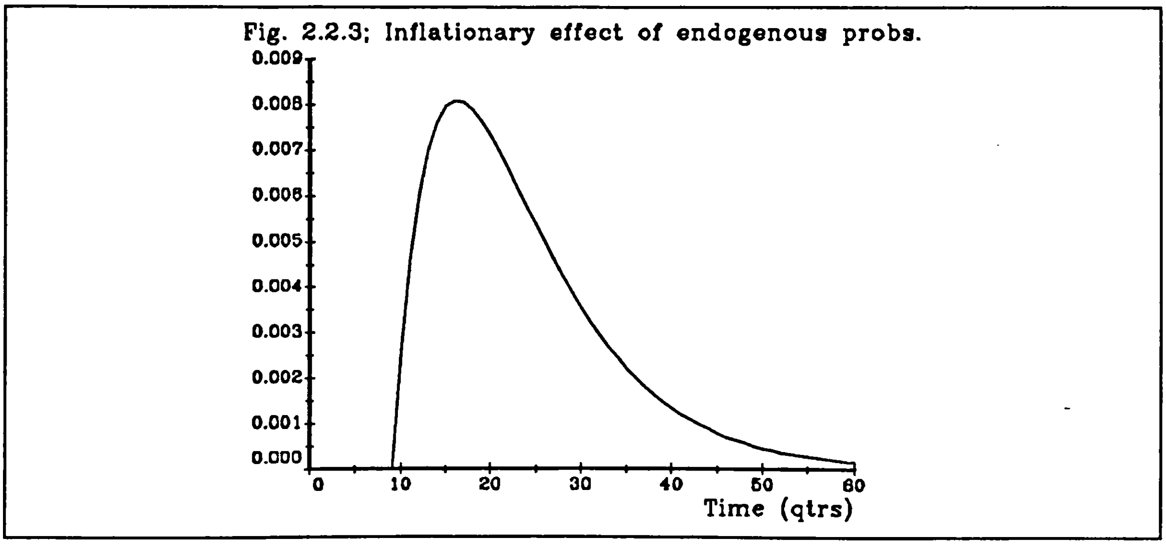


Figure 2.2 Impact of a 10% reduction in the money stock (a=-1.47, b=15)







flexibility in response rather than from any (unrealistic) informational advantage.

Second, attempts to understand aggregate wage movements will involve an analysis of the extent of current and expected future wage inertia in all sectors of the economy. The recognition that wage negotiations will occur only periodically in the future provides an important forward-looking element in wage settlements which may generate complicated wage dynamics which are difficult to model econometrically. These will be further complicated if there are feedbacks from the evolution of wages to the decision on when to negotiate. However, apart from the extreme cases in which the sensitivity of negotiation probabilities to wage movements is very high, the fact that negotiation probabilities may be endogenously determined does not alter qualitatively the properties of the model.

Perhaps the single most important insight to be gained from the above model, however, is the importance of **expectations** in the evolution of the economy. The two central features of the model are that it involves more than one sector (disaggregation) and that there is some element of inertia involved. As such, there is scope for information imperfections and for less-than-instantaneous adjustment, so that the need to form expectations is sure to be a characteristic of the model solution. The precise nature of this solution depends on the way in which information imperfections are accommodated within the model, and the assumed expectations formation process. In the illustration above, expectations were assumed to be formed rationally, and symmetric information on the model structure and on the nature of the expectational errors ε_{1t} and ε_{2t} was assumed known by both sectors. Alternative assumptions on the information structure of the model and on the process of expectation formation would of course provide different solutions and the policy implications of disaggregation and inertia would be altered.

One example of this line of analysis is given in Taylor (1983a) in which the degree of wage inertia generated under alternative wage-setting rules is considered. These wage setting rules in effect define the information set used in wage setting and the way in which the information is used. In the paper, a two-sector economy is described in which wages are set for two periods with a stagger. Agents are assumed to set wages relative to a "reference wage" given by the average of existing wages outstanding at the time that the wage is determined. In this context, Taylor shows that extrapolative wage-setting rules are sure to lead to real output loss under a a disinflation programme. Two examples of such rules are specifically noted: the first sets wages under the assumption that the reference wage will grow at the same rate over the next year as it did over the past; the second assumes that the wage will be raised relative to its previous level by the same amount as the reference wage was most recently raised. These rules have "reasonable" properties in the sense that under them agents will retain a constant relative position so long as wage inflation is constant, and represent reality in so far as wage differentials are seen to be of over-riding importance in wage negotiations. On the other hand, if a monetary disinflation programme is undertaken, even if it has been credibly announced prior to its implementation, then these properties are lost, and the inability of wages and prices to respond to the reduction in the money growth rate means that real balances will fall, interest rates will rise, and aggregate demand and output will contract. This is shown to be in sharp contrast to the position when expectations are formed rationally, where wages are able to jump to a position in keeping with the announced money growth rate, and all adjustment is completed within the length of the longest contract (two periods), without the corresponding output and employment costs.

The ideas expressed in this paper are further illustrated in Taylor (1983b) in which actual data on union wage settlements in the US is used in a simple model to simulate the time path of wages during a disinflation. Although recognised as a simplification, it is assumed that unions negotiate one, two, or three-year contracts, and that they can be assigned to one of twenty-four groups according to the length of their contract and the timing of negotiations over the quarters of a three-year cycle. Having aggregated the data in this way, a model is presented in which a union's wages are set equal to the average aggregate wage expected to prevail during each one-year period, with expectations formed on the information available at the time the contract is negotiated by the union. Assuming forecasts of future wages are made rationally, and constraining real GNP to equal a trend (full-employment) level, the joint influence of future and past wage decisions on the current wage is demonstrated in a simulation of a disinflation from a previously-steady rate of wage inflation of 10% to a new one of 3%. Since expected future average wages affect any current wage decisions, the behavioural equations of the model are forward-looking, and the disinflation can occur even with full-employment given. The staggering of wage contracts generates a backward-looking element to wage decisions, and the disinflation is shown to take five years to work through, with extremely gradual changes in the first two years of the disinflation program. Through this simulation, then, Taylor demonstrates the importance of both current and future levels of inertia (imposed through the use of fixed-length contracts), and the complexities of the time path of wages as the degree of inertia alters as different combinations of the twenty-four groups negotiate in any period.

The main proposition of the work described above is that the process of disinflation can be greatly influenced by the way in which wages and prices are set, and in particular, it is argued that the costs of reducing the rate of inflation can be much reduced if agents set wages with forward-looking parameters in mind, rather than basing them on backward-looking predetermined variables.[20] It is on the basis of these illustrations that Taylor argues that governments might undertake to make the process of expectation formation in wage setting more "rational". Noting that the use of sophisticated forecasting procedures involves externalities for the individual firm or worker, this argument implies a clear role for government-backed agencies in the provision of of a credible and widely-available forecasting service. Certainly, Taylor's work highlights the potential gains to be achieved from an active pay policy which attempts to improve coordination of wage setting by influencing agents' information sets in a disaggregated world involving inertia . In order to establish whether these suggestions are of any relevance in the real world, we turn now to a brief reflection on the empirical literature describing disaggregated wage setting in the UK.

Wage-wage comparisons and wage leadership

A recurring theme in the literature on wage setting in the context of disaggregate models of wage determination in the UK has been that of wage-wage comparisons in pay bargaining, and the concept of wage leadership. So, for example, Sargan's (1971) paper presents estimates of industrial wage equations which incorporate terms to capture the belief that a union, when it puts in its wage claim, "will have an eye on wage bargains struck earlier in the annual sequence of wage settlements" (p. 59) both generally and with particular industries. Again, in Ashenfelter and Layard (1983) it is noted that the ultimate breakdown of incomes policies in the UK has frequently been ascribed to the erosion of differentials that the incomes policies have entailed. Meade (1981) argues that the "keeping-up-with-the-Joneses syndrome" has generated substantial inflationary pressures for the UK in the past: here, groups' attempts to maintain (or improve upon) past differentials mean that they continually "leap-frog" each other as pay claims are put forward, getting larger in each occasion to offset in advance the counter-claims of other groups. Through the 1960's and 1970's, successive governments took distinct policy stances on the role of pay relativities and differentials (see Addison (1979), for example), and a large academic literature was generated investigating these influences on wage settlements (see Dearden (1979) for a survey of the literature on wage leadership, and Brown and Nolan (1987) for a survey of the industrial relations contributions). Beyond the work of Sargan, recent studies by Foster, Henry and Trinder (FHT) (1984, 1986), Holly and Smith (1987), and Mackie (1987) have each provided empirical support for the interdependence of wage settlements. In the first of these, it is shown that settlements in the public corporation sector help explain wage behaviour in the general government sector, and in the private sector (both manufacturing and non-manufacturing), while the Smith and Holly work provides support for the idea that "settlements of the large manufacturing groups determine the "going-rate" in the wage round" (p. 98)., finding that wage change in this sector help explain wage movements in private non-manufacturing. Mackie's work finds evidence for a two-way influence between manufacturing and 'non-manufacturing' (including non-manufacturing in the private and public corporation sectors), and that wages in both of these are influenced by public corporation wage settlements. From this literature then, it is clear that policy makers and academics alike have taken very seriously the importance of wage-wage comparisons and wage leadership in wage determination. However, while many investigators have found evidence for these effects, there does not appear to be a single clear pattern across the results as to what forms the basis of comparisons or of what constitutes a wage leader.

One clear difficulty involved in studies of this type is that of choosing the appropriate level of disaggregation at which analysis should be carried out. The FHT article, for example, notes a related work by Zabalza (1984) in which evidence is presented of a causal link from wage settlements in the private sector to those in the public sector. FHT explain this in terms of the merging of the general government and public corporation sectors into one public sector group, the behaviour of which is dominated by the larger general government sector. But this raises the question of whether a further degree of disaggregation, while complicating the analysis, might not provide more insights into the true process of wage-wage comparison bargaining. So, while FHT (1984) point out that the wage bill in the public corporation sector as a whole increased considerably during 1974, the miners' pay settlement of that year, obtaining a 47% increase, far outpaced the rest of the sector (27%), and, because of its high profile, it seems reasonable to suggest that this one settlement had a disproportionate influence on wage setting both in its own sector, and in the rest of the economy (with this influence likely showing up in 1974 and 1975).

It remains doubtful, however, whether a clear pattern to describe wage leadership and pay comparabilities would emerge even if we had extremely disaggregated data. These doubts are raised simply because of the wealth of the literature on the topic of wage leadership, and the wide variety of hypotheses that have been put forward to explain the phenomenon. As an illustration, Dearden (1979) notes seven different classes of wage-leadership hypothesis, with leading industries defined in each according to such different factors as their industrial structure, or their rate of productivity growth, their international competitiveness, their responsiveness to demand shifts, and so on. In fact, while these hypotheses are often looked at as alternatives, it seems reasonable that any of these factors might become more or less relevant over time, so that the structure of the wage round would alter. These problems show clearly in the disaggregated data described in Elliott (1976). Here, on the basis of the timing and size of settlements in the major negotiating groups in the UK between 1950 and 1973, Elliott found no evidence for the existence of a <u>stable</u> wage round defined in terms of similarities in the timing of settlements, in terms of subsets of negotiating groups settling together systematically, or in terms of similarities in the size of settlements. The changing nature of wage-leadership would indeed make it very difficult to identify the any simple causal relationships although the wide acceptance of the practical relevance of wage-wage comparisons suggests that there does exist a known structure to wage emulation.

One suggestion that might help explain the difficulties experienced in identifying any simple pattern of wage-wage comparisons revolves around the sort of information imperfections discussed in the papers by Taylor mentioned above. This suggestion is put clearly by Okun (1981) who argues that if "it is difficult and costly to define and sample objectively a universe of "reference wages", firms and workers may focus on a few key indicative wages as the basis for a pattern of emulation" (p. 94). In this case, wage leaders are likely to be simply those whose wage negotiations, and their settlement, are particularly well publicised. While some industries may be more susceptible to leadership than others on these grounds (possibly linked with features associated with public or private sector ownership, whether the industry is in the manufacturing or non-manufacturing sector, its rate of productivity growth, and so on), it seems unlikely that the complexities of the process could be captured accurately even by an analysis conducted at a low level of disaggregation since these key settlements may not remain constant over time, and may be highly localised. Hence, the miners' pay settlement of 1974 mentioned above would provide a good example of an instance of wage leadership of this sort. Equally, however, the (private-sector) bargaining in the engineering and shipbuilding industries in the late 1950's, the activities of the energy and transportation (public corporation) sectors during the Heath administration during the early 1970's, and the (general government) pay settlements of the nurses, local government workers, and school teachers in 1975 were all significantly well-publicised to affect settlements elsewhere.

These reflections suggest that while wage-wage comparisons are important in wage determination, it may be difficult to predict precisely the form that these comparisons will take at any time. In practice, where wage setting is carried out through decentralised decision making, as in the UK, information imperfections may dominate the process. We have seen that "reference wages" may be important in individual wage setting decisions, both indirectly if they play a significant part in the process by which agents form expectations on future aggregate outcomes, and directly if they influence unions' aspirations (recalling the earlier "kinked indifference curve" argument). The informationally-inexpensive elements of the reference wage might be those which are simply well-publicised, or those which are known and backward-looking (emphasising relativities in pay negotiations). In both cases, Taylor's argument that governments might act positively to influence individuals' information sets to improve the "rationality" of wage setting decisions would be upheld. The practicalities of such a policy are considered in the final section below, where we conclude the chapter by summarising the discussion of the preceding sections and drawing together the implications for policy.

2.6 Concluding remarks

The debate on the effectiveness of government policy discussed at the outset of this chapter centred attention on rigidities in nominal magnitudes, concluding that their presence provides a path through which government policy can exert an influence on real phenomena, so that, for example, we would expect severe deflationary policy to incur significant costs in terms of output loss and unemployment. This is true even when agents' expectations are formed rationally and are based on information sets which include all available data, so that systematic errors are not made, and there is no potential for any agents to be "fooled" by a government holding additional information. In these circumstances, however, the question of the source of inertia is naturally raised, since, if the output costs of a disinflationary programme, for example, are generated purely through the presence of inertia, then there are clear incentives for agents to eradicate this inertia. In sections 2.2 and 2.3, we discussed explicitly the source of costs in adjusting prices and wages. The discussion showed that these costs are in many ways intrinsic to the processes of shopping, of production, and of pay bargaining, so that their continuing presence can be easily understood in terms of the institutions of the supply side. It is clear that government intervention in these circumstances needs to concern itself with the microeconomics of adjustment costs. As we shall see in Chapter 4, there is evidence that governments have been able to influence these costs in the past, and there remains scope for such influence to be used to good effect in a macroeconomic context in future policy formulations.

The effects of inertia generated at the level of the individual unit taken in isolation can be exacerbated in two ways, and these were discussed in sections 2.4 and 2.5. Section 2.4 noted that the impact of nominal inertia is greater in the presence of real rigidities, and various explanations for inflexibilities in the real wage in the face of demand shocks were elaborated in the context of labour market models involving trade unions. These explanations were each concerned with the responsiveness of individual (real) wage settlements to conditions outside the bounds of the settlements. Hence, the potential importance of notions of "equity" or "wage aspirations" was raised, both of which are possibly formed with reference to wage settlements and labour market conditions outside the sector in which the firm/union unit may operate. Equally, the circumstances under which decision makers are insulated from the influence of the unemployed were considered in the discussion of insider-outsider models and explanations of unemployment hysteresis. Each of these explanations can therefore be seen in terms of the feedbacks between the decision making of individual, uncoordinated decision makers and the consequences of their joint actions. Similar ideas are encountered in section 2.5 where the issue of disaggregation is addressed explicitly, and where it was noted that the nominal inertia generated by the individual may accumulate as each individual assesses, and forms expectations on, the likely behaviour of others. To the extent that governments can influence the coordination of decisions across individuals, these arguments provide a potential for active government policy in improving the responsiveness of the supply side and the economy's resilience to shocks.

The recent literature on cross-country performances discussed in section 2.1 provides some useful insights into the practicalities of such policies. We recall that many commentators have noted the success of some economies, in terms of the maintenance of low inflation and low unemployment rates, relative to others in the face of the supply and demand shocks of the seventies and early eighties. In particular, this success has been associated with particular supply-side characteristics, and more specifically, that of "corporatism". While this concept is only loosely defined, it is clearly related to the problem of coordination discussed above, and some insights may be gained through some of the detailed analysis of these studies. For example, Calmfors and Driffill (1988) have recently attempted to identify the important characteristics of corporatism in order to establish the extent to which policy can help to improve labour market institutions within a country. They argue that three interrelated concepts appear to be important in defining corporatism: the first is the possible presence of an institutionalised bargaining framework; the second is the existence of "consensus" between different parties to the bargaining process over the goals of economic activity; and the third is a high degree of centralisation in bargaining. Calmfors and Driffill concentrate on the third of these elements, presenting evidence of a "hump-shaped" relationship between centralisation and economic performance over seventeen developed economies. In this, countries with highly centralised and highly decentralised bargaining appeared to have done well over the last two decades, while intermediately centralised economies did less well. The authors' explanation for this stylised fact is that increasing centralisation of bargaining, assumed to mean the progressive amalgamation of sectors producing closely related products, would generate two forces working in opposite directions: first, individual unions would gain in market power as centralisation increased, and second, the effect of their wage setting on aggregate prices would be progressively increased. As centralisation rises, there is pressure on real wages in each sector to increase as increasing market power allows the output price of the sector to rise (hence, unions take advantage of the fact that the rise in the <u>product</u> real wage due to a given money wage increase is reduced if the wage rise can be passed on in a price increase). At the same time, however, a rise in wages also leads to an increase in the aggregate price level, and as unions become larger the real wage gain of a given money wage increase is progressively reduced through this feedback. Calmfors and Driffill argue that the market power influence is most important at first as amalgamation takes place between small unions producing close substitutes. As larger, and less closely related, units amalgamate, however, the aggregate price effect dominates. Real wages rise and then fall as the extent of centralised bargaining rises because the two effects dominate in turn. In terms of policy prescription, then, government is faced with the apparently dichotomous choice of either encouraging decentralisation in bargaining, so that real wages are reduced through the rigours of product market competition, or of encouraging further centralisation so that the economy-wide externalities incurred through individuals' decisions are progressively internalised.

The analysis described above provides a useful insight into the sphere of the economy that government may need to manipulate if it wishes to influence supply side responsiveness. However, it is clear that such policies will be difficult to implement. The encouragement of more or less centralised bargaining in an economy is at best a slow process, and would be associated with the evolution of new bargaining frameworks (with more or less formal structures), and the development or abandonment of "consensus" on economic goals, depending on the direction that government policy takes. Moreover, progress on any of these fronts would depend on the historical and political climate in the country, so that it may be simply not possible to construct a single set of policy prescriptions that would achieve a given desired state. Having said this however, there may be policies which can be introduced piece-meal in order to encourage developments in a desired direction.

An illustration of such a policy for the UK might be Meade's (1981) suggestion of "not-quite-compulsory arbitration". In this, the vast majority of wage settlements would continue to be set without outside influence, as employers and employees make use of their detailed knowledge of their own labour market to settle at a "reasonable" rate of pay. In this sense, the policy suggestion works within the UK context of disaggregated and decentralised decision making. When a settlement cannot be achieved, however, external influence would be exerted through a single Arbitration Body to whom either party to the negotiations could refer the dispute. This Body would make an award which put a premium on the generation of employment in the sector, while also taking into account the needs of the sector in attracting (or losing) labour in the face of structural change. It is through this Body therefore that the externalities of a decision are brought to bear on the negotiating parties. "Pendulum arbitration" might be incorporated into the scheme, where the Arbitration Body supports the position of one or other side, and avoids compromise decisions. In this way, both parties are forced to set their claims relatively close to what they believe will be the Arbitration Body's preferred position, thereby encouraging consensus. Parties would retain the right to strike or lock-out following the settlement of an award, but should they do so, they would be penalised in ways chosen to reduce their bargaining strength. Such a scheme might help to improve supply side responsiveness in two direct ways. The first involves the elimination of some of the information imperfections that we have suggested may dominate current wage setting practices in the UK, since Meade's Arbitration Body would be in a good position to provide forecasts of future innovations that should be accommodated within wage setting decisions. Their implications for wage setting could be announced, or inferred from decisions on disputes taken to the Body. These forecasts would emphasis the forward-looking factors that should be incorporated within wage setting decisions, and insofar as these replaced backward-looking variables and high-profile settlements as indicators of future changes in the aggregate economy, this would result in "more rational" expectations and speedier nominal adjustment.(21) The second direct gain to be achieved through Meade's scheme would be that it allows the economy-wide implications of decisions to be explicitly incorporated into the process of wage bargaining at the individual level. The responsiveness of real wages to aggregate demand shocks should be correspondingly quicker, so that some element of real wage rigidity would also be eliminated.

Meade's suggestions have the advantage that they could be introduced in the UK without the abandonment of the current decentralised bargaining structures. Indeed, to some extent they circumvent the dichotomous choice posed by Calmfors and Driffill in suggesting a means of improving coordination of wage settlements without the need to move to a more centralised bargaining structure, which may not be politically viable in the UK.(22) There may be side-effects to Meade's arrangements, of course, if consensus over the aims of economic policy developed, or if the scope for centralisation of bargaining altered. However, these would evolve out of the political and economic consequences of the legislation and could not be easily manipulated by government policy. Nevertheless, the benefits that would be obtained through the direct routes mentioned above provide a good illustration of the sort of policies that could be pursued by government through legislation.

The discussion of this chapter has provided a background to some of the theoretical issues involved in the discussion on wage and price inertia, and has hopefully illustrated the potential significance of the issues in terms of macroeconomic performance, and the scope for government policy intervention. In the remainder of the thesis, I shall present some empirical work carried out to investigate the extent of the rigidities found in the supply side of the UK economy in practice, and to identify their causes. In this I shall first concentrate on nominal wage inertia, considering the influences on the speed of adjustment in nominal wages in chapters 3 and 4. The influences on the speed of price adjustment are considered in chapter 6, building on the results obtained through the estimation of a disaggregated model of the UK supply side elaborated in chapter 5. These results are also employed in an analysis of real wage and price rigidities in a sequence of simulation exercises described in chapter 7. In these, particular attention is paid to the issue of pay comparability, and to the argument that settlements in one sector might influence those elsewhere not only through their ultimate effect on the price level, but also more directly through their influence on sectors' "reference" wages, as discussed above. The precise nature of the reference wage is only ambiguously defined, and may change over time, making it difficult to model econometrically. Nevertheless, as we have seen, its significance in wage determination could be high, given the disaggregated nature of wage setting practices in the UK, and it could be important to distinguish the significance of this influence, as compared to the internal and external influences more commonly explored, if policy prescriptions are to be found.

CHAPTER 3

An Indirect Investigation into Nominal Wage Inertia

Throughout the previous two chapters, I have emphasised the definition of inertia as being the lack of responsiveness of a variable in the face of changes which would warrant a response. Given this definition, it is clear that the variability of a particular variable, looked at in isolation, will not provide much information on the flexibility of that variable. This argument is put forward in Jenkinson and Beckerman (1986), who point out that an economy which experiences great variability in the factors which determine wage growth, say, would be expected to show greater variability in the rate of wage growth over time than another economy, whose institutions are equally responsive, but who have not experienced such variability in the underlying driving variables. While this is true, it is not accurate to say that the variability in wage growth cannot provide some insights into the determinants of wage flexibility if this information is supplemented with details on the underlying driving factors. This point is made clearly in Hamermesh (1985) who suggests a test for the existence of nominal, and ex-ante real, (Keynesian) wage rigidity based on the variability of wage growth across sectors, and its relation with inflation. Hamermesh's idea is based on the asymmetries generated by the presence of Keynesian nominal wage rigidities, in which money wages cannot be reduced, and by ex-ante real wage rigidities, in which money wages cannot rise at a lower rate than the expected rate of inflation. In a world with nominal wage rigidities, for a given degree of variability in labour demand conditions across the different sectors of the economy, the variability of wage growth will be greater during periods of high inflation as fewer agents are constrained by the zero-growth lower bound. If nominal wage rigidity is absent, Hamermesh argues, no association with inflation should be found (the test for ex-ante real wage rigidity is the same, except here the level of inflation over the anticipated rate would provide the range over which agents are unconstrained).

Hamermesh applies these tests to U.S. data over the period 1965-81 and discovers a negative relation between the variability of wage growth and inflation (particularly the unanticipated component). Two scenarios are proposed which are consistent with this finding. The first is that inflation uncertainty causes workers and employers to focus more on inflation when wage increases are determined; while Hamermesh's estimations take into account the fraction of the labour force whose wages are formally indexed, so that this cannot provide an explanation for the observed relation, this informal indexing might be associated with reduced wage growth variability exactly as explicit wage indexation would be. The second explanation is that increased inflation is associated with an increased frequency and synchronisation of settlements which could generate the results.

In the next section, I look more closely at Hamermesh's test for the existence of wage rigidity, and consider a more general approach to its derivation which can explicitly incorporate the second of these explanations into the theoretical model. On this basis, I will demonstrate that wage growth variability may be positively associated to inflation even in the absence of simple Keynesian wage rigidities (so that Hamermesh does not test for their existence). I will then present some results for the U.K. which run counter to those obtained for the U.S., indicating that, for the U.K. at least, the extended model may provide a reasonable description of the influence of inflation on labour market responsiveness.

3.1 Testing for labour market adjustment

As the discussion in chapter 2 indicated, there are a variety of possible reasons why wages might not change in each period, and the simple notion of downward Keynesian rigidities is just one of these. In deriving his test, however, Hamermesh concentrates exclusively on this one element of wage adjustment, so that the basis for the test is given by the wage setting equation

$$w_{it} = \max\{\, p_t^e + p_t^u + \alpha y_{it} \,,\, 0 \,\} \tag{3.1}$$

where i is an economic unit, w is the instantaneous rate of wage increase, p_t^e and p_t^u are instantaneous rates of expected and unexpected aggregate price inflation, and y_i is the level of excess demand in the i^{th} sector. This equation clearly incorporates a zero-growth lower bound, as implied by nominal wage rigidity. By assuming y_{it} to be a random variable with density function g(y) and distribution function G(y), we can write:

$$\begin{aligned} \mathrm{var}(w_{it}) = & \int_{y_t^*}^{\infty} [\, p_t^e + p_t^u + \alpha y_{it} \,]^2 \, g(y_{it}) \, dy \\ & - \{ \int_{y_t^*}^{\infty} [p_t^e + p_t^u + \alpha y_{it}] \, g(y_{it}) \, dy \,\}^2 \end{aligned} \tag{3.2}$$

where $y_t^* = -\dfrac{(p_t^e + p_t^u)}{\alpha}$ = minimum level of excess demand associated with non-zero wage growth

This provides the result (see Appendix):

$$\mathrm{var}(w_{it}) = [1-G(y_t^*)] \, \alpha^2 \mathrm{var}(\tilde{y}_{it}) + G(y_t^*)[1-G(y_t^*)] \, E(\tilde{w}_{it})^2 \tag{3.3}$$

where $var(\tilde{y}_{it})$ = variability of excess demand among those units with non-zero growth, and $E(\tilde{w}_{it})$ = average wage growth in the same units.

Written in this way, the basis for Hamermesh's test of the existence of wage rigidity becomes apparent; with $G(y_t^*)$ constant, $var(w_{it})$ is positively related to p_t^e and p_t^u via the term $E(\tilde{w}_{it})$ in (3.3). As p_t^e or p_t^u rise, then so does the average level of wage growth among those who are not constrained by the zero-growth lower bound, and the variability of wage growth rises. Note that because $E(\tilde{w}_{it})$ has a coefficient of $G(y_t^*)[1-G(y_t^*)]$, this influence is greatest when the division between the units with zero and non-zero wage growth is at its keenest; i.e. where $G(y_t^*) = \frac{1}{2}$. Further, the influence exists only when $G(y^*_t)$ lies strictly between zero and one; if the level of excess demand is sufficiently low for $G(y_t^*) = 1$, so that all agents are on the zero-growth lower bound, then no renegotiations occur, and clearly, the variability in wage growth is zero. On the other hand, if the level of excess demand for labour is sufficiently high for no agent to be constrained by the lower bound, so that $G(y_t^*) = 0$, than the variability in excess demand for labour over the sectors is the sole determinant of wage growth variability. This is clearly also true if the lower bound does not exist, i.e. there is no nominal wage rigidity.

Hamermesh's test for the existence of wage rigidities is a natural one given the wage-setting process described at (3.1). However, this captures only one of the features of the labour market which might contribute to imperfect wage adjustment, and a generalisation of (3.1) is therefore given in (3.4):

$$w_{it} = \begin{cases} \max\{ p_t^e + p_t^u + \alpha y_{it}, 0\} & \text{with probability } \pi_{it} \\ 0 & \text{with probability } (1-\pi_{it}) \end{cases} \tag{3.4}$$

The probability π_{it} can be thought of as the probability of renegotiating beyond the influence of simple Keynesian rigidities, and because it can alter from period to period and from agent to agent, it provides the means of incorporating any number of labour market features into the wage adjustment process. For example, a freeze incomes policy might reduce the probability of renegotiation for all agents to zero, while Hamermesh's proposition that increased inflation might raise π_{it} directly can also be accommodated.(1)

Ignoring for simplicity the possibility of industry-specific influences on π_{it} (so that $\pi_{it} = \pi_{jt} = \pi_t \; \forall i, j$),(2) the variance of w_{it}, given the same description of the distribution of y_{it} as before and the wage-setting process at (3.4), is:

$$var(w_{it}) = \pi_t^* \alpha^2 \, var(\tilde{y}_{it}) + \pi_t^*(1-\pi_t^*) \, E(\tilde{w}_{it})^2 \tag{3.5}$$

where $\pi_t^* = \pi_t(1 - G(y_t^*))$

This form is clearly very similar to that at (3.3), although the proportion of agents negotiating here is given by the more general term π_t^*. Again, p_t^e and p_t^u will affect $var(w_{it})$ positively so long as this proportion lies strictly between one and zero, with the influence greatest when the division between those agents negotiating and those leaving wages unaltered is greatest, i.e. where $\pi_t^* = \frac{1}{2}$.

The important feature to note about (3.5) is that if excess demand is sufficiently high that no agent is constrained by the Keynesian rigidities, or equivalently, if no rigidities of this sort exist, then we can write $G(y_t^*) = 0$, and (3.5) simplifies to

$$var(w_{it}) = \pi\alpha^2 \, var(\tilde{y}_{it}) + \pi(1-\pi) \, E(\tilde{w}_{it})^2 \qquad (3.6)$$

Even if simple Keynesian rigidities are absent, $var(w_{it})$ will still be related to $E(w_{it})$, and hence p_t^e and p_t^u, so long as $\pi \in]0,1[$, so that the empirical search for such a relation cannot provide a test of their existence.

Further, the responsiveness of $var(w_{it})$ to p_t is shown in the following:

$$\frac{\delta var(w_{it})}{\delta p_t} = \pi^* . \frac{\delta var(\tilde{y}_{it})}{\delta p_t} + \frac{\delta \pi^*}{\delta p_t} \alpha^2 var(\tilde{y}_{it}) + \frac{\delta \pi^*}{\delta p_t} (1-2\pi^*)[E(\tilde{w}_{it})]^2 + \pi^*(1-\pi^*) \frac{\delta [E(\tilde{w}_{it})]^2}{\delta p_t} \qquad (3.7)$$

Given the evidence of, for example, Pencavel (1982) or Christofides (1985), on the positive impact of inflation on the frequency of negotiation (i.e. $\delta\pi^*/\delta p_t > 0$), the contribution of the last three terms of (3.7) is most likely to be positive: even if π^* exceeds $\frac{1}{2}$, so that the third term in (3.7) is negative, this will be dominated by the second and fourth terms which are unambiguously positive. In this model, then, it is clear that a negative relation between inflation and $var(w_{it})$ would require inflation to exert a very strong (negative) influence on $var(y_{it})$.(3) In the absence of a justification for such an influence, an economy with any features likely to impede instantaneous wage adjustment would therefore be expected to demonstrate a positive relationship between inflation and wage variability.

3.2 The U.K. experience

In the previous section, I not only asserted that the method employed by Hamermesh would not allow us to test the hypothesis that nominal, or ex-ante real, wage rigidities are a feature of the wage adjustment process, but I also argued that the presence of any impediment to instantaneous wage adjustment would be likely to generate a

Table 3.1

Variability of wage growth across industrial sectors

Date	100*var(w_{it})
1964(2)	.158
1965(1)	.178
(2)	.091
1966(1)	.126
(2)	.089
1967(1)	.060
(2)	.129
1968(1)	.149
(2)	.158
1969(1)	.098
(2)	.121
1970(1)	.046
(2)	.150
1971(1)	.167
(2)	.063
1972(1)	.108
(2)	.092
1973(1)	.059
(2)	.071
1974(1)	.165
(2)	.927
1975(1)	.689
(2)	.115
1976(1)	.048
(2)	.036
1977(1)	.021
(2)	.078
1978(1)	.345
(2)	.235
1979(1)	.102
(2)	.108

positive link between inflation and wage variability. Given this, it is of interest to find whether similar results to those obtained with U.S. data are to be found for the U.K., so that below I present exactly equivalent estimates using U.K. data.

Table 3.1 presents the variable to be explained in the study; namely, the variability of wage change across industrial sectors over time. These figures are derived from data on average earnings in 23 industrial groups, covering the whole economy, and based on the 1968 SIC, and are calculated according to the formula used by Hamermesh:

$$var(w_t) = \Sigma_i \left[\frac{W_{it}}{W_{it-2}} - 1 \right]^2 . E_{it} \tag{3.8}$$

where W_i is the ratio of the average hourly earnings in sector i to a weighted average of earnings among all sectors, and E_{it} is the i^{th} sector's share of total employment at time t.(4) As in the U.S., this variable shows no particular trend over time, although it should be noted that there are two outliers in the periods 1974(2) and 1975(1) where variability is very high. This was, of course, a period of very high inflation, which reached a record level of 30% in 1975(1).

The measure of expectations of inflation rates employed here is a 'rational expectations' measure of anticipated rates of change in the consumer expenditure deflator generated by the macromodel at the National Institute. Anticipated inflation rates over a variety of horizons were available, although I have concentrated on the 12-month forward expectations series.

Again following Hamermesh, consideration of incomes policy effects has also been made, although given the variety of forms of incomes policy experienced in the U.K. over the period, more attention has had to be paid in this area. In particular, it is noted that while guide-posts of the form "£x per annum" (i.e. flat-rate incomes policies) can be expected to reduce the variability of wage growth during their implementation, those of the form "x% per annum" (i.e. proportional guidelines) will not.(5) Table 3.2 presents a brief summary of the aims of the various periods of incomes policy regarding acceptable increases in earnings (see Ashenfelter and Layard (1983), Pudney (1984) or Whitley (1986) for more detailed expositions of these aims). As is clear, there have been a number of periods during which incomes policies could have had a dampening effect on wage growth variability; the period of 'Wage Freeze' and 'Severe Restraint' of 1966(iii)-1967(ii), and the 'Standstill' of 1974(ii) to 1973(i) both attempted to reduce the number of negotiations over wages to zero; phase two of the Heath administration between 1973(ii) and 1973(iii), the 'threshold payments' of 1974(ii) to 1974(iii), and phase one of Labour's 'Social Contract' each involved a lump-sum wage limit, of £1, £4.40, and £6 respectively; and finally, the policies of 1973(iv)-1974(i) and 1976(iii)-1977(ii) (phase two

Table 3.2

Brief description of pay policies ; 1964-1982

Period	Description
Wilson's Labour Government	
1965ii-66ii	Ceiling incomes policy; target increase of 3.5% enforced in public sector only
1966iii-67ii (F1)	"Wage Freeze" and "Severe Restraint". Statutory.
1967iii-68i	Ceiling policy; voluntary restraint with zero norm
1968ii-70ii	Ceiling policy; statutory 3.5% limit
Heath's Conservative Government	
1972iv-73i (F2)	Wage freeze during "Standstill". Statutory.
1973ii-73iii (C1)	Pay increases restricted to £1+4% (£5 maximum). Statutory.
1973iv-1974i (C2)	Pay increases restricted to 7% or £2.25 if higher. Statutory.
1974ii-74iii (C3)	Above augmented by £4.40 paid for "threshold" agreements.
Labour's "Social Contract"	
1975iii-75iv (C4)	Ceiling policy with limit equivalent to £6. Statutory
1976iii-77ii (C5)	Pay limit of 5%, subject to £2.50 per week minimum and £4 per week maximum. Statutory.
1977iii-78ii	Statutory limit of 10%
1978iii-1978iv	New statutory limit of 5%; rejected by TUC and statutory powers removed early 1979.

of the Social Contract), while stated as proportional policies, also included maximum and minimum bounds for wage change. The influence of these seven periods of policy on wage growth variability will therefore be investigated.

Equations (3.1) and (3.4) incorporate the effects on wage growth in sector i of the real excess demand for labour in the sector, y_{it}. This is a natural explanatory variable to include in the determination of wage growth, but it is by no means clear how it should be measured at the sectoral level. In his study, Hamermesh used changes in sectoral output as the measure of the level of excess demand. This measure has the advantage that sectoral output is a well defined concept that is easily measured. However, it is clear that changes in sectoral output provide, at best, only an indirect indication of the state of the sectoral labour market. A more usual measure of labour market slack, following the Phillips curve literature, is the sectoral unemployment rate. However, even this measure is not a perfect proxy for the excess supply of labour, and there are a number of problems associated with its measurement.

The difficulties involved in the use of unemployment rates as a measure of excess demand for labour have been widely discussed, especially in the literature on frictional unemployment and the effects of structural change on sectoral labour markets.(6) For example, it is widely recognised that the level of unemployment understates the degree of labour market slack to the extent that there are people who are 'partially unemployed'. These people may be employed part-time, but may prefer to work full-time, and may be searching for full-time employment. Equally, some people classified as 'not-in-the-labour force', in the sense that they are neither employed nor looking for work, may be simply 'discouraged workers', and have ceased to look for work as they do not think that there is a reasonable chance of finding it. Even assuming that the measure of the unemployed in a sector accurately represents the numbers of workers equipped and looking for work, it is clear that a growth in the numbers unemployed which is matched by a corresponding growth in the number of job opportunities available would not constitute an increase in labour market slack in the sector. This suggests the use of data on vacancies, as a complement to the unemployment data, to obtain a more complete picture of the state of the sectoral labour market. However, there are similar problems involved in the use of vacancy data. For example, employers may not advertise vacancies which they do not believe they have a reasonable chance of filling, so that there is an element of unsatisfied labour demand excluded from the vacancy data (an element which will grow as the extent of unsatisfied labour demand grows). Alternatively, employers may use the adverisement of vacancies in different ways according to the state of the labour market: for example, in recession, employers may become more selective in the recruitment of new employees for any given number of advertised vacancies (so that the number of vacancies again overstates the degree of unsatisfied labour demand).

In practice, these conceptual problems related to the interpretation of unemployment and vacancy data are compounded by the problems of data availability and reliability. Jackman and Roper (1987) note that in the U.K., only about one third of vacancies are recorded, and that the extent of non-notification is unlikely to be uniform across sectors (industrial, regional, or occupational). Further, in the U.K., the unemployed are generally assigned to the industry in which they last worked. This procedure not only leaves many of the unemployed unclassified by industry (some 24% of the unemployed were unclassified in 1981, for example), but also understates the excess supply of labour in any one sector as many unemployed are available to work in several different industries. This latter point highlights the fact that the tightness of the labour market can be affected over many different dimensions; for example, there may be upward pressure on wages generated through excess demand for skilled labour, for labour in the South, for female labour, or for adult labour, while demand for unskilled labour, for labour in the North, for male labour, or for youth labour remains unchanged. Some of these pressures may be reflected by the shedding of labour in particular industries, and by increases in the number of vacancies in others, but it is clear that the published industrial unemployment and vacancy data cannot be expected to capture all of the pressures generated across the many dimensions of the labour market.

Despite these reservations, the published figures do provide some information on the conditions in sectoral labour markets, and in the absence of better data, output change, unemployment rates, and an unemployment rate measure adjusted for vacancies will all be used in the following analysis to capture the pressure on wage growth variability generated by excess demand for labour. Moreover, it is recognised that in moving from the static relationship of (3.5) to a time series analysis, the description of the distribution of excess demand has to be amended to take up movements in excess demand pressure over time. Hence, we might write

y_{it} = aggregate excess demand for labour in i at time t

$= y_t + y_{it}^*$

where y_t = aggregate level of excess demand at time t, and y_{it}^* has the distribution and density functions described earlier. From this, it is clear that y_t should figure in the determination of $\text{var}(w_{it})$ in exactly the same way as $(p_t^e + p_t^u)$; positively with coefficient $\pi^*(1-\pi^*)$. Consequently, both the variability in excess demand over sectors and its aggregate level will be used in our regression analysis.

The results of the econometric analysis of the variability of wage growth across sectors are given in Tables 3.3 and 3.4. Table 3.3 presents the results of the estimation of equations for the U.K. corresponding to those of Hamermesh, covering the period 1964(2)-1979(2) using semi-annual data. Three sets of results are reported in columns (1)-

Table 3.3
Dependent variable: $v(w_{it}) = 100*var(w_{it})$

		$y_{it} = \Delta output_{it}$		y_{it} = (unem-vac)$_{it}$%			$y_{it} = unem_{it}$%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-0.056 (0.589) [0.552]	-0.016 (0.193) [0.199]	0.028 (0.412) [0.525]	-0.004 (0.058) [0.058]	-0.016 (0.418) [0.401]	0.011 (0.289) [0.279]	0.095 (1.096) [0.906]	0.156 (2.560) [1.688]	0.144 (2.227) [1.803]
p	0.025 (2.622) [2.303]			0.031 (5.820) [3.352]			0.032 (5.603) [2.964]		
p_t^e		0.026 (3.172) [1.318]	0.024 (3.806) [3.267]		0.038 (10.116) [8.113]	0.034 (8.533) [5.447]		0.039 (9.254) [6.192]	0.035 (8.344) [5.109]
p_t^u		-0.002 (0.163) [0.180]	-0.001 (0.121) [0.176]		0.001 (0.116) [0.119]	0.008 (1.075) [1.262]		0.001 (0.124) [0.112]	0.006 (0.779) [0.820]
$v(y_{it})$	0.705 (0.688) [0.596]	0.369 (0.405) [0.410]	-0.056 (0.077) [0.094]	0.610 (1.242) [0.773]	0.914 (2.805) [1.715]	0.610 (1.962) [1.267]	0.190 (0.407) [0.299]	0.502 (1.527) [1.014]	0.298 (1.092) [0.737]
y_{it}	0.030 (0.163) [0.158]	-0.079 (0.475) [0.426]	-0.115 (0.888) [1.076]	-0.136 (2.045) [1.341]	-0.190 (4.259) [2.537]	-0.143 (3.087) [2.006]	-0.074 (1.117) [0.835]	-0.134 (2.830) [1.751]	-0.101 (2.278) [1.499]
C1	-0.145 (0.927) [2.418]	-0.030 (0.207) [0.4032]		-0.202 (1.538) [3.932]	-0.100 (1.140) [3.087]		-0.170 (1.223) [2.732]	-0.047 (0.471) [0.875]	
C2	-0.175 (1.167) [3.102]	-0.233 (1.735) [3.714]		-0.284 (2.098) [3.739]	-0.423 (4.504) [7.943]		-0.213 (1.541) [3.259]	-0.316 (3.234) [6.529]	
C3	-0.252 (1.569) [2.193]	-0.301 (2.108) [2.729]		-0.416 (2.849) [3.132]	-0.554 (5.608) [8.232]		-0.338 (2.307) [2.675]	-0.453 (4.354) [5.827]	
C4	-0.401 (2.661) [2.531]	-0.240 (1.639) [1.908]		-0.441 (3.432) [2.373]	-0.310 (3.550) [3.929]		-0.413 (3.030) [2.539]	-0.290 2.983) [6.297]	
C5	-0.415 (2.901) [2.455]	-0.339 (2.621) [3.168]		-0.391 (2.728) [2.005]	-0.391 (4.173) [3.676]		-0.323 (2.263) [2.319]	-0.318 (3.228) [3.095]	
CINC			-0.222 (3.088) [3.022]			-0.321 (5.742) [3.780]			-0.269 (5.228) [3.909]

(cont...)

F1	-0.029	0.008		0.024	0.091		-0.012	0.045	
	(0.219)	(0.073)		(0.240)	(1.388)		(0.114)	(0.635)	
	[0.403]	[0.166]		[0.485]	[2.130]		[0.451]	[1.238]	
F2	-0.125	-0.075		-0.001	0.034		-0.073	-0.058	
	(0.729)	(0.490)		(0.005)	(0.367)		(0.530)	(0.618)	
	[1.206]	[0.772]		[0.008]	[0.476]		[1.474]	[1.455]	
FINC			-0.009			0.034			-0.012
			(0.108)			(0.531)			(0.185)
			[0.236]			[0.696]			[0.297]
R^2	0.599	0.705	0.648	0.701	0.879	0.795	0.670	0.851	0.779
SSR	0.420	0.309	0.368	0.313	0.127	0.215	0.345	0.156	0.232
DW	1.429	0.854	1.149	1.810	1.667	2.006	1.807	1.516	1.939
SC	4.579	9.177	3.703	6.744	2.554	6.125	5.533	0.970	2.774
ADD	6.236	5.945	4.090	6.988	6.809	3.129	7.324	4.346	2.047
N	14.644	13.418	7.522	3.679	0.692	0.428	11.933	0.238	2.032
H	11.418	11.689	15.151	7.117	0.383	5.645	5.915	2.549	5.851

Notes:

Standard absolute t-statistics in ( ); absolute t-statistics based on White's heteroskedasticity-consistent estimate of the error variance-covariance matrix in [ ].

SSR is the sum of squared residuals; DW is the Durbin Watson statistic; SC is a Lagrange Multiplier test of serial correlation (two periods), cf. $\chi^2(2)$; ADD is a test of the null hypothesis that the addition of two lagged dependent variables does not contribute to the fit of the eqaution, cf. $\chi^2(2)$; N is a test for Normality of residuals, cf $\chi^2(2)$; and H is a test for heteroskedasticity, cf. $\chi^2(1)$.

When excess demand is measured through output change, equation (3.3) is employed to obtain its variability over sectors. The standard variance measure is employed when the unemployment rates (adjusted and unadjusted) are used.

Define

$$y_{it} = (\text{unem-vac})_{it}\% = \frac{(\text{no. unemployed in sector i - no. vacancies in sector i})}{\text{total employment in sector i}}$$

$$y_{it} = \text{unem}\% = \frac{\text{no.unemployed in sector i}}{\text{total employment in sector i}}$$

Data source:

See Data Appendix

(3), (4)-(6), and (7)-(9) in which the three alternative measures of excess demand are used (the growth in sectoral output, the sectoral unemployment rate adjusted for vacancies, and the unadjusted unemployment rate respectively). The clearest result to emerge from all of the equations is the strong positive relationship that exists between wage growth variability and inflation, as predicted by the model of the previous section. This holds true with excess demand measured by any one of the three alternative variables. Splitting this effect into its expected and unexpected components significantly improves the fit, as given in (2), (5), and (8), with expected inflation showing significantly, and unexpected inflation insignificantly, in each case. The results of the tests, with excess demand measured by output change, (unemployment-vacancies) rate, and the unemployment rate respectively, give F-statistics of 6.81, 27.93, and 23.02, each compared to $F_{1,19}$. This provides strong evidence to support the use of separate variables to capture the effects of unanticipated and anticipated inflation in subsequent analysis.[(7)]

Restricting attention to columns (2)-(3), (5)-(6), and (8)-(9), then, it is clear that the results obtained are also influenced by the choice of the excess demand measure. In columns (2), (5), and (8), for example, it is noted that although var(y_{it}) exerts a positive influence in all cases, as predicted, this influence is statistically significant only when excess demand for labour is measured by the adjusted unemployment rate. Further, while the aggregate level of excess demand exerts influence on var(w_{it}) in the predicted direction in each case (positively for output change, and negatively for the adjusted and unadjusted unemployment rates), this influence is insignificant when output change is the measure used. Taken with the diagnostic test statistics presented, and to be discussed below, these results suggest that the more direct measures of excess demand, i.e. the adjusted and unadjusted unemployment rates, are to be preferred to the less direct measure employed by Hamermesh.

The direction of influence of the incomes policy dummies are, by and large, negative, as we would expect. In particular, incomes policies C2, C3, C4 and C5 consistently show significantly, although C1 and, surprisingly, the periods of freeze incomes policy fail to do so. (The fact that in each case the freeze policies were only operative during a part of the consecutive 6-month periods for which F1 and F2 were set to one may provide some explanation for these results.) Columns (3), (6), and (9) display similar results to those of (2), (5), and (8), but with the effects of all of the periods of flat-rate and freeze policies captured by the two variables CINC (=C1 to C5), and FINC (=F1 + F2). Tests of the restrictions involved here indicate that apart from column (6), where there is weak evidence against the restrictions, the analysis is unable to adequately distinguish between the impacts of the separate periods of policy. This is demonstrated through F-statistics of 0.72, 2.64, and 1.84 (cf $F_{5,19}$) for equations (3), (6), and (9) respectively. Having said this, however, the diversity of estimated coefficients on the incomes policy dummies suggests that the separate periods of policy were more or less influential in the development of sectoral wage growth, and the unrestricted equations of columns (5) and (8) therefore represent the preferred equations in Table 3.3. Finally on the impact of incomes policy, it should be noted that the use of additional dummies to capture the influence of the remaining 'proportional guidelines' policies was also considered. These did not contribute significantly to the fit of the equations, however: the joint significance of dummy variables C65 (1965(1)-1966(1)), C67 (1967(2)-1968(1)), C68 (1968(2)-1970(1)), C77 (1977(2)-1978(1)) and C78 (1978(2)) in equations (3), (6), and (9) is given by F-statistics of 0.20, 1.01, and 0.96 respectively (cf. $F_{5,19}$).(8)

Given that the dependent variable, as noted previously, has no particular trend over time, the R^2 obtained in the regression analysis, and given at the foot of the Table, are reasonable, with around 70% of the variability in the dependent variable explained. The set of equations with least explanatory power is that in which output growth is used as the measure of excess demand, and this set is also the one in which the Normality assumption is most clearly rejected. This provides further support for the use of the direct measures of excess demand over Hamermesh's measure. The test for homoskedasticity in the errors is also most clearly rejected in the equations in columns (1)-(3), although this finding is not restricted to these columns. In fact, although there is no evidence of heteroskedasticity in the preferred equations of columns (5) and (8), it is clear that this may be a more general problem. It is for this reason that a second set of t-values are presented (in square parentheses) in the Table which use adjusted White's heteroskedasticity-consistent estimates of the variance-covariance matrix. Inferences based on these statistics will be more reliable in the presence of heteroskedasticity, although in fact the inferences made are qualitatively unaltered form those described in the paragraphs above: the influence of expected inflation, while less pronounced, remains highly significant, the direct measures of excess demand remain superior to the output change measure, and the significance of the incomes policy dummies is, if anything, emphasised.

Finally, here, the statistics denoted 'DW', 'SC', and 'ADD' all consider the dynamic properties of the regressions, and suggest that the original specification considered by Hamermesh may not be sufficiently general to accomodate all of the influences on var(w_{it}) over time in the case of the U.K.. Specifically, the Durbin Watson statistic (DW) is rather small, and although the statistic lies in the region of indeterminancy in all cases, this of course provides some evidence of (first order) serial correlation in the errors. The statistic denoted 'SC' is the Lagrange Multiplier statistic testing for serial correlation in the residuals for two lags jointly, while the statistic denoted 'ADD' is a joint test of zero restrictions on two lagged dependent variables added to the reported equations. These are of obvious interest, given that the data employed here is semi-annual, so that two lags are necessary to capture any annual

Table 3.4
Dependent variable: $v(w_{it}) = 100*var(w_{it})$

		$y_{it} = \Delta output_{it}$		y_{it} = (unem-vac)$_{it}$%			$y_{it} = unem_{it}$%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-0.008 (0.074) [0.078]	-0.002 (0.024) [0.024]	0.009 (0.126) [0.139]	0.125 (1.459) [1.305]	0.030 (0.507) [0.568]	0.006 (0.147) [0.126]	0.157 (1.704) [1.345]	0.159 (2.413) [1.837]	0.127 (1.788) [1.813]
p	0.027 (2.578) [1.532]			0.033 (4.706) [2.272]			0.034 (4.475) [2.021]		
p_t^e		0.026 (3.172) [1.936]	0.021 (2.725) [1.990]		0.034 (7.553) [4.076]	0.029 (5.601) [2.695]		0.036 (6.737) [3.312]	0.032 (5.553) [2.510]
p_t^u		-0.002 (0.163) [0.474]	-0.009 (0.659) [0.952]		-0.003 (0.309) [0.300]	-0.001 (0.057) [0.057]		0.001 (0.075) [0.067]	0.002 (0.142) [0.133]
$v(y_{it})$	0.704 (0.688) [0.573]	0.535 (0.686) [0.744]	0.541 (0.071) [0.086]	0.222 (0.429) [0.294]	0.773 (2.197) [1.849]	0.662 (2.014) [1.412]	-0.219 (0.435) [0.344]	0.303 (0.789) [0.749]	0.300 (1.048) [0.783]
y_{it}	0.132 (0.163) [1.031]	-0.021 (0.120) [0.127]	-0.083 (0.605) [0.698]	-0.096 (1.379) [1.030]	-0.166 (3.532) [2.673]	-0.141 (2.846) [1.944]	-0.022 (0.312) [0.260]	-0.098 (1.815) [1.560]	-0.091 (1.951) [1.412]
C1	-0.169 (1.091) [2.448]	-0.012 (0.085) [0.166]		-0.233 (1.775) [2.864]	-0.085 (0.948) [1.823]		-0.212 (1.543) [2.457]	-0.051 (0.483) [0.797]	
C2	-0.187 (1.256) [2.033]	-0.218 (1.713) [2.761]		-0.308 (2.235) [2.615]	-0.383 (4.256) [4.973]		-0.259 (1.856) [2.316]	-0.303 (3.018) [3.916]	
C3	-0.300 (1.773) [1.436]	-0.285 (1.982) [1.903]		-0.463 (2.965) [2.197]	-0.512 (5.072) [4.220]		-0.414 (2.619) [1.926]	-0.440 (3.880) [3.169]	
C4	-0.128 (0.435) [0.544]	0.130 (0.521) [0.441]		-0.170 (0.565) [0.550]	-0.015 (0.076) [0.109]		0.246 (0.761) [0.782]	0.039 (0.165) [0.191]	
C5	-0.440 (2.905) [1.866]	-0.311 (2.265) [1.977]		-0.332 (2.219) [1.360]	-0.341 (3.534) [3.209]		-0.275 (1.769) [1.317]	-0.283 (2.551) [3.031]	
CINC			-0.155 (1.988) [1.505]			-0.274 (4.130) [2.303]			-0.226 (3.515) [2.142]

(cont...)

F1	-0.009	0.017		-0.014	0.077		-0.037	0.040	
	(0.066)	(0.153)		(0.145)	(1.154)		(0.366)	(0.528)	
	[0.106]	[0.294]		[0.225]	[1.727]		[0.777]	[0.923]	
F2	-0.206	-0.114		-0.096	0.001		-0.151	-0.088	
	(1.186)	(0.754)		(0.669)	(0.010)		(1.095)	(0.881)	
	[2.399]	[1.373]		[1.097]	[0.0166]		[2.484]	[1.984]	
FINC			-0.002			0.040			-0.006
			(0.027)			(0.590)			(0.082)
			[0.052]			[0.680]			[0.125]
$v(w_{i\ t-1})$	0.183	0.288	0.314	0.076	0.202	0.2229	0.0682	0.136	0.172
	(0.867)	(1.565)	(1.761)	(0.411)	(1.662)	(1.543)	(0.333)	(0.923)	(1.074)
	[0.559]	[1.035]	[1.325]	[0.280]	[1.194]	[1.239]	[0.223]	[0.650]	[0.786]
$v(w_{i\ t-2})$	-0.878	-0.576	-0.160	-0.835	-0.428	-0.090	-0.898	-0.473	-0.128
	(2.085)	(1.538)	(0.902)	(2.235)	(1.681)	(0.694)	(2.258)	(1.559)	(0.937)
	[2.054]	[1.319]	[1.019]	[2.100]	[2.505]	[0.754]	[2.025]	[1.701]	[1.164]
R^2	0.696	0.794	0.718	0.775	0.913	0.820	0.754	0.882	0.798
SSR	0.318	0.215	0.295	0.235	0.091	0.189	0.258	0.124	0.212
DW	1.941	1.706	1.828	2.038	2.288	2.492	2.091	2.062	2.362
SC	0.081	6.379	0.317	4.004	2.431	10.379	2.822	1.046	6.404
N	22.478	11.506	26.467	0.773	0.370	5.260	1.782	0.127	5.845
H	6.246	7.845	6.201	6.319	6.616	7.436	6.988	8.111	7.626

Notes:

See notes to Table 3.3

pattern in the residuals. Again the results obtained are not unambiguous in that the null hypotheses of no serial correlation is accepted in the preferred equations of columns (5) and (8), although the addition of the extra lagged dependent variables is shown to be important in column (5). However, the results of these tests in the remaining columns indicates further analysis of the dyanamics is warranted.

The results in Table 3.4 take up this issue and present equivalent results to those in Table 3.3, but include also two lagged dependent variables in the nine equations to allow for a richer dynamic specification. On the main issues discussed above, the results again are qualitatively unchanged from those of Table 3.3, although the presence of heteroskedasticity is now more pronounced, so that the t-values based on the heteroskedasticity-consistent estimates of the standard errors are certainly applicable. The positive relationship between inflation and var(w_{it}) is confirmed, and the distinction between expected and unexpected inflation remains statistically important (F-statistics of 7.185, 23.736, and 16.210 relating to the restrictions imposed on equations in columns (1), (4) and (7), are all highly significant, cf. F(1,15)). The output growth measure of excess demand is again the least satisfactory, in terms of the performance of v(y_{it}) and y_{it} and in terms of the diagnostics. On the former criteria, there is now also some support for the unemployment rate adjusted for vacancies as the preferred measure of excess demand, in preference to the unadjusted one, as the t-values on the unadjusted unemployment rate fall below their critical values when the possibility of heteroskedasticity is taken into account. The dummies entered to capture the effects of flat rate incomes policies again show significantly negative. Further, the F-tests of the restrictions imposed on (2), (5), and (8) to achieve (3), (6), and (9) are 1.116, 3.231, 2.129 which are to be compared to F(5,15). Hence, there is rather stronger evidence against the simplifying restriction on the incomes policy variables than was seen in Table 3.3, and rather more support for the idea that the separate periods of incomes policy had quantitatively different effects on sectoral wage growth. This, taken with the problem of serial correlation that are observed in the restricted equations of (6) and (9), means that columns (5) and (8) also provide the preferred equations in Table 3.4.

Turning to the coefficients on the lagged dependent variables (ldv) themselves, it is noted that the first ldv takes a positive, but relatively small, coefficient, and the second ldv takes a negative, but larger, coefficient in all of the equations. Significance levels differ, but in columns (5) and (8), the negative coefficient on the second ldv is significantly different to zero, while the first ldv is not. The evidence then is that there is an annual pattern in which, other things equal, a high value in the variability in wage growth in one year is followed by a low value one year later. This is the sort of dynamic pattern that might be observed if the same groups negotiate annually and if there was a role for 'catch-up' behaviour. For example, suppose that a flat rate incomes policy successfully constrains wage growth in high wage sectors relative to those in low wage sectors; this results in wage growth variability which is lower than it would be in the absence of the incomes policy. If the same groups reset wages one year later, after the incomes policy has ended, it might be that the high wage sector attempts to regain lost ground and negotiates wage increases in excess of those warranted purely by the observed changes that have occurred in the sector over the year. The observed variability in wage growth in the year following the incomes policy in these circumstances will be higher than would have been observed in the absence of policy. In a regression analysis, this will therefore show as a negative coefficient on wage growth variability measured one year previous, exactly as obtained in the results of Table 3.4.

3.3 Conclusions

The results provided in the previous section are clearly in sharp contrast to those obtained in the U.S.; the relations obtained are generally in the direction we would expect on the basis of (3.5) and are significant. While these results do not prove the existence of Keynesian wage rigidities, they are entirely consistent with the presence of nominal wage inertia as captured by probabilities of renegotiation (π^*) which are less than one in each period. Moreover, given the evidence of 'catch-up' behaviour provided by the results of Table 3.4, the results here appear to be influenced by the annual nature of wage bargaining.

These results, along with those for the U.S., provide some information on the process of wage adjustment, illustrating the importance of the speed of renegotiation and of indexation in explaining this process. However, a more detailed analysis of the wage-setting process at the level of the decision maker is clearly necessary to fully understand these influences, and to explain the time pattern of wage settlments. Such a study is considered in the following chapter.

CHAPTER 4

A Direct Investigation of Nominal Wage Inertia through the Frequency of Wage Negotiations

The preceding chapter provides an indirect means of looking at labour market adjustment and nominal wage inertia. The analysis indicates that, contrary to the results obtained in the U.S., wage responsiveness in the U.K. is influenced by labour market conditions in a way that is consistent with Keynesian rigidities, or more generally, with less-than-instantaneous wage adjustment in each period. In so doing, it highlights the importance of the frequency of negotiation, as captured by the π_t^* term. Of course, the frequency of negotiations is only part of the story in explaining wage change (since the size of wage change, given that negotiation occurs, is also important), but from the discussion of the last chapter (and from the algebraic model of section 2.5) it is clear that the decision on how often and when to negotiate is important in its own right, and provides insights into the process of wage-determination as a whole. This chapter therefore concentrates on this aspect of nominal wage change, looking at the timing of wage settlements of individual industries in the U.K. in order to investigate more directly the influences on the wage-setting decision and the causes of nominal wage inertia.

In chapter 2, we noted three distinct approaches to explaining the frequency of wage negotiations; the first underlies much of the literature on inter-country differences in wage-setting institutions and in the literature on strike behaviour, and concentrates on the costs involved in negotiations over wages (these costs are potentially high because wages not only allocate labour resources for economic efficiency, but also determine income shares); the second approach emphasises the importance of uncertainty in wage negotiations, and is associated with Gray's (1976, 1978) papers on indexation working within the framework of fixed-length contracts; and the third approach considers the simultaneity of the decision of when and by how much to alter wages, working within a framework of variable-length, open-ended contracts. This framework is most relevant to the U.K., and is well illustrated in Pencavel (1982).

While these three approaches have generally been considered separately, they are not mutually exclusive, and in section 4.2, I shall consider a model of the decision on whether to enter negotiations, working within the U.K. context of open-ended contracts, which illustrates that all three influences can be justified within the same optimising framework. This raises the question of whether any of these explanations is empirically more relevant than the others, particularly in view of the fact that past empirical work has also concentrated on the explanations in isolation. These issues are investigated in the empirical work of section 4.3. First, however, in the next section, I describe briefly an overview of a database containing details of the timing of industrial wage settlements in the UK. The main point of this exercise, apart from introducing the data which is to be used in subsequent analysis, is to show that although the majority of wage settlements take place one year after the previous one, there is considerable variability in the length of time between successive wage settlements, and certainly it is not true that wages are uniformly renegotiated annually.

4.1 Some exploratory analysis

The Aberdeen wage rates database, constructed at the University of Aberdeen by Elliot, Steele and Bell (1977), provides a base from which to study the frequency of wage settlements. Collated primarily from the Department of Employment publications "Time rates of wages and hours of work" and "Changes in rates of wages and hours of work", the database contains details of all the wage settlements of the 191 largest national negotiating groups over the period 1950-75 (these being those groups which covered 5000 or more workers at some point during the sample period. In total, these groups covered around 12 million workers in 1975). In particular, the database includes information on the bargaining system employed, trade unions involved, weekly and hourly rates of pay negotiated for various groups, and the dates of implementation and of settlement for each of these wage negotiations.

The availability of data on the timings of settlements enables us to assess the variability of periods between negotiations. Before embarking on this course, however, we note two reservations. First, in dealing with national agreements we have no information on those elements of wage negotiation occurring at lower levels (i.e. we miss the effects of "wage drift"). It is difficult to assess the importance of such a loss, although Elliot and Steele (1976) have argued strongly to assert the importance of nationally negotiated wage rates. Second, interpretation of the data must take into account the definition of a "settlement" that has been used in collating the data. In the case of the Aberdeen database, wage changes that occur in different calendar-years are treated as separate settlements even if they result from one set of negotiations. When more than one wage change occurs in the same calendar year but they are the result of separate sets of negotiations, they are also treated as separate settlements. However, if more than one wage change is made within the same calendar year but they are the result of the same set of negotiations, then they are treated as part of one settlement. In this case, settlements are aggregated to the last implementation date in that year. While this procedure reduces the complexities faced in collating the data, unless care is taken in analysis, some of the figures obtained in this way may be misleading, particularly where the wage change occurs as the result of an indexation clause. As an illustration, we might consider the data for the year 1974; the introduction of the 'threshold' at the end of 1973, allowing for compensation of 40p per week for every one percentage point rise in RPI above 7%, led to such payments every week from the second quarter in 1974 to late 1974 (and indeed into 1975 for some). In the data set these have been aggregated to the last payment date, with the consequence that almost all groups reached new 'settlements' at least once in the fourth quarter of 1974. Fortunately, the database specifies where wage changes occur as the result of indexation clauses, or as part of long-term or staged settlements, so that we can take these features into account. In particular, as we shall see later in the paper, the ability to distinguish between those groups covered by cost-of-living clauses and those with no protection against inflation is essential in an analysis of the determination of the length of time between negotiations.

Elliot (1976) provides a detailed description of the timing of settlements in the data set, demonstrating, among other things, that there is little evidence to support the stylised view that U.K. wages are invariably renegotiated on an annual basis. Figure 4.1, which is based on the entire sample of 191 industries, also provides an indication of the variability of periods between negotiations; while the majority of negotiations dò take place four quarters after the previous negotiation, significant numbers occur both more and less frequently than this. The mean duration of the 4 295 settlements covered in the data set is 3.85 quarters, but with a standard deviation of 2.06 quarters there is clearly some significant variation around this mean.

Figure 4.2 confirms this variability, also demonstrating that industries differed in their disposition to negotiate. The constructional engineering industry were seen to implement 57 settlements over the sample period, giving a mean contract length of just 1.9 quarters, while two industries, dock labour and fur manufacture, had mean contract lengths in excess of 6.5 quarters. The mean of these average industry contract lengths is 4.07 quarters, and again a standard deviation of 0.94 quarters illustrates the presence of some variability.

Finally, Table 4.1 provides an indication of the variability of renegotiation probabilities over time; in the table, attention is restricted to industries in the manufacturing sector (as it will be in later empirical work), and gives

$$\pi_t = \Sigma_i^k N_{it} / N_t$$

where N_{it} = number of workers involved in new settlement i in time t, i=1,... k_t; k_t = number of new settlements in time t; and N_t = total number of workers employed in time t.

Figure 4.1

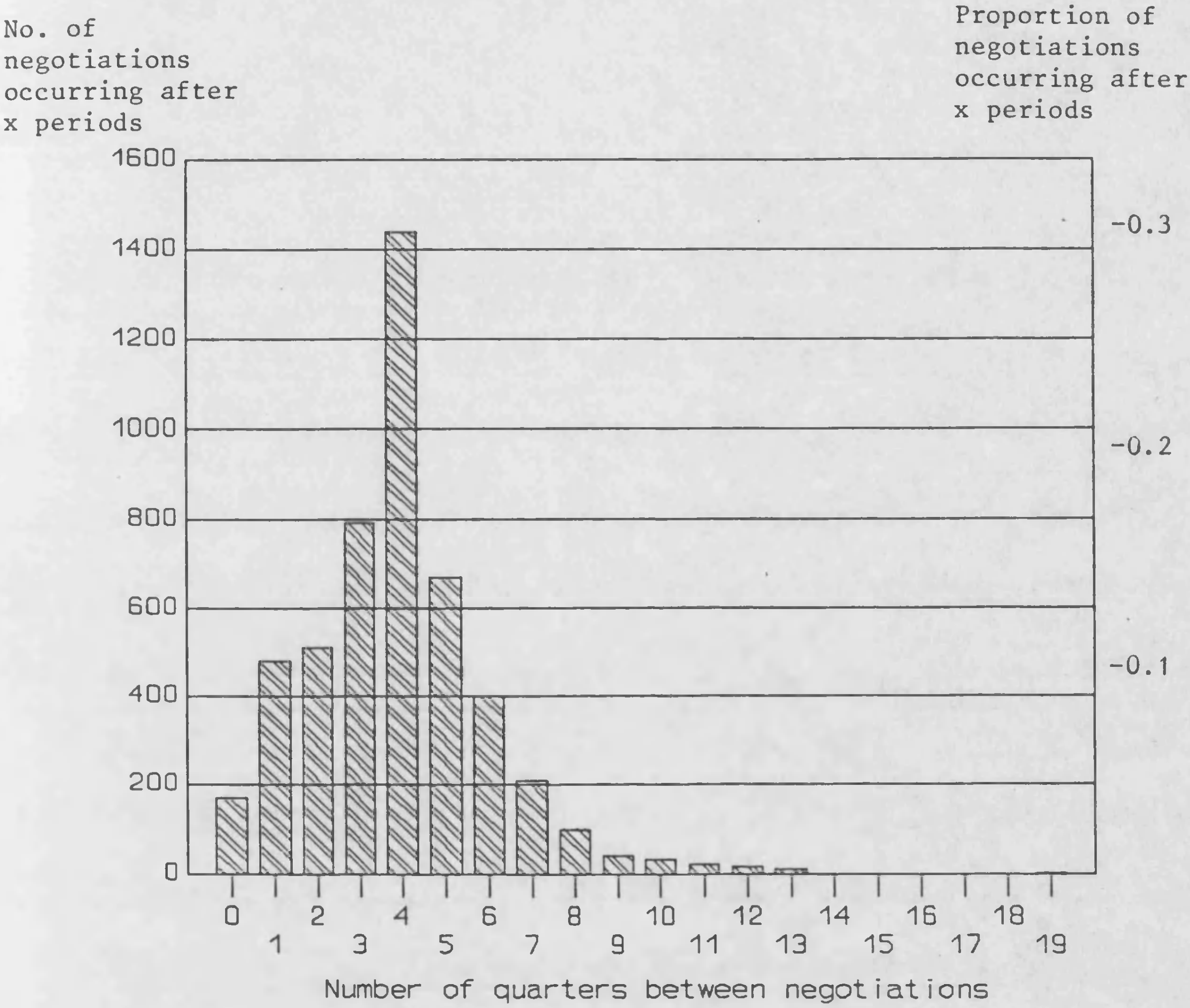
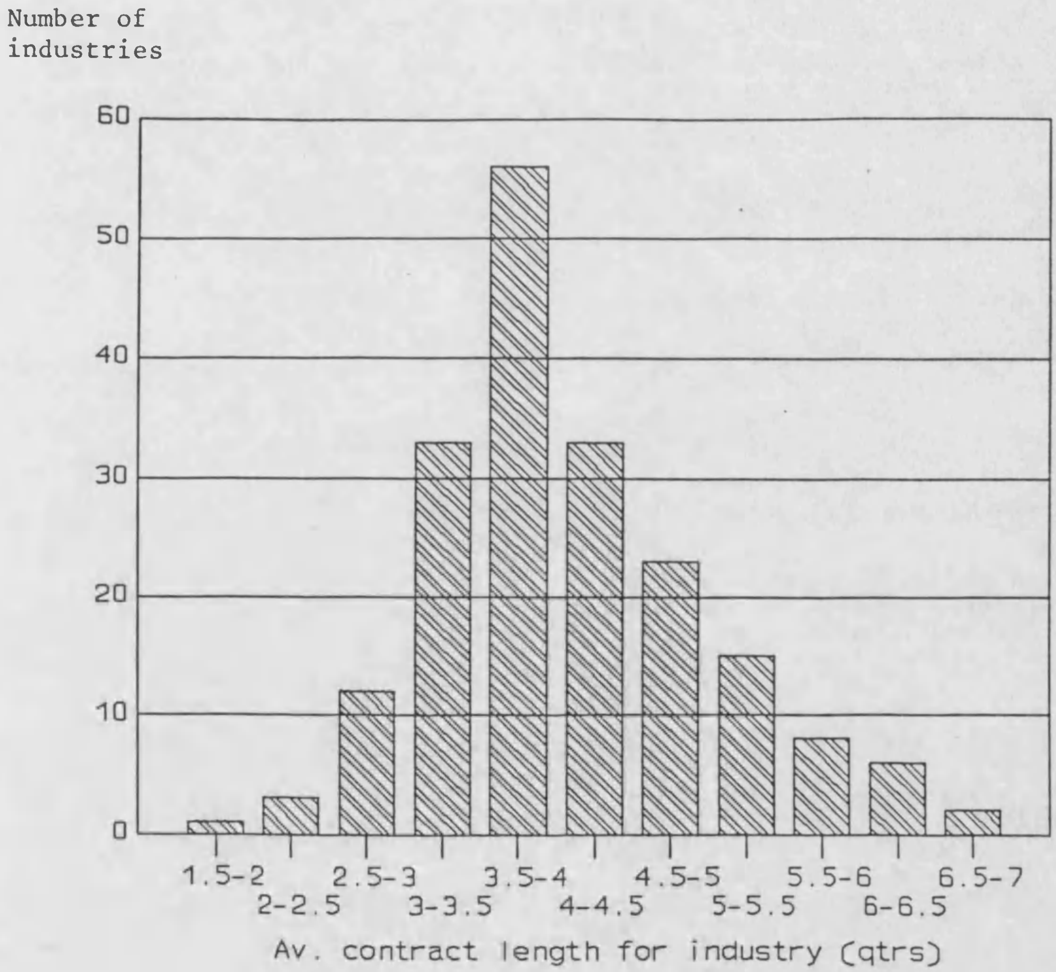

No. of negotiations occurring after x periods
Proportion of negotiations occurring after x periods
1600
1400
1200
1000
800
600
400
200
0
-0.3
-0.2
-0.1
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Number of quarters between negotiations

Figure 4.2



Number of
industries
60
50
40
30
20
10
0
1.5-2
2-2.5
2.5-3
3-3.5
3.5-4
4-4.5
4.5-5
5-5.5
5.5-6
6-6.5
6.5-7
Av. contract length for industry (qtrs)

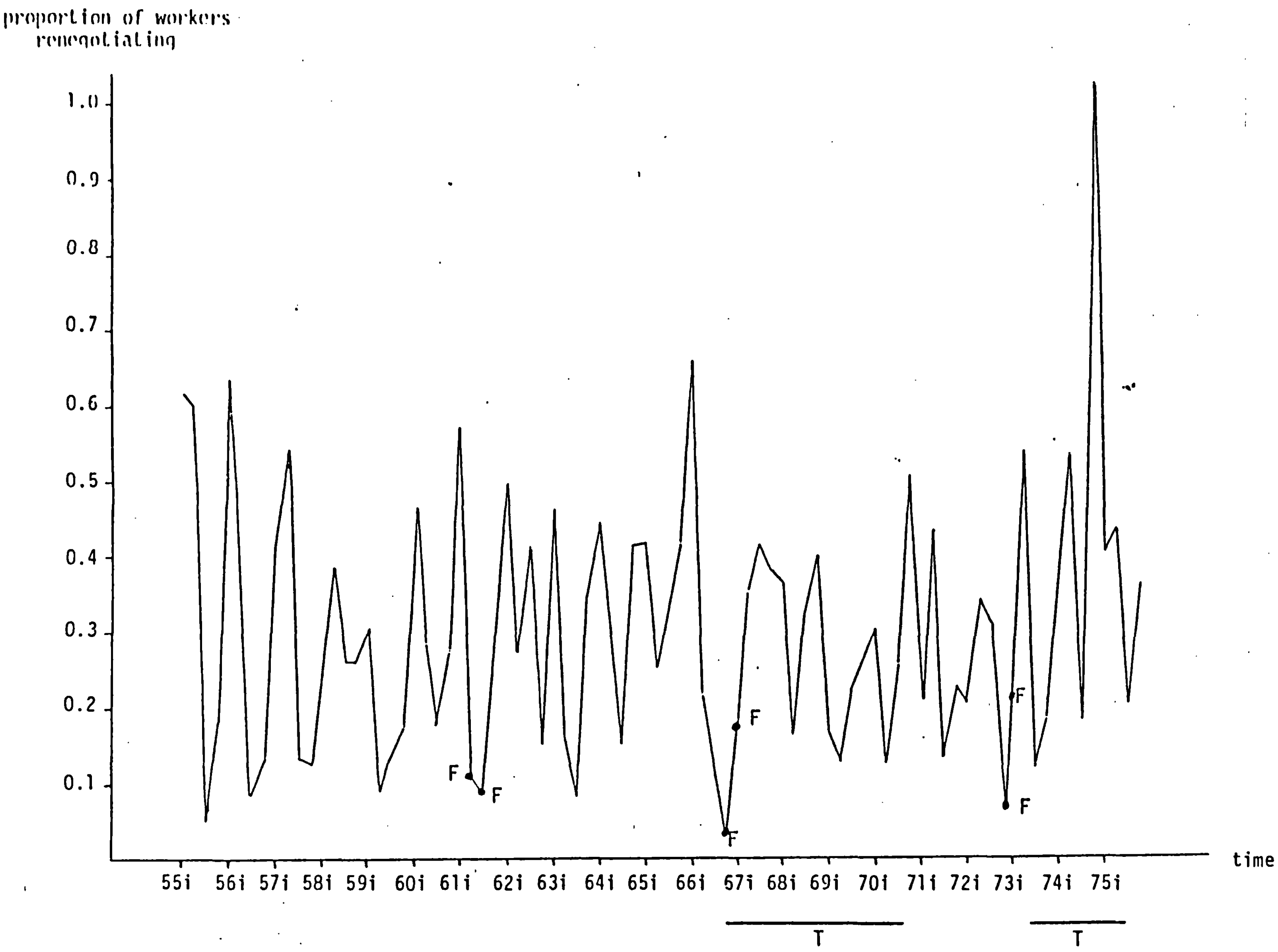
Table 4.1

Proportion of workforce involved in new wage settlements

	Ql	Q2	Q3	Q4	TOTAL
1955	0.623	0.604	0.049	0.188	1.455
1956	0.636	0.406	0.089	0.122	1.264
1957	0.421	0.547	0.132	0.126	1.226
1958	0.259	0.385	0.260	0.262	1.165
1959	0.310	0.089	0.141	0.170	0.710
1960	0.465	0.286	0.178	0.274	1.203
1961	0.570	0.107	0.087	0.282	0.976
1962	0.500	0.270	0.418	0.154	1.342
1963	0.462	0.176	0.078	0.349	1.065
1964	0.448	0.234	0.160	0.415	1.257
1965	0.418	0.258	0.350	0.414	1.440
1966	0.665	0.220	0.113	0.027	1.025
1967	0.168	0.355	0.416	0.378	1.317
1968	0.367	0.161	0.324	0.396	1.248
1969	0.172	0.131	0.219	0.263	0.789
1970	0.303	0.125	0.244	0.509	1.181
1971	0.213	0.439	0.136	0.227	1.015
1972	0.206	0.344	0.314	0.062	0.926
1973	0.274	0.538	0.120	0.181	1.113
1974	0.310	0.534	0.180	1.025	2.049
1975	0.402	0.431	0.202	0.368	1.403

Figure 4.3

Proportion of workers achieving wage settlements 1955-74



'F' indicates wage-freeze incomes policy in effect
'T' indicates incomes policies limiting negotiation to one per annum in effect

The table clearly shows that these proportions alter greatly over time, although it is by no means clear whether this variation is in any way systematic. Figure 4.3, in which the proportions are plotted against time, perhaps provides some insights, especially when written against the various periods of income policy regimes experienced in the UK; certainly the periods during which wage freezes were imposed appear to have fewer negotiations occurring, while some annual pattern can be discerned during periods in which negotiations were limited to one per annum. We will return to these issues later in the chapter.

The Aberdeen wage rates database provides some justification for our proposed framework of open-ended contracts of varying length; certainly there appears to be a great deal of variability in the length of time between negotiations over wages, both between industries and within any industry at different periods of time. In the following sub-section I will discuss in more detail a model of the labour market and the determination of negotiation frequency which will fit into this framework. As mentioned earlier, the model provides a justification for all three of the approaches to explaining negotiation frequency outlined in section 2.3.

4.2 Modelling the decision to renegotiate wages

The microeconomic theory

The discovery that the duration of wage contracts in the UK is variable is, in fact, perfectly in keeping with microeconomic theory. Since it is not possible to accomodate all contingencies which are pertinent to workers and firms when wage settlements are struck, there will be a loss of welfare generated because the terms of a contract cannot be altered during the contract period. Further, if innovations in the variables relevent to firms and workers are serially correlated, then the terms of the contract are likely to become increasingly inappropriate over time. Optimal control theory suggests that in these circumstances a state-contingent rule should be followed in which the contract expires when the relevent variables reach a critical limit. If the innovations to the relevent variables occur stochastically, then the frequency with which the critical limit is reached, and with which contracts are reset, is also stochastic. In these circumstances, it is appropriate to consider nominal inertia in probabalistic terms, with the degree of inertia captured by the probability of renegotiation. This, of course, is precisely the form in which nominal wage inertia has been considered so far in the thesis, forming the basis of the illustrative macromodel in section 2.5, and providing the generalisation to Hamermesh's model of wage rigidities in chapter 3.

In fact, we have already discussed in section 2.2, state-contingent rules of the form described above in the context of price adjustment. The papers by Barro (1972) and Sheshinski and Weiss (1978) illustrate, in a deterministic environment, the optimality of so called '(s,S) rules' for price adjustment, while papers by Sheshinski and Weiss (1982) and Danziger (1984) extend the analysis to a stochastic framework. These latter papers in particular are of direct relevence to the modelling of the decision on whether or not to enter wage negotiations since many of the elements of the analysis have direct counterparts in the decision on wage negotiation. In the next few paragraphs, we summarise these elements and note the counterparts in the wage setting decision.

The analysis in Danziger (1984) demonstrates the optimality of an (s,S) pricing policy, in which nominal prices are reset to achieve a real value of 'S' whenever the real price falls to a lower bound of 's'. The contribution of the paper is to demonstrate that this is true when real prices evolve over time according to a stochastic process of a particular (reasonably realistic) form. In the paper, aggregate prices rise over time through a sequence of non-zero shocks, ε_i. The shocks are independently and identically distributed with a distribution function $F(\varepsilon_i)$, and each shock ε_i causes the aggregate price to grow by $\exp(m\varepsilon_i)$. The shocks are assumed to occur according to a Poisson process, so that the interval between shocks is independent of time and follow themselves an exponential distribution. The intensity of the arrival of the shock is captured by the parameter λ, the mean interval between shocks. Having characterised the time path of aggregate prices, Danziger is able to evaluate the expected real price of the firm's output in all future periods. Assuming that real profit at any time depends only on the real price of output, and that there is a fixed real cost involved in adjusting nominal prices, the expected discounted future profit stream can be calculated on this basis. Further, assuming that the profit function is of a standard form (i.e. differentiable, strictly quasi-concave, and obtaining a unique internal maximum at some real price), the choice of the optimal sequence of renegotiation times and price settlements can be shown in these circumstances to be provided by the (s,S) strategy, with the 's' and 'S' parameters chosen to maximise the average expected real profit.

A directly comparable framework is contained in the following illustrative description of the wage-setting decision. Here, we recall the discussion of chapter 2 and assume that wages are set unilaterally by a union which represents all of the workers in an industry, and that employers set employment levels in the light of this decision (i.e. we assume a 'monopoly union' model). Union utility is derived from real wages and from employment, and the latter is itself (negatively) dependent on the real wage through the labour demand relationship. In addition, the union recognises the real potential costs involved in wage negotiation, as discussed in section 2.3. In this situation, the union's decision on when to reset nominal wages, and by how much, mirrors precisely the decision made by firms, and described by Danziger, on when, and by how much, nominal prices should be altered. The union's utility function corresponds to the firm's profit function, both being dependent on real magnitudes, with an exogenously determined deflator, and involving fixed real adjustment costs. If the utility function is of a standard form, then a unique internal maximum of the utility function can be assumed to exist at some real wage. Further, assuming that the union has some idea of the stochastic nature of the aggregate price deflator (it may follow the sort of process described by Danziger, for example), then the union will choose a wage setting strategy which maximises average expected utility. The union does not reset wages at each stage because of the presence of adjustment costs. Instead, nominal wages are reset to achieve a real wage of 'S' whenever real wages have fallen to a level 's'. The (s,S) parameters will depend on the nature of the stochastic process which provides innovations to the aggregate price level and on the size of the adjustment costs, exactly as in the Danziger paper. The intervals between negotiations are stochastic, and the probability of renegotiation at any moment is defined by the probability that real wages fall to their lower bound.

Of course, in order to keep the mathematics tractable, Danziger is forced in his paper to impose a very restricted form on his analysis of price adjustment, which reduces its applicability to the real world. Hence, in reality, the firm's profit function will not remain unchanged over time, as changes in demand conditions, for example, complicate the relationship between real prices and profits. Equally, the process by which aggregate inflation evolves in the model is a very stylised one, and the exogeneity assumption abstracts from the important issue of how the pricing policies of individual firms affect the properties of the aggregate price level. Similar comments are applicable to the wage-setting process, as the relationship between union utility and the real wage alters when the demand for labour curve shifts. Industry-specific shocks to productivity, for example, affect the labour demand constraint faced by union, and hence the level of utility which is achievable. Such effects could be incorporated directly into the Danziger analysis through a careful choice of functional forms for union utility and for the labour demand relationship so that a composite exogenous deflator (dependent on aggregate price shocks and on industry specific productivity shocks) would be appropriate in a union utility function which is otherwise fixed over time. Such an exercise would be useful in showing, for example, that the probability of renegotiation can differ between industries if productivity shocks occur at different times in different industries. However, it is more useful to think of the above discussion as providing an explanation for why these elements might affect renegotiation frequency, with the recognotion that, in the real world, there are many more influences that might play a part in the decision to renegotiate than those that can be incorporated into a stylised mathematical model of this sort. Hence, while Danziger's (and our own) discussion of renegotiation concentrates on the effects of aggregate price movements, we recognise that a more comprehensive set of variables than the aggregate inflation rate alone would effect the decision to reset wages in reality.

Having said this, we note that in the context of Danziger's model, changes in the rate of inflation are obtained if we observe an increase in the frequency with which shocks occur (increased λ) or an increase in the responsiveness of aggregate inflation to shocks (increased 'm'). As is the case with a firm's pricing decision, such changes have an ambiguous effect on renegotiation frequency and expected renegotiation probabilities. Increasing inflation causes the union to reset its (s,S) parameters to widen the band within which nominal wages remain unaltered. Hence, although the expected rate of decline in real wages over any contract is increased, the extent of the decline is greater, leaving the overall effect on renegotiation frequency ambiguous. (Having said this, it is recognised that the probability of renegotiation would rise in the face of increases in the expected inflation rate if any of a wide variety of functional forms are specified for the union utility function). Increases in the real cost of entering wage negotiations unambiguously extend the expected interval between negotiations, and correspondingly reduce renegotiation probabilities. Changes in the distribution function F(.) which preserve the mean size of the shock but which alter the variance of the size of the shocks might be interpreted as changes in the level of aggregate price uncertainty. These too have an ambiguous effect on renegotiation probabilities, since a mean-preserving spread in the shocks can cause the average expected utility to rise or fall, depending on the functional form of the utility function, so that the effect on the (s,S) parameters is not generally defined.

Despite the ambiguities described above, it is clear that this framework provides the justification for the inclusion of all three elements which are generally considered important in determining the frequency of wage negotiations:

(i) changes in economic conditions that have occurred since the previous settlement, denoted $\mathbf{X}_t$-$\mathbf{X}_{t-s}$, where $\mathbf{X}$ is a vector of influential variables, and where t-s is the date of the previous negotiation (this is captured in the Danziger paper by the growth in aggregate inflation generated by the accumulation of shocks);

(ii) negotiation costs, C_t; and

(iii) uncertainty over the variables relevent to the wage negotiation, $U(X_t)$.

In the light of the above discussion, in what follows, we simply assume that wage negotiations occur at discrete intervals, with the probability of renegotiation dependent on these three sets of influences.

Operationalising the model

In order to choose a comprehensive set of variables that might influence the negotiable nominal wage, we need to consider not only the wage setting behaviour of an industry, but also its output and pricing decisions. This is because these affect the labour demand constraints faced by the union when setting wages. Below then, we set out a static model of nominal wage determination which accommodates these elements. The description of the model is brief since it is derived and discussed in detail in the following chapter, which is explicitly concerned with the employment, pricing and output decisions of an industry, as well as its wage-setting. Here, we simply wish to obtain a set of potentially important influences on the nominal wage. Briefly then, and referring to section 5.1 for details, it is noted that a stylised representation of an industry is given by the following general forms for its labour demand, price, and output demand equations:

$$n_a = n(y_a, w_a, q_a, k_a) \qquad n_1,n_3>0,\ n_2,n_4<0 \qquad (4.1)$$

$$p_a = p(\alpha_a, y_a, w_a, q_a, k_a) \qquad p_1,p_2,p_3,p_4>0,\ p_5<0 \qquad (4.2)$$

$$y_a = D_1(p_a, p, pm_a, \sigma) \qquad D_1<0,\ D_2,D_3,D_4>0 \qquad (4.3)$$

where n_a = employment in industry A, y_a = output in industry A, k_a = capital stock in industry A, w_a = price of labour input to industry A, q_a = vector of other input prices to industry A (materials), p_a = price of industry A's output, p = aggregate price level, pm_a = price of imported industry product, σ= measure of aggregate cyclic variation, and α_a = oligopoly power in industry A.

In chapter 2, we discussed some of the recent advances made in the study of the labour market, and noted some of the ways in which unions are now playing an important role in many analyses of labour market behaviour. In the "right to manage" union model, unions and firms bargain over wages knowing that employment will be set (subsequently) according to (4.1). Both sides to the bargain maximise utility. In the case of the firm, this is determined simply by profit levels. In the case of the union, utility depends on real wages, possibly in comparison to some reference group, and employment. The bargaining solution depends on the bargaining strength of the firm relative to the union, and provides the following expression (with more complete details given in Chapter 5):

$$w_a = w(\ w, \alpha_a, q_a, k_a, p, \text{taxes}, \sigma, \text{costs}) \qquad = w(\chi_a) \qquad (4.4)$$

where w = aggregate wages, and 'costs' are variables which affect negotiation costs to the union, to be identified below. This expression provides us with our vector of potentially influential variables in the decision to renegotiate, χ_a. If nominal wages are set according to (4.4) whenever negotiations are entered into, then changes in these variables since the last wage settlement provide a measure of the extent to which the nominal wage that was last negotiated has become inappropriate, and provides an indicator of the likelihood of new wage negotiations being entered into.[1]

It is important to note that the model of wage determination described above is static, and that, in a more realistic setting, there will be information imperfections and dynamic considerations which necessitate expectations to be formed. For example, as was illustrated in the algebraic model of section 2.5, if we allow for many sectors in the economy, then individual unions have to form expectations on the outcome of decisions by unions in other sectors of the economy made simultaneously with their own, so that expectations on current values of aggregate variables have to be formed. Similarly, if the union recognises the presence of inertia in its own or in other sectors, then the influences affecting the current negotiable wage will include not only expectations of current dated variables, but also expectations of future dated variables and past observations on these variables. In view of these comments, (4.4) above can be written more realistically as

$$w_{at} = w(\chi_{at-1}, {}_t\chi^e_{at}, {}_t\chi^e_{at+1}, {}_t\chi^e_{at+2}...)$$

$$= w({}_tX^e_{at}) \quad (4.5)$$

where ${}_t\chi^e_{at+j} = E(\chi_{at+j} \mid \Omega_{at})$, j=0,1 1, 2,..., with Ω_{at} representing union A's information set at time t, and X_{at} is the vector of variables, dated at any time (past, present, or future), which are influential in the determination of the negotiable wage in A at time t.

Written in this way, two points become apparent. First, changes in the influences affecting the current negotiable wage since the previous negotiation, $({}_tX^e_{at} - {}_{t-s}X^e_{at-s})$, will depend not only on the changes taking place in variables observed in time t compared to time t-s (the date of the previous negotiation), but will depend on changes in the whole profile of past, present, and future values of the relevent variables, $({}_t\chi^e_{at-1} - {}_{t-s}\chi^e_{at-s-1})$, $({}_t\chi^e_{at} - {}_{t-s}\chi^e_{at-s})$, $({}_t\chi^e_{at+1} - {}_{t-s}\chi^e_{at-s+1})$, and so on. In practice, it will be very difficult to incorporate these broader horizons into analysis, and in the empirical work we will use the simple vector of variables $(\chi_{at} - \chi_{at-s})$; however, we should be aware of the importance of the past and expected future movements, and interpret results accordingly.

The second point to note is the influence of unexpected innovations that occur between settlements. This influence is identified by noting that

$$\begin{aligned} {}_tX^e_t - {}_{t-s}X^e_{t-s} &= (X_t - X_{t-s}) - (X_t - {}_tX^e_t) + (X_{t-s} - {}_{t-s}X^e_{t-s}) \\ &= (\text{actual change in } X_t) - (\text{shock to } X_t \text{ unanticipated at t}) + \\ &\qquad (\text{shock to } X_{t-s} \text{ unanticipated at t-s}). \end{aligned}$$

Clearly, at time t, when making the decision on whether to enter negotiations, the second element above is unknown, and assuming that decisions are formed rationally, this element will not systematically influence the decision. Growth in the variables relevent to wage setting, as captured by the first term, is important, however, as are the observed innovations in the variables that have occurred since the previous negotiation. Hence, on the basis of the third element, negotiations are more likely to occur if an unanticipated shock reduces the real wage below the level that had been anticipated when the previous negotiation was struck (since the lower bound is more likely to be reached), while a shock that causes real wages to be higher than bargained for will make the occurance of a new wage settlement less likely.(2) Of course, in practice there will be some difficulty in measuring unanticipated shocks, especially when these are based on expectations which are different across agents and formed over differing time horizons by different groups. The recogntion of the fact that unexpectedly rapid inflation experienced during a contract will raise renegotiation probabilities, while unexpectedly slow inflation will reduce pressure for wage change will therefore also complicate the empirical analysis of negotiation frequency; again results obtained in the empirical work must be interpreted with these complications in mind.

Throughout this model description, we have made reference to negotiation costs, C_{at}, as a justification for less than complete wage adjustment in each period; this follows directly from the discussion in section 2.3 of chapter 2. In that chapter, we also considered some of the sources of negotiation costs, and it is appropriate here to remind ourselves of these so that we can consider how to model them in our empirical work. In fact, we noted a variety of potential indicators of the level of negotiation costs, working from two alternative views of the bargaining process (these having been spelt out in Turk's (1984) analysis of strike behaviour). These indicators are justified according to their influence on the ease of communication between parties to the negotiations in an industry, on the costs of a strike or lockout to the two parties, and on the size of the bargaining zone within which negotiations take place. These indicators included the following (with the direction of the influence in parentheses):

(i)	Nature of output	(?)
(ii)	Bargaining system used	(?)
(iii)	Seasonals	(?)
(iv)	Aggregate and/or local unemployment rates	(-)
(v)	Unemployment/social security benefits	(+)
(vi)	Trade union membership	(+)
(vii)	External strike activity	(?)
(viii)	Profit levels	(+)

(ix)	Ratio of inventories to sales	(-)
(x)	Uncertainty	(?)
(xi)	"Freeze" and "12-month-rule" incomes policies	(-)
(xii)	"Ceiling" incomes policies	(+)

Each of these variables will be used in the empirical work on the determination of the negotiation frequency which follows in section 4.3.

4.3 The empirical work

Introduction

The preceding section set out the factors influential in the determination of the negotiable wage in an industry, and suggested that the probability that the industry will negotiate in any period will depend on the change in the determinants of the negotiable wage since the last negotiation, on the costs of negotiation (also specified in the last section), and on uncertainty. That is

$$\pi_{it} = \text{prob(i negotiates in time t)}$$
$$= f\ [\ ({}_tX_{it} - {}_{t\text{-}s}X_{it\text{-}s}),\ C_{it},\ X^u_{it},\ v_{it}\ ] \qquad (4.6)$$

where t-s = time of last negotiation for industry i. Here, we also include a term v_{it} which is a stochastic element intended to capture any idiosyncratic behaviour based on non-observable costs or shocks.

This formulation is more general than those implied by the empirical work that has previously been carried out in this area, and in this section we will provide some empirical evidence on its appropriateness and its superiority, or otherwise, over its predecessors. Specifically, we will compare estimates of the relationship given in (4.6), based on the Aberdeen wage rates database described in section 4.1, with related equations reported in the papers by Pencavel (1982), and C+W (i.e Christofides and Wilton (1983), and Christofides (1985)) mentioned earlier. Since we will be using a different data set to those used in these earlier papers, direct statistical comparisons will not be possible, although tests of some of the restrictions implied in the earlier work can be carried out.

Table 4.2 presents some of the relations reported in these earlier papers. It is clear from this that the Pencavel model (shown in column (1) of the table) is closest in spirit to that of (4.6). In his probit analysis of the probability of negotiation in the U.K. coal industry, Pencavel has used changes in prices, in output per man, and in the selling price

Table 4.2: Equations explaining renegotiation frequency

Dept. variable	π=probability of wage change in U.K. coal industry = 0 or 1 Pencavel (1982, Tab2, Col.1) (1)			L=length of 1440 non-indexed contracts in Canadian unionised sector(mths) Christofides + Wilton (1983, Tab1, Col.2) (2)		
$_tX_{it}-_{t-s}X_{it-s}$	(1) Change in retail price since last negotiation: Δp	Δp	0.285 (0.085)	(1) Length of previous contracts: PL	PL	0.573 (24.30)
	(2) Change in output per man: Δx	Δx	0.033 (0.036)			
	(3) Change in setting price of coal: Δc	Δc	-0.007 (0.045)			
	(4) Aggregate unemployment: u	u	-0.301 (0.465)			
C_t	(1) Constant	C	-1.077 (0.900)	(1) Constant plus industry-specific intercepts: C, SIC1-SIC3:	C	84.529 (11.93)
	(2) Seasonals S1-S3	S1	0.360 (0.442)		SIC1	2.216 (1.36)
		S2	-0.005 (0.494)		SIC2	4.207 (2.79)
		S3	-0.373 (0.559)		SIC3	2.732 (3.99)
	(3) Incomes policy dummies I1-I3	I1	-1.754 (0.609)	(2) Dummy = 1 if size of industry > 1,000 workers: DSIZE	DSIZE	-0.074 (0.11)
		I2	-0.540 (0.969)			
		I3	0.206 (0.498)			
	(4) Dummy for structural shift in 1967iv: D	D	3.280 (2.770)			
		UD	-1.266 (0.947)			
X_t^u				(1) Square of standard error of sliding regression on p: UNCERT	UNCERT	-12.234 (8.69)

Table 4.2 (cont)

Dept. variable	L = length of 3,765 non-indexed contracts in Canadian private sector (quarters) in Christofides (1985)					
	Tab 3, Col. 1			Tab 2, Col. 1		
	(3)			(4)		
$_tX_{it}-_{t-s}X_{it-s}$	(1) Length of previous contract: PL	PL	1.00 (imposed)	(1) Length of previous previous contract: PL	PL	0.353 (24.89)
C_t	(1) Incomes policy dummy: DAIB	DAIB	-1.273 (4.50)	(1) Constant plus industry-specific intercepts: C, SIC1-3	C	30.210 (15.74)
					SIC1	1.419 (2.29)
					SIC2	1.791 (3.19)
					SIC3	1.221 (5.19)
				(2) Incomes policy dummy: DAIB	DAIB	-3.028 (8.63)
X_t^u	(1) Square of standard error of sliding regression on p: UNCERT	UNCERT	-5.599 (12.19)	(1) Square of standard error of sliding regression on p: UNCERT	UNCERT	-2.847 (8.30)

Note: Standard errors in parentheses in cols 1,2; absolute t-ratios in parentheses in cols 3,4.

of coal, plus an unemployment measure to capture the influence of $({}_{t}X_{it} - {}_{t-s}X_{it-s})$. Dummies for seasonal variation and the impact of incomes policies are included to incorporate the effect of C_t. No reference is made to the effect of uncertainty. In contrast, the C+W papers stress the importance of uncertainty in their analysis of Canadian contract length. Underlying the results in column (3), for example, is a model of contract length which constrains the effects of the variables measured by ${}_{t}X_{it} - {}_{t-s}X_{it-s}$, and of those in C_t other than those incurred through the imposition of incomes policies to be constant over time, so that they can be captured by the inclusion of a lagged dependent variable (with unit coefficient). The model behind the results in columns (4) and (2) explicitly considers the possible industry-specific costs incurred in negotiation by including shift dummies, and an additional dummy for incomes policy effects is included in column (4), and one for the size of the bargaining unit is included in column (2). However, again, uncertainty is cited as the key determinant of contract length, and a lagged dependent variable is used to capture the influence of the remaining elements of transaction cost.

The empirical work previously carried out, as presented in Table 4.2, can be extended on a number of counts. First, having established that the three "distinct" approaches to explaining negotiation frequency are different elements of the one desire to minimise the net costs of negotiations, we can now include all of these elements in our work where previously they had been considered in isolation. Further, since we have explicitly set down both a model of nominal wage determination and a list of variables which may influence negotiation costs directly, we can consider a far broader range of possibly influential variables than that used previously. Second, having clarified the theoretical basis of the decision on when to enter negotiations in the previous section, we are now better able to interpret any patterns in the timing of settlements over and above those explained by our model. For example, having noted the forward-looking element of wage determination described earlier, we might expect surges and slumps in the number of negotiations to occur prior to policy implementation as agents respond to the release of the news of this policy. And finally, we recognise that we have in the Aberdeen wage rates database a highly detailed description of the pattern of U.K. wage settlements in many industries, using a variety of bargaining methods and in different sectors of the economy. Certainly then any relationships found on the basis of this database will neither be dependent on, nor spoiled by, the idiosyncratic behaviour of a particular industry or sector (as we suggested might be true of the Pencavel analysis). These points will be borne in mind during the empirical work reported in the following two subsections.

Linear analysis

In the first instance, we will consider a relatively unsophisticated regression analysis of our database, working with variants of the following aggregated linear model:

$$\pi_{it} = B_{I0} + (X_{It}-X_{It-4}).\alpha + C_{it}.\beta + X^{u}_{It} + T_{It}.\delta + \varepsilon_{It} \qquad (4.7)$$

where π_{It} = proportion of agents in grouping I negotiating in time t, X_{It} = vector of variables influential on the negotiable wage, C_t = vector of direct cost variables, T_{It}= vector of variables to take into account the time profile of past settlements in I, X^{u}_{It}= uncertainty over variables in X_{It}, and ε_{It}= random element.

The imposition of linearity on a general form when moving from theoretic to empirical work is a procedure which is often employed because of the ease of estimation of the linear form. It is recognised that, when explaining a bounded variable such as π_{It}, the error terms will not have the properties assumed to hold to justify an application of OLS regression analysis, but we will ignore these problems in this first section, and consider a more sophisticated analysis later.

We note too that in using the variable π_{It} we have moved from an analysis of the individual negotiating units to a more aggregate level, so that it is not possible to incorporate the time profile of past settlements directly through the change in the negotiable wage since the last negotiation. Here we use two sets of variables to pick up these effects: the change in variables affecting the negotiable wage over the previous four quarters, (X_t-X_{t-4}), and T_t which includes the dependent variable lagged by a variety of quarters, and dummies to pick up 'catch-up' behaviour when a once-and-for-all shock has altered the pattern of past settlements.(3)

Our initial empirical analysis considers the simplest possible specification in which all production industries are included in grouping I of (4.7) (and with "I" defined in this way, π_{It} is presented in Table 4.1, and illustrated in Figure 4.3, of this chapter). While this specification makes the least use of the information contained in our dataset, it provides a useful base for initial exploration. At this level of aggregation, of course, we cannot take account of any industry-specific cost elements, although aggregate measures of the other cost variables (unemployment, stocks, profits, seasonals, incomes policy implementation, etc.) are clearly still appropriate. Regarding the influences on the negotiable wage, we note that data on the aggregate wholesale price level, on the tax wedge, on the price of materials, and on the replacement ratio are readily available, while movements in the underlying capital stock and level of technical progress are, in anticipation of later work at the sectoral level, measured by changes in output-per-man productivity. Changes in the level of aggregate real demand can be represented alternatively by movements in exogenous variables such as world trade, government spending, and international competitiveness, or, again anticipating future work at a more disaggregated level, by movements in aggregate real domestic output.

Although the model of wage setting of the last section indicates that increased uncertainty over any of the variables influencing the nominal wage will cause more frequent negotiations, in the following analysis we will concentrate our attention solely on price level uncertainty, as is emphasised in the C+W papers, and in much of the literature concerned with the effects of uncertainty. Price level uncertainty will be measured in three alternative ways:

UNCERT1 is given by the square of the standard error of a sliding regression of price inflation on its own lagged values, (as employed in the C+W work);

UNCERT2 is given by the variance of price inflation over the preceding quarters (as used in Lucas (1973), for example);

UNCERT3 is given by the (absolute) gap between the actual and expected inflation rate. In this latter case, rational expectations of the inflation rate have been generated by the NIESR macromodel.

Figure 4.4 demonstrates the similarities between movements over time of all of these measures of price uncertainty and with movements in the actual inflation rate. This may come as little surprise since the uncertainty generated during periods of inflation is often cited as one of the greatest costs of inflation, as in Hayek's famous (1945) paper, or in Friedman's (1977) Nobel lecture, and a paper by Logue and Willet (1976) has demonstrated previously the link between high and volatile rates of inflation. On the other hand, it could be argued that none of our uncertainty measures truly capture the inability of agents to predict price movements, but rather shows the inadequacies of attempts to model these movements statistically, and that the inadequacies become more apparent during periods of rapid price increase. In either case, the importance of these similarities will become apparent as we now consider some of our estimated relations.

In Table 4.3 the estimation shown in Columns (1) and (2) represents the results of a specification search in which all of the influences mentioned in the previous sections were considered. In this we find the rate of change of the aggregate wholesale price level (Δwhpr), changes in material's prices (Δfc), and productivity changes (Δprody) to be most influential amongst the variables we have suggested determine the negotiable wage, and their influence is in the direction we would expect, although significance levels are low. Changes in taxes (direct and indirect) were not shown to be significant, and neither were changes in aggregate demand, whether measured by the growth of real gdp or by the joint influence of world trade, competitiveness and the government's fiscal stance. Movements in the replacement ratio also made no contribution to the explanation of π_{It}.

Figure 4.4

Inflation and Price Level Uncertainty

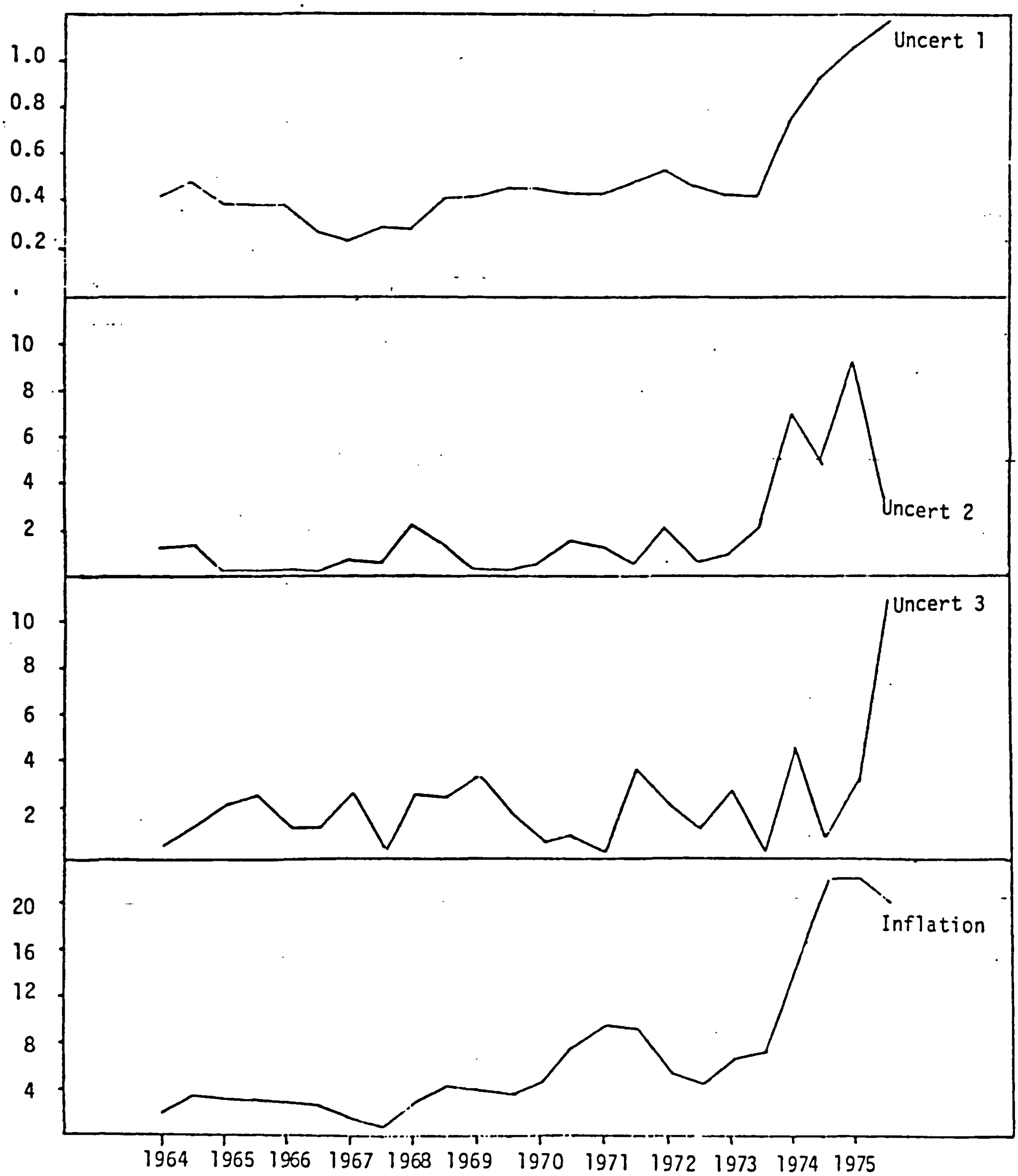


Table 4.3

Dependent variables = π_{It}
I = (all production industries); 1964i-75iv (n = 48)

		(1)	(2)	(3)
β	Constant	1.109 (1.545)	1.344 (2.455)	0.278 (3.386)
T_t	π_{it-1}	-0.353 (2.300)	-0.373 (2.547)	-0.212 (1.685)
	π_{it-2}	-0.162 (1.251)	-0.142 (1.165)	-0.183 (1.465)
	D74iv	0.603 (3.783)	0.581 (3.842)	0.591 (4.212)
	CATFR1	0.037 (0.197)	0.063 (0.360)	0.066 (0.414)
	CATFR2	0.218 (1.363)	0.212 (1.353)	0.271 (1.893)
X_t-X_{t-4}	Δwhpr	2.251 (1.454)	2.889 (3.129)	
	Δfc	-1.151 (1.880)	1.220 (2.013)	
	Δprody	1.627 (0.780)	1.498 (0.733)	
C_t	stocks	-0.042 (0.985)	-0.053 (1.543)	
	un	-0.044 (0.906)	-0.036 (0.794)	
	q^1	0.111 (1.425)	0.128 (1.845)	0.034 (0.639)
	q^2	0.037 (0.476)	0.053 (0.750)	0.002 (0.032)
	q^3	0.040 (0.723)	-0.050.(0.833)	-0.064 (1.183)
	df1	-0.133 (1.591)	-0.139 (1.708)	-0.111 (1.441)
	df2	-0.126 (0.947)	-0.159 (1.369)	-0.146 (1.529)
	C1	0.125 (1.531)	0.124 (1.540)	0.156 (2.194)
	C2	0.182 (1.453)	0.172 (1.411)	0.135 (1.321)
	C3	-0.022 (0.363)	-0.016 (0.272)	-0.068 (1.294)
	C4	0.180 (1.040)	0.175 (1.030)	-0.072 (1.043)
	C5	-0.097 (0.598)	-0.042 (0.346)	-0.221 (1.609)
X_t^u	UNCERT1	0.160 (0.518)		0.303 (2.234)
RSS		0.330	0.341	0.438
SE		0.114	0.112	0.119
R^2		0.761	0.758	0.689
R^2(adj)		0.567	0.579	0.528
DW		2.215	2.259	2.354

Notes:

Absolute t-values in parentheses. See Data Appendix for definitions and Table A4.5 for a description of the choice of incomes policy dummies.

Of the cost variables considered, the unemployment level (un), and the level of stocks relative to output (stocks), were seen to have a constraining influence over the decision to negotiate, although again significance levels are low. Some seasonal variation is also distinguished as the proportion of workers negotiating in the first quarter of the years is shown to be significantly higher than the rest of the year. (The dummy variable q1 takes the value 1 in the first quarter of the year, and zero otherwise. Variables q2 and q3 are similarly defined). Other experiments with trade union membership, profit levels, and strike activity were unproductive, however.(4) Incomes policy dummies are provided by F1, F2, and C1-C5, and these are described in Table 4.4. (5) The estimates of Table 4.3 demonstrate that while both of the freeze incomes policy over our period reduced negotiations, only during some of the ceilings policies is there any evidence of the increased propensity to negotiate during these periods that was predicted earlier.

The variables introduced to model more closely the influence of past settlements and of once-and-for-all shocks, not captured by the (X_t-X_{t-4}) term, namely π_{it-1}, π_{it-2}, d74iv, and CATRFl and CATRF2, each have coefficients of the expected sign and are by and large significant. Hence negative coefficients on π_{it-1} and π_{it-2} capture the idea that if there is a jump in the number of negotiations in one period, then there is likely to be fewer in the succeeding periods; insignificance of π_{it-3} and higher order lags illustrate that this effect is relatively short-lived. Positive coefficients on the D74iv dummy and the CATRFl and CATRF2 dummies pick up the influence of the threshold agreements (as explained in section 4.1), and of an increase in negotiations immediately following periods of freeze incomes policy, as agents attempt to catch-up with movements which they had been unable to respond to previously.

Finally we consider the variable UNCERT1 which has been introduced to capture the effects of price uncertainty. Clearly this variable contributes little explanatory power to the model over that captured by the other variables in Table 4.3 Column (1). However, comparing (1) and (2), in which UNCERT1 is omitted, shows a high degree of collinearity between this variable and our inflation measure, as we would expect from our earlier observations (and demonstrated by the instability in the estimated coefficient on inflation). In fact, if we drop those variables which we have associated with the negotiable wage and concentrate instead on the uncertainty measure and incomes policy variables alone, as in (3), then we have an equation which is comparable to those in the C+W papers and set out in Columns (2), (3) and (4) of Table 4.2, and with similar results: uncertainty is now seen as exerting a significantly positive influence on negotiation frequency, while the effects of the imposition of incomes policies become more marked. This pattern is replicated if uncertainty is measured by the variability of recent inflation rates (UNCERT2), although UNCERT3 (the absolute gap between actual and expected inflation) displays little explanatory power either in conjunction with our

Table 4.4

Brief description of pay policies ; 1964-1975

Period	Description
Wilson's Labour Government	
1965ii-66ii (C1)	Ceiling incomes policy; target increase of 3.5% enforced in public sector only.
1966iii-67ii (F1)	"Wage Freeze" and "Severe Restraint". Statutory.
1967iii-68i (C2)	Ceiling policy; voluntary restraint with zero norm
1968ii-70ii (C3)	Ceiling policy; statutory 3.5% limit.
Heath's Conservative Government	
1972iv-73i (F2)	Wage freeze during "Standstill". Statutory.
1973ii-74ii (C4)	Ceiling policies; guidelines equivalent to 6.7%, 8.5%, and 13% between 1973ii-73iii, 1973iv, and 1974i-74ii respectively. Statutory.
1974ii-74iii	Cost of living threshold increases (40p per week for every 1% point rise in RPI above 7%)
Labour's "Social Contract"	
1975iii-75iv (C5)	Ceiling policy with 10.4% limit equivalent to £6. Statutory.
Twelve-month restraint	
1967iii-70iv (DT1)	Voluntary restraint requested to limit negotiations to one per annum.
1973ii-75ii (DT2)	Statutory limit of one new settlement per annum.

other variables, or in isolation (see Table A4.1 in the Appendix for details of the results with these alternative uncertainty measures).(6) These results highlight the fact that conclusions drawn in earlier work in which only some of the factors relevant to negotiation frequency were included in the analysis may be wrong: while inflation certainly has an impact on negotiation frequency, it is by no means clear whether this influence is a direct one, or one exerted indirectly through its effects on uncertainty, or both. Unfortunately, at this level of aggregation, the data is unable to resolve this issue; both the F test on the validity of excluding price uncertainty to obtain (2) from (1) and that on the joint significance of the variables excluded from (1) in (3) fail to reach significance (with F values of 0.268, cf $F_{1,27}(0.9) = 2.90$, and 1.563, cf $F_{5,26}(0.9) = 2.07$), although the evidence falls in favour of the direct rather than indirect influence being significant (if UNCERT2 is used in place of UNCERT1, exactly equivalent results are obtained; if UNCERT3 is used, the evidence if unambiguously in favour of the direct influence with significance at the 5 per cent level reached in the test of the restrictions involved in (3)).

In the hope of improving our understanding of the relative importance of these contributory factors a second linear analysis of negotiation frequency was also attempted, again with the specified form of (4.7), but this time better use was made of our data as π_{It} was redefined as the proportion of agents undertaking negotiations in industries in the i^{th} out of twenty-six industrial groups (corresponding to the classification of the 1968 SIC). While C_t, X_t^u, and T_t, and many of the variables X_{It} are still measured at the aggregate level, sectoral productivity measures can now be employed, although the use of the aggregate price of materials is made because of the absence of detailed disaggregate data. The assumption that the same slope coefficients are applicable to all industrial classifications is made so that we can pool the data, although separate intercept coefficients are used for each class in an attempt to capture some of the costs related to the internal characteristics of the industry mentioned earlier (these are assumed to be similar across industries within any SIC classification). Again we ignore the possibility of any complexities in the distribution and interrelations of the ε_{It} (although in practice it is likely that the ε_{It} are correlated across any time interval, i.e. $E(\varepsilon_{It}.\ \varepsilon_{Jt}) \neq 0$, since there are likely to be aggregate shocks to negotiation frequency which are not picked up by our other explanatory variables).

Table 4.5 presents equivalent results to those in Table 4.3, but based on this extended data set. Once more, the inclusion of our other candidates for influence does not significantly improve the explanatory power over that shown in Column (1), although the relative importance of the variables in this column differ significantly from that in Table 4.3 Column (1).(7) In particular, we note that the coefficient on UNCERT1 is now

Table 4.5
Dependent variables = π_{It}
I = (industries in SIC I); 1964i-75iv (n = 864)

		(1)	(2)	(3)
β_{I0}		Constant plus 17 industry-specific dummies		
T_t	π_{t-1}	-0.315 (9.527)	-0.314 (9.477)	-0.297 (9.128)
	π_{t-2}	-0.246 (7.609)	-0.237 (7.321)	-0.243 (7.512)
	D74iv	0.531 (5.730)	0.484 (5.278)	0.426 (5.191)
	CATFR1	0.010 (0.099)	0.094 (0.957)	0.111 (1.210)
	CATFR2	0.089 (0.974)	0.074 (0.807)	0.210 (2.489)
X_t-X_{t-4}	Δwhpr	0.993 (1.286)	2.813 (6.013)	
	Δfc	1.096 (3.330)	1.184 (3.596)	
	Δprody	0.167 (0.763)	0.126 (0.577)	
C_t	stocks	-0.013 (0.534)	-0.046 (2.132)	
	un	-0.009 (0.302)	-0.017 (0.623)	
	q^1	0.060 (1.405)	0.097 (2.363)	0.034 (1.122)
	q^2	-0.033 (0.758)	0.011 (0.265)	-0.047 (1.446)
	q^3	-0.025 (0.747)	-0.043 (1.313)	-0.052 (1.672)
	df1	-0.076 (1.482)	-0.093 (1.825)	-0.085 (1.876)
	df2	0.006 (0.079)	-0.096 (1.439)	-0.087 (1.549)
	C1	0.173 (3.472)	0.167 (3.341)	0.173 (4.328)
	C2	0.175 (2.794)	0.133 (2.165)	0.098 (1.714)
	C3	0.030 (0.827)	0.044 (1.224)	-0.010 (0.329)
	C4	0.263 (2.578)	0.223 (2.190)	-0.061 (1.516)
	C5	-0.225 (2.312)	-0.042,(0.559)	-0.250 (3.162)
X_t^u	UNCERT1	0.513 (2.954)		0.466 (6.316)
RSS		73.7955	74.5761	74.9490
SE		0.299	0.300	0.301
R^2		0.259	0.251	0.247
R^2(adj)		0.225	0.210	0.218
DW		2.153	2.166	2.188

Notes: See footnote to Table 4.3.

significantly positive, while that on annual inflation remains positive but with only a low level of significance. Further, F-tests carried out on the validity of the restrictions imposed on (1) to obtain (2) and (3) this time fall in favour of the uncertainty measure (with values of F = 8.727, cf $F_{1,825}(0.995) = 7.88$, and F = 2.579, cf $F_{5,825}(0.975) = 2.57$), although the evidence here clearly indicates the significance of both paths of influence. (The use of UNCERT2 and UNCERT3 produces similar results; tests on the exclusion restrictions in both (2) and (3) are rejected, although with these higher significance levels are found in the test on (3))[8]. On the basis of this extended analysis then, we would conclude that inflation raises negotiation frequency both directly and indirectly through its effect on uncertainty; however, we shall return to this issue when employing our more sophisticated analysis in the next section.

Apart from the developments discussed above, we note that the influence of the remaining variables show similarly in Table 4.5 as in Table 4.3: the lagged dependent variables, D74iv, CATFR1 and CATFR2, are again of the expected direction, although while the significance of the former three variables is increased, the latter two remain with low significance. Again our "cost" variables perform disappointingly, although the seasonal variation and incomes policy effects show still. In particular, the ceilings incomes policies C1, C2 and C4 now take coefficients which are significantly positive (although surprisingly C5 now shows as significantly negative). The SIC-specific intercept terms, shown in Table A4.2 of the Appendix, range from -0.138 up to 0.093 in value, although only those relating to industries producing "Metal goods not specified elsewhere" and the "Construction" industry were significantly different to zero at the 10 per cent level.

We conclude this subsection with a brief summary of the ideas suggested by our linear analysis. First, we note that the high correlation between the actual inflation rate and price level uncertainty make it difficult to distinguish between their relative importance in determining negotiation frequency. In either case, however, it is clear that inflation, either directly or through its effects on uncertainty, does significantly influence this frequency. The significance of our lagged dependent variables, especially in our estimations on the basis of our extended data set, provides some hope that moving to a more sophisticated analysis, which can properly take into account the pattern of past settlements, will enable us to resolve this difficulty.

In general, the variables suggested for affecting costs of negotiation performed disappointingly, although the implementation of incomes policies did show up in the results as generally having significant coefficients in the expected direction. The variability in their estimated effects and the failure of the catch-up dummies to show significantly suggest however that there are complex influences behind these results which cannot be captured by simple dummy variables covering the whole of each period.

The use of sector-specific proportions, and of SIC-specific intercepts was useful, but this still clearly fails to use our database adequately. In the following subsection, we will consider a non-linear specification of (4.6) which will enable us to make better use of this database, so that a more detailed view of the determination of negotiation frequency can hopefully be found, and so that some of the issues raised by the linear analysis can be resolved.

Non-linear analysis

In this section we report the results of a non-linear analysis of the probability of negotiation which makes full use of our dataset by working at the level of the actual bargaining unit. Specifically we recognise that in our database we have a record of the presence or absence of an event (i.e. negotiation) in each period for 191 industries; so that the use of discrete choice modelling methods is suggested. In the previous section, we noted that the decision to negotiate would depend on $({}_tX_{it} - {}_{t-s}X_{it-s})$, on C_{it}, X^u_{it} and v_{it}, as these reflect the likelihood of the relevent magnitudes reaching thecritical lower bound in the optimal (s,S) framework. In this section, we operationalise this framework by writing (4.6) as

$$\pi_{it} = \begin{cases} 0 & \text{if } \alpha(X_{it}-X_{it-s}) + \beta C_{it} + \gamma X^u_{it} + v_{it} > 0 \\ 1 & \text{if } \quad '' \quad < 0 \end{cases} \tag{4.8}$$

This translates the (s,S) strategy into a linearised form in which the determinants of the (s,S) parameters, and of the evolution of the utility derived from a given nominal wage, constitute a continuous latent variable which belies the occurance of the event. Negotiation occurs when the latent variable exceeds a zero threshold (reflecting the attainment of the lower bound).

Estimation of the parameters of this model involves the maximisation of the likelihood of obtaining our data having specified a particular probability distribution for $v_{it,}$ the stochastic component introduced to capture any idiosyncratic behaviour based on non-observable costs or shocks, and some consideration must therefore be given to this element. In particular, we note first that v_{it} is unlikely to be described by the same probability distribution across all types of bargaining method employed in negotiations; even if C_{it} includes in it an SIC-specific intercept component, as in the latter part of the last section, v_{it} may be affected further by whether industry i is in the public or private sector, whether a national body (e.g. the Wage Council) influences negotiations, and so on. Consequently, in the following analysis we will restrict analysis solely to those industries which negotiate in the private sector, and in the absence of external influences. Since the majority of wage settlements are made in such an environment, this is clearly the main group of interest, while the influence of other non-economic factors (e.g. political in the public sector, social in those negotiations in which Wage Councils participate) may obscure the economic features of the decision to negotiate in the other sectors.

A second point to note with v_{it} is that these terms are likely to be correlated across industries at any point in time; that is $E(v_{it}.\ v_{jt}) \neq 0,\ i \neq j$. Even if C_{it} includes time-specific variables which fully incorporate the effects of seasonal variation and incomes policy implementation, we have already noted that aggregate shocks can influences changes in the negotiable wage in a way which will not be picked up by our term $(X_{it}-X_{it-s})$; jumps in the negotiable wage following the announcement of a future policy change have been cited as an example of this. To incorporate these features into our model, then, we must split up the error term into a time-specific and a truly random component; that is, write

$$v_{it} = \omega_t + \varepsilon_{it},$$

where $E(\omega_t.\varepsilon_{it}) = 0$, $E(\varepsilon_{it-s}.\varepsilon_{it}) = 0$, $\forall s \neq 0$, and $E(\varepsilon_{it}^2) = \sigma_\varepsilon^2$. Of course, in estimation it will be impossible to disentangle the separate effects on ω_t arising from seasonal variation, from the effects of incomes policy, and from the other time-specific influences on the industries' decision to alter wages. However, we can investigate patterns in the estimated values for ω_t to obtain some insights into the effects of policy.

Now, if we accept that having excluded all industries other than those engaged in unconstrained negotiation in the private sector and having separated out a time-specific element from v_{it}, we have a truly independent random error term ε_{it}, described by the probability distribution $F(\varepsilon)$, and density function $f(\varepsilon)$, say, then the probability that industry i negotiates in time t is given by

$$\text{prob}\{\ \alpha(X_{it}-X_{it-s}) + \beta C_{it} + \gamma X_{it}^u + \omega_t + \varepsilon_{it} > 0\ \}$$

$$= \text{prob}\{\ \varepsilon_{it} > -\alpha(X_{it}-X_{it-s}) - \beta C_{it} - \gamma X_{it}^u - \omega_t\ \}$$

$$= \text{prob}\{\ \varepsilon_{it} > -G_{it}\ \} = \int_{-G_{it}}^{\infty} f(\varepsilon)\, d\varepsilon$$

In what follows, we shall assume that the ε_{it}, are described by the sech^2 distribution, so that $f(\varepsilon) = e^{\varepsilon}/(1+e^{\varepsilon})^2$, and $\pi_{it} = e^{G_{it}}/(1+e^{G_{it}})$; i.e. we shall employ a Logit analysis. Before we set down the results of such an analysis however we make two further notes related to the use of our data at this level. First we recognise that, working at the level of the bargaining unit, we can now make use of our information on implementation of cost of living clauses in settlements. Specifically we note that price inflation will be less important in the decisions to negotiate made by firms covered by cost of living clauses than those made in firms without coverage, so that α will be different in these groups. Indeed, given the variety of forms taken by cost of living clauses, α may well vary from industry to industry even amongst those employing indexing. Again we avoid these problems by simply omitting those industries which make use of indexation from the analysis. Secondly we note that while many of the factors influencing wage decisions are determined at the aggregate level, some are truly industry-specific. However, detailed data at the industry level is difficult to obtain, and in the following analysis we have had to use proxies, based on aggregate measures or on SIC-level data, for some of the variables. Results should therefore be interpreted with these approximations in mind.

Table 4.6 again presents the results of a specification search in which all of the possibly relevant variables were considered, with our preferred equation shown in Column (1). On the negative side, the search demonstrated that none of our proposed measures of the "direct" costs of negotiation, (stock levels, trade union membership, strike activity or profit levels) significantly contribute to our explanation of negotiation frequency, with the possible exception of unemployment rates. Equally, changes in the replacement ratio and changes in aggregate demand, as measured by changes in domestic output, or alternatively as captured by international competitiveness and government spending, were not influential.(9) On a more positive note, however, these results illustrate clearly the importance of changes in the negotiable wage on negotiation frequency, with aggregate wholesale price inflation, materials' price change, productivity change, changes in tax rates(10) and that component of aggregate demand change captured by growth in world trade all entering with coefficients of the predicted direction and at high levels of significance. Further, in this analysis, where $(X_{it}-X_{it-s})$ actually picks up the change in the X_{it} since the last negotiation entered into by industry i, we are much better able to pick up the direct effect of changes in aggregate prices on negotiation, which show up positively and significantly at the 0.01 per cent level. In contrast, the coefficient on the uncertainty measure, while positive, is not significant, so that (1) provides good evidence in favour of the idea that price level uncertainty in itself has little influence on negotiation frequency. These conclusions are supported by the results in Table A4.3 in which equivalent relations to that of Table 4.6, Column (1) are presented with uncertainty measured by UNCERT2 and UNCERT3.

Table 4.6

Dependent variable = π_{It} = 0 or 1

I = (103 industries engaged in unconstrained negotiations in the private sector); 1964ii-75iv (n= 3333)

		(1)	(2)
β	Constant	-1.159 (3.059; 0.705)	-1.130 (3.076; 0.713)
		plus 13 industry-specific dummies	
X_{it}-X_{it-s}	Δwhpr	5.608 (2.068; 0.007)	10.760 (2.303; *)
	Δfc	-7.495 (1.505; *)	-8.297 (1.510; *)
	Δprody.	11.301 (4.277; 0.008)	8.062 (4.352; 0.064)
	Δtax	-11.647 (6.502; 0.073)	-31.102 (7.771; *)
	Δwdtd	3.442 (1.116; 0.002)	2.228 (1.159; 0.055)
C_{it}	un	-0.747 (0.577; 0.195)	-1.073 (0.581; 0.065)
	DT1	-1.955 (0.219; *)	-1.932 (0.220; *)
	DT2	-2.584 (0.328; *)	-2.471 (0.326; *)
	Δprofits		5.662 (1.119; *)
X^{u}_{it}	UNCERT1	4.386 (7.356; 0.551)	5.844 (7.389; 0.429)
Time dummies		Separate dummy for each period (see table A4.5 and Figure 4.5)	Separate dummies for each period (see table A4.5 and Figure 4.6)
-2logL		3216.84	3191.08
FRAC		0.780	0.785
RANK		0.572	0.581

Notes:

1. Standard errors; p-values in parentheses. Standard errors estimated by calculating the square root of the appropriate diagonal element of the estimated convariance matrix. Test statistics for each estimate obtained by computing the square of the parameter estimate divided by the standard error. Under the assumption of asymptotic normality of estimators, these statistics are then compared to the χ_1^2 distribution as a test of the hypothesis that a parameter is zero. P-values indicate the probability that the hypothesis is true. * indicates p<0.001.
2. "FRAC" = fraction of concordent pairs of predicted probabilities and responses. "RANK" = rank correlation between predicted probability and response.

Again recognising that by working at this level of aggregation we can explicitly incorporate the pattern of past settlements into our analysis, we have included here two new dummies, DT1 and DT2, to capture the effects of two periods of incomes policy during which agents were constrained to negotiate at most once per annum. These dummies capture this constraining effect by taking the value one for each observation in which the industry has negotiated within the preceding three quarters over the period of policy implementation (1967iii-1970iv for DT1, 1973ii-1975ii for DT2), and zero otherwise. The high levels of significance on both of these dummy variables indicates that these policies were indeed successful; for example, working from a position in which the probability of negotiation is 0.278 (the mean proportion of industries negotiating in any period over our sample), the implementation of the second of our policy periods (estimated to reduce G_{it} by 2.584) would reduce the probability of negotiations to 0.028, other things being equal ($e^{G_{it}} = 0.27/1\text{-}0.27 \Rightarrow e^{G_{it}-2.584} = 0.02905 \Rightarrow$ (new) $\pi = 0.028$) i.e. the policy succeeded in reducing negotiations to close to zero.

Much of the explanatory power of the model described in Column (1) of Table 4.6 is provided by the time-specific dummies, and so we turn now to a more detailed look at these. As previously explained, these dummies will capture the effects of all of the aggregate shocks influencing negotiation frequency during any one period. Two sources of aggregate shocks have been noted in the discussion above as being potentially important (namely incomes policies and unexpectedly rapid inflation), and we will pay particular attention to these in interpreting the pattern of time dummies obtained in the model estimation.

In looking at the effects of incomes policy on the time dummies, it is clear that while our model is well equipped to capture the effects of policies specifically directed at negotiation frequency (i.e. "freeze" and "twelve-month" policies), the effects of ceilings policies are captured only indirectly. An effective wage freeze will be captured by the model through high negative coefficients on the time dummies which correspond to the period of the policy. Catch up behaviour following the freeze will also be accomodated explicitly in the model, since any 'losses' incurred through the imposition of the policy (as wages fall behind prices, say) will be reflected in the variables already included in the model which measure growth in the relevent variables since the previous negotiation. The significant positive coefficient on aggregate price inflation since the previous negotiation, for example, means that any losses incurred as wages fall behind prices will be translated by our model into a surge of wage settlements following the end of the freeze policy. In contrast, we note that ceiling policies do not directly affect negotiation frequency; only in as far as a policy successfully keeps wages set during the policy below the level which would be obtained in its absence will it affect negotiation frequency. Catch-up effects here show up as positive time dummies, the size of which depends both on the success of the policies in achieving their aims and on the extent to which the policies' targets were set below the negotiable level. Moreover, the effect of these constraints may have a cumulative effect on negotiation frequency so that understanding the pattern of time dummies is by no means straightforward.

As noted earlier, for any industry, renegotiation is made more likely if there is growth in the determinants of the negotiable wage, $(X_{it} - X_{it-s})$, or if there are movements in variables which had been unanticipated when the previous settlement was struck, i.e high $(X_{it-s} - {}_{t-s}X_{it-s})$. An example of this latter influence would be where inflation is unexpectedly rapid in the period following negotiation. In our analysis, we have taken the first of these into account explicitly, but given the limitations of data, we have not been able to accomodate the effects of industry-specific unanticipated shocks. The latter element may contribute to the pattern of the time dummies obtained, therefore, and at the least we should consider the impact of unanticipated shocks at this aggregate level. For this, we can use the expected rate of annual inflation published by the NIESR (described earlier in the discussion on the measurement of uncertainty). This series is not directly applicable in the non-linear analysis as it considers expectations formed over a fixed time horizon; namely 12 months ahead. However, at the aggregate level, the unexpected inflation series obtained on the basis of this data will provide an indication of any shocks that have occured to inflation within the previous year, and can be used to help explain the number of negotiations observed in the aggregate at any time over and above those already covered by the model.

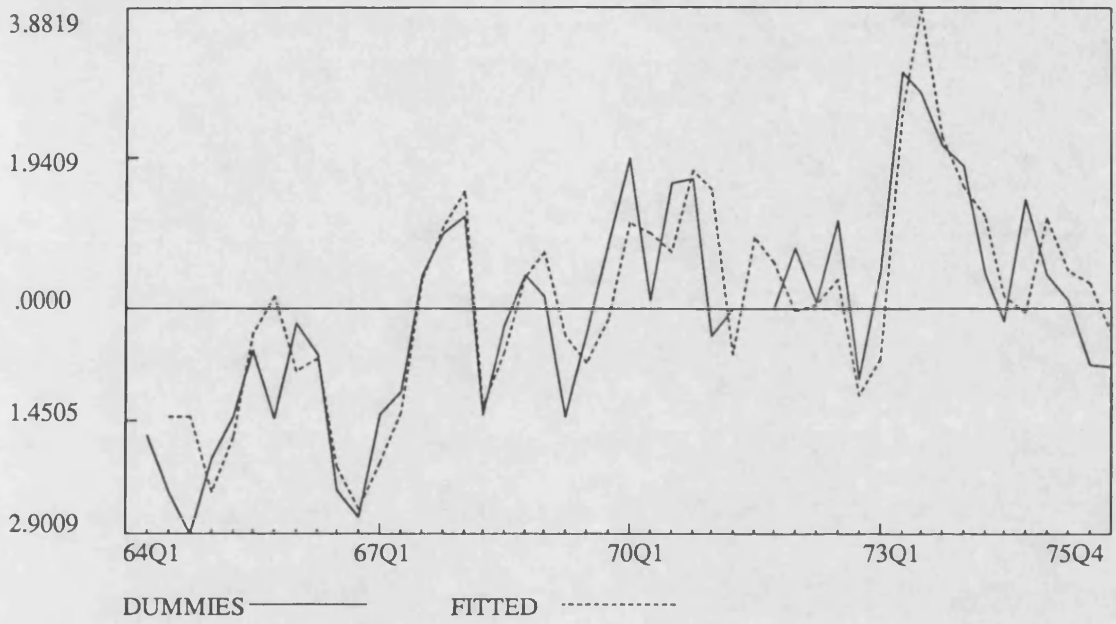
Figure 4.5 provides an illustration of the time specific influences on negotiation frequency which we have not yet explicitly explained through our model, plotting the (adjusted) estimated coefficients on the time dummies associated with the model described in Table 4.6, column 1. The adjustment that has been made aims to take into account the precision of the estimate of the time-specific effects by dividing the estimated coefficients on the time dummies by the square root of their estimated standard errors. (The actual coefficient estimates on the time dummies, and their estimated standard errors are provided in Table A4 of the Appendix). This adjustment is that which is necessary to eliminate heteroskedasticity in the equation

$$\hat{\beta}_t = \alpha z_t + u_t \qquad (4.9)$$

where $\hat{\beta}$ are the estimated coefficients on the time dummies, and where $E(u_t)=\sigma_t$, which depends on $E[\,(\beta_t - \hat{\beta}_t)^2]$ and varies over time.

Looking at Figure 4.5, we note that the period begins with a series of negative values which cannot be explained in terms of incomes policy effects, although there is a

Figure 4.5 (Adjusted) Time dummies relating to Table 4.6, column 1.



gradual increase in negotiation frequency over the period 1965ii-1966ii which might be associated with the cumulative effects of a ceiling incomes policy. The very sharp decline in negotiations occurring between 1966iii-1967ii is associated with the "wage freeze" and "severe restraint" policies implemented during this period, although the impact of the policy is not uniform over the entire period of its implementation. Immediately succeeding the period of severe restraint, the Wilson government implemented a voluntary zero-norm policy which appears to be associated with a period of increased negotiation frequency. In fact, given the voluntary nature of this policy, the size of the coefficients found during this period may be surprising, although they may incorporate some element of catch-up behaviour following the period of "freeze policy" and the effects of the 1966 Redundancy Act might also be included. The statutory $3\frac{1}{2}$ per cent limit enforced by policy carried out between 1968ii and 1970ii attempted to reduce wage inflation by just 2-3 per cent so that the sequence of insignificant dummies (upto mid-1969) followed by significantly positive observations fits well with the idea that agents engaged in more negotiations as the cumulative effect of the policy became large. The Heath Administration, elected in June 1970, made no attempt at incomes policy until 1972iv (so that we have used this period as our baseline), but a significantly positive dummy is found in 1972iii (perhaps in anticipation of the forthcoming freeze), followed by a negative, though insignificant, observation in the first period of this policy. A series of positive dummies are associated with the implementation of (statutory) ceiling policies during the latter part of the Heath Administration, exactly as we might expect given that these allowed no scope for agents to regain their positions held before the freeze, while a kink at 1974iv can be explained by the settlements generated by the "threshold" agreements as discussed earlier in the chapter. Finally, we note the two (insignificantly) negative observations at the end of the period of analysis, coinciding with the implementation of phase I of Labour's Social Contract.

In Table 4.7, we present results of a regression analysis of an equation of the form at (4.9), where appropriate adjustment has been made to accomodate the presence of heteroskedasticity (i.e. we regress [$\hat{\beta}_t/\sqrt{s.e.(\hat{\beta}_t)}$] on [$z_t/\sqrt{s.e.(\hat{\beta}_t)}$]). Columns (1) and (2) of the Table relate to the coefficients on the time dummies of the model presented in Table 4.6 column 1. (Columns (3) and (4) relate to those of the model presented in Table 4.6 column 2 to be discussed shortly). Column (1) includes all of the variables which have been considered above as potentially important in explaining the time-specific effects, while column (2) represents the results of a specification search in which variables with (absolute) t-values less than one were eliminated from the equation. Following the discussion above, four sets of variables are included in the regression analysis:

(i) incomes policy effects: F1 and F2 are dummies entered to capture the effects of the two periods of 'freeze' incomes policy, and are as previously defined. C1INC-C5INC

Table 4.7

Dependent variable = $\beta_t^* = \hat{\beta}_t/\sqrt{s.e.(\hat{\beta}_t)}$
= (adjusted) time dummies relating to Table 4.6
(t = 1965iii-1975iv; n = 44)

	(1)	(2)	(3)	(4)
Constant	1.0968	1.3140	0.5395	0.6321
	(1.5746)	(2.0464)	(0.7259)	(0.9495)
U(Δp)	0.1401	0.1159	0.1472	0.1093
	(1.9025)	(1.7256)	(1.7115)	(1.4292)
C1INC	0.4275	0.4545	0.4434	0.4310
	(1.7605)	(2.3612)	(1.5753)	(1.9235)
C2INC	0.8722	0.9083	0.9200	0.9320
	(2.7953)	(3.1336)	(2.5413)	(2.7720)
C3INC	-0.0537		-0.0861	
	(0.6940)		(0.9563)	
C4INC	0.3643	0.3364	0.3048	
	(1.2248)	(1.1824)	(0.8865)	
C5INC	-1.9420		-1.9309	
	(1.2854)		(1.1302)	
F1	-0.0656		0.2245	
	(0.0784)		(0.2302)	
F2	-1.5169	-1.5138	-1.5331	-1.6774
	(2.3617)	(2.6168)	(2.0606)	(2.6308
Q1	0.1954		0.1977	
	(0.8928)		(0.7689)	
Q2	-0.2718	-0.4087	-0.3207	-0.4389
	(1.0168)	(2.2455)	(1.0240)	(2.0721)
Q3	0.0822		0.0315	
	(0.3543)		(0.1155)	
Parameter of autoregressive error	0.9312 (17.3284)	0.9391 (18.5322)	0.8928 (13.4386)	0.8923 (13.4061)
RSS	23.8274	25.8525	31.3304	34.6825
SE	0.8497	0.8248	0.9744	0.9430
R^2	0.7214	0.6977	0.6866	0.6531
R^2(adj)	0.6201	0.6421	0.5726	0.5997
LLF	-51.1510	-53.0858	-57.2352	-59.5712
DW	2.0115	2.0347	1.9016	1.9554

Notes

Regression estimated assuming that the residuals follow an AR(1) process; i.e $\beta_t^* = z_t\alpha_t + u_t$, where $u_t = \rho u_{t-1} + \varepsilon_t$, and ε_t are white noise. The exact inverse interpolation method of estimation is employed. See text for variable definitions. Absolute t-values based on asymptotic standard errors in brackets.

relate to the periods of 'ceiling' incomes policy previously captured by C1-C5, but in place of the simple 0,1 dummies, these variables increase over time, taking the values 1,2,3,... during the period of policy implementation. In this way it is hoped that the cumulative effect of ceilings incomes policies might be captured.

(ii) unanticipated inflation: i.e $U(\Delta p_t) = \Delta p_t - E[\ \Delta p_t \mid \Omega_{t-4}\ ]$, where the 12 month forward forecasts are obtained from the NIESR model.

(iii) seasonal variability: Q1-Q3 are as previously defined.

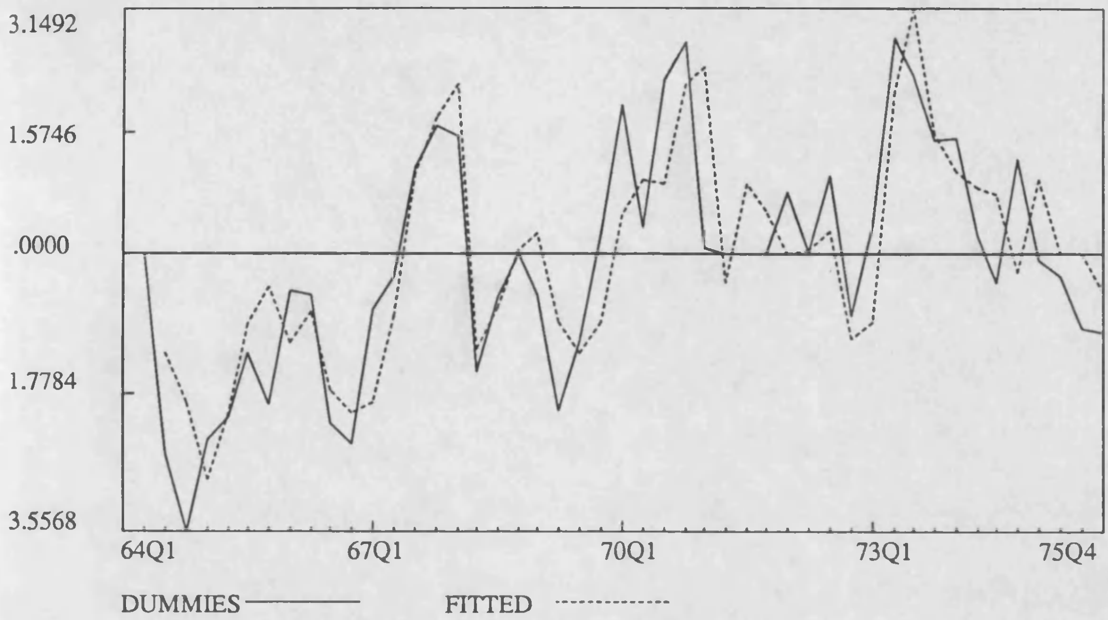
(iv) autoregressive errors: the regression is estimated assuming the errors follow an AR(1) process. This assumption is made to accomodate the persistent effects of the $U(\Delta p_t)$ variable at the aggregate level. An unexpectedly rapid inflation rate in any period may cause an increase in negotiations above the level that would have occurred otherwise for a number of periods. This is because the effect on each industry is to move real wages closer to the critical lower bound, making negotiation more likely in all subsequent periods.

The results obtained in Table 4.7 indicate that both periods of incomes policy and unexpectedly rapid inflation were influential on renegotiation frequency over this period. Significantly positive coefficients are found on $U(\Delta p_t)$ indicating that there is evidence of increased negotiating activity following a period of unexpectedly rapid inflation, and the strong autoregressive element indicates that these effects do indeed persist over time in the aggregate. Clear incomes policy effects are observed during the periods of 'ceiling' incomes policy captured by C1INC, C2INC, and C4INC, as negotiations occur more frequently as wages are held below their desired level.(11) The second period of 'freeze' incomes policy also shows as expected, with negotiations occuring significantly less frequently during this period. Surprisingly, given the sharp fall observed in 1966iii in Figure 4.5, the first period of 'freeze' policy does not show significantly in the regression results, although as we have noted, the impact of the policy is notably different during the 4 quarters of its implementation, and the apparent breakdown of the policy in its latter stages has clearly influenced this result. Some seasonal variation is picked up by the regression analysis, as there appears to be fewer negotiations occuring in the second quarter than during the rest of the year.

In summary, we recognise that while this two stage approach to explaining negotiation frequency would not be the desired one in principle, given the limitations of the data, it does provide a reasonable indication of the determinants of negotiation frequency in practice. As we have stressed previously, there may be many economy-wide influences in addition to those explicitly included in this analysis, which could contribute to the influence of the time-specific dummies. In particular, two (related) influences were suggested in chapter 2. First, many of the relationships suggested by the literature on wage leadership would be picked up here by the time dummies; as an example, consider the effects of a successful wage claim by a very high-profile industry (such as the miners pay claims in the early 1970's), which might alter many unions' fallback wage levels and result in a large number of unions pushing for new wage settlements at a particular time. And second, a widely-publicised indicator of future wages, generated in a purely random way, can significantly influence the time path of wages: if each agent expects all other agents to treat the indicator as influential, then it becomes individually rational to use the indicator to forecast future wages, and it becomes influential. Statistically, it is impossible to show that the indicator is no more than a "will-o-the-wisp". On these grounds, any number of possible factors could generate a sequence of periods with large numbers of negotiations, upto the point where the "speculative bubble" bursts, and these would be picked up here by the time dummies. Having said this, however, the model presented in Table 4.7 shows that we **have** identified some important influences on negotiation frequency. This second stage regression analysis explains altogether around 70% of the variability in the (adjusted) time dummy coefficients, so that the residual time-specific influences are reasonably well explained by the aggregate magnitudes that are considered by our model.

The results discussed above provide some good evidence to support the idea that incomes policies have strong effects on negotiation frequency, and that these are broadly in the direction predicted by our earlier discussion. However, as we have already noted, our description of the pattern of time dummies is merely indicative of the likely time-specific influences not captured in the original model estimation. In order to try to capture the effects of incomes policies more directly, Column (2) of Table 4.6 includes, in addition to the other variables of Column (1), the rate of change of profits (Δprofits). The idea here is that the extent to which wages are constrained below their "true" market value by policies will show up in increasing profits. In fact, the inclusion of this variable significantly improves the fit of the overall model (2 log (L_0/L_1) = 25.76, cf χ_1^2), and effects the size of the coefficients on the variables already included (so that "un" now becomes significant). Joint significance tests of the variables excluded from Column (2) remain insignificant,(12) however, and conclusions about the influence of price uncertainty remain unchanged. Hence the estimate of column (2) represents our preferred equation. However, as the pattern of Figure 4.6 (and the associated regression analysis of columns 3 and 4 in Table 4.7) demonstrate, the inclusion of this variable does not significantly alter the size or significance of the estimated time-specific dummies, so that the influences picked up by this variable are not those on which we had originally based its inclusion, and the influence of incomes policies and of unanticipated inflation are still picked up by the time dummies.

Figure 4.6 (Adjusted) Time dummies relating to Table 4.6, column 2.



Of course, increasing profits will occur for reasons other than the imposition of incomes policies. However, being endogenous to the model presented in section 4.2, we might expect this variable to add no more to the explanatory power of the model other than through the incomes policy effects working beyond the model outlined above. Having said this, given the poor performance of our variables used to measure aggregate demand movements, a sensible interpretation can be given to the significance of the coefficient on (Δprofits) in these terms; certainly profits rise as aggregate demand increases so that the direction of influence is as expected, while we note that the inclusion of this variable has reduced the significance of the coefficient on the growth of world trade (and on productivity growth, which also typically rises and falls with changes in aggregate demand), showing some degree of collinearity between these variables. Certainly the significance of (Δprofits) supports the idea that wage negotiations occur more frequently during upswings on the business cycle, and along with the other estimates presented in Column (2), this provides good evidence in support of our hypothesis that negotiations occur when the net gains of negotiating are high, even if our attempts to identify those variables which might influence the costs involved in negotiations, have been disappointing.

Finally in this section we consider the magnitudes of the estimates presented in our preferred equation in (2). The simplest way of interpreting these coefficients is in terms of the change in the probability of negotiations from an initial point caused by a change in one of its determinants, with other things being equal. So, for example, we might imagine that at some point, the probability of negotiation for industry i is 0.25, say. Now, given the estimated coefficients in Table 4.6 Column (2), we recognise that, had the rate of change of wholesale prices since this industry's previous negotiation been 1 per cent higher, then with all other things equal, this probability would be 0.269, since

$$\text{(original) } \pi_{it} = 0.25 \qquad \Rightarrow e^{G_{it}} = 0.25/0.75 = 0.333;$$

$$e^{G_{it}}.e^{10.76 \times 0.01} = 0.368 \qquad \Rightarrow \text{(new) } \pi_{it} = 0.368/1.368 = 0.269$$

Exactly similar calculations can be made for each of the influential variables in turn, although given the large standard errors estimated for some of the variables, there is probably little to be gained in attempting to "rank" the variables in order of influence.

Having said this however, we note that the effects of the incomes policies and other influences picked up by the time dummies, as shown by the size of the estimated coefficients, are large compared to those of the other factors included in the model. There are many dummies with absolute values in the region of 1.5, or more, for example, and these will each exert influence on negotiation frequency comparable to that generated by a rate of wholesale price inflation of 15 per cent. As we have stressed, incomes policies constitute an important component of these aggregate time-specific effects, and this indicates a clear role for government policy in this area. In the concluding section below, we summarise the findings of the empirical work, and consider in more detail their implications for government policy.

4.4 Conclusions

This chapter has concentrated on the decision on how often and when an industry chooses to alter its wage, on the grounds that the frequency of negotiations influences the speed of wage adjustment directly, and provides some insights into industrial wage-setting as a whole. A simple examination of the Aberdeen wage rates database was sufficient to show that over the data period there is a good deal of variability both in the length of time elapsing between successive negotiations for many individual industries, and in the numbers involved in negotiations across all industries at any point in time. The empirical work of the subsequent sections provides an attempt to explain this variability, and it is appropriate to summarise the findings of the empirical work at this stage before considering any possible policy implications.

Working within the context of open-ended contracts, it was shown that a variety of factors could potentially influence the frequency of negotiation, and that, contrary to the implicit assumptions of previous empirical work in the area, these factors could co-exist and could be justified on a single decision-making base. In particular, it was shown that higher inflation rates and greater degrees of price level uncertainty might *both* increase negotiation frequency, although because of the high correlation between the measures of these variables, it might be difficult to distinguish which is the more important through a simple statistical analysis of the data. The more sophisticated discrete-choice model of the decision to negotiate showed the importance of accounting for the pattern of past settlements, however, and demonstrated that, if these are taken into account, the rate of price change appears highly influential in the determination of negotiation frequency, while price level uncertainty, in itself, fails to show significantly. We should be clear that this does not mean to say that unexpectedly rapid inflation does not have an effect on negotiation frequency. On the contrary, our second stage analysis indicated that as one might expect, unexpectedly rapid inflationary periods have also been associated with an increased number of settlements as real wage levels fall behind the levels that were bargained for when the settlement was struck.

The results of the discrete-choice model provide good support for the proposed (s, S) framework for wage-setting behaviour in the UK. Here, industry-specific intercept dummies were useful in capturing some elements of the costs involved in negotiation, as was the unemployment rate, although other variables used to capture these costs performed disappointingly. On the other hand, variables introduced to measure the offsetting gains to be made in negotiations performed well, and many of the intuitively sensible variables showed significantly and in the right direction. In this category, aggregate price inflation, tax changes, materials' price inflation, productivity growth, profits, and changes in aggregate demand all showed as important. The impact of incomes policies was also noted, and, using the estimated time-specific dummies, it was argued that many periods of policy have had an effect on negotiation frequency. Most obvious amongst these were the effects of the frequency-directed policies ("freeze" and "twelve-month delay") which reduced the number of negotiations directly. In addition, however, it was also argued that some periods of high negotiation activity might have occurred either in anticipation of future freeze incomes policies, or because of the constraining effects of ceilings policies.

The empirical work described above has interesting implications for policy formation. While there is clear evidence that the decision to enter negotiations is adequately captured by a model based on utility-maximising agents, it is equally clear that the framework within which these agents operate can, and has been, manipulated by government. The underlying cause of wage inertia centres around the presence of costs of wage adjustment which are not within the control of government. However, it is apparent that governments can impose costs of its own which can significantly influence the timing of wage settlements. The feasibility of goverment influence on the timing of negotiations has been well established; the question is whether this influence can be used to good advantage in a macroeconomic context.

Throughout this discussion, we have been concerned with the effects of nominal rigidities on real magnitudes, and in considering macroeconomic policy formulation here it is reasonable to restrict attention to the impact that government can have on the economy's ability to adjust to nominal shocks, ignoring the distributional effects of policy (i.e. ignoring issues of whether particular groups within the economy gain more than others as policy is implemented). As an illustration, we might refer back to the disaggregated model of section 2.5. Here, there is an implicit 'natural' level of output and employment described by the long run properties of the model, but there are also important dynamic elements which mean that nominal shocks have real effects over some period because adjustment takes place less-than-instantaneously. In these circumstances the aim of policy is to ease the pain of adjustment to exogenous nominal shocks, and seen in this light, there are two types of policy which might be useful: the first type has beneficial macroeconomic effects because it reduces directly the degree of inertia generated at the level of the firm; and the second type is useful because it accepts the given level of inertia experienced by individual firms, but attempts to manage this inertia to achieve gains at the economy wide level. We will consider each of these in turn below, using the framework of the disaggregated model of section 2.5 to illustrate the gains to be achieved through policy.

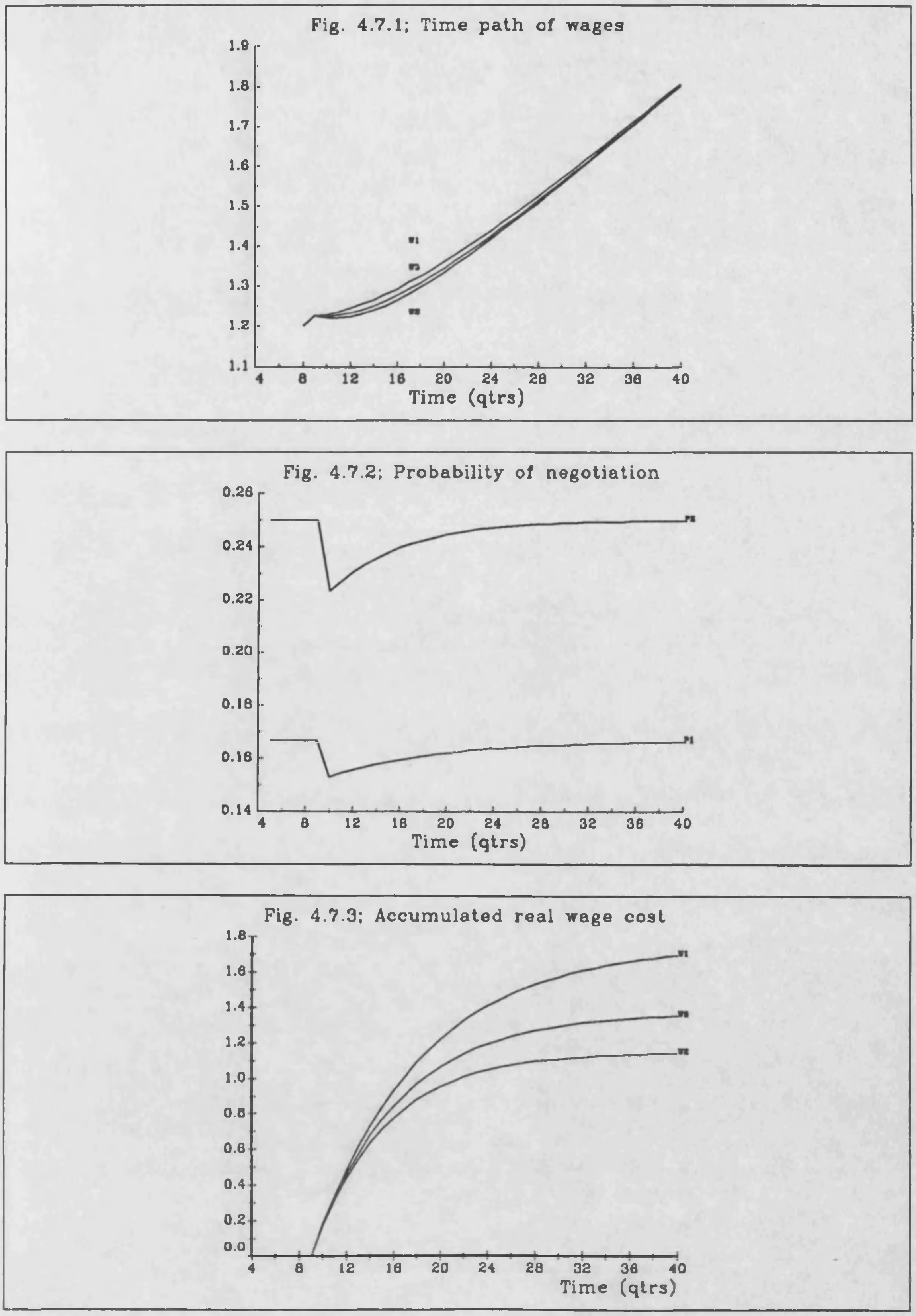
In section 2.5, we set out in equations (2.4)-(2.7) a simple model of the economy based around two sectors. We recall that the decision making in the two sectors was interrelated because of the influence of the aggregate price level, defined as the average price over the two sectors. Specifically, the demand for output (and hence employment levels) in each sector depended on the price of its output relative to the aggregate price level, and the union's labour supply decision was based on the sectoral nominal wage relative to the aggregate price level. Inertia was introduced to the system by the assumption that wage negotiations are entered into in any period with a finite probability, with the expected probability of negotiation taking place in the current, and all future, periods dependent on the current level of aggregate price inflation. Specifically, in (2.10) we wrote that

$$\pi(\Delta w_t^e) = \pi_{at+j}^e = \frac{\exp(a + b\Delta w_t^e)}{1 + \exp(a + b\Delta w_t^e)}, \qquad j = 0, 1, 2, ... \qquad (2.10)$$

where w_t is the logarithm of the aggregate wage (so that Δw_t represents the rate of aggregate wage growth). Here, the parameter 'a' captures one aspect of the effects of a fixed cost of adjustment, while the inclusion of the term ' $b\Delta w_t^e$ ' indicates that there is a feedback from inflation to renegotiation frequency; this is of course a simplified version of the non-linear model estimated in the previous section.

The first type of policy discussed above, in which government directly increases the frequency with which firms renegotiate wages, can be simply illustrated in this framework. For example, an increase in the parameter 'a' would capture the idea of a reduction in negotiation costs, raising the probability of renegotiation at all levels of wage inflation. Figure 4.7 illustrates such a change, looking at the evolution of wages and renegotiation probabilities over time (each period representing a quarterly observation of the series). In this, the money supply is assumed to be rising at 10% per annum throughout, but there is an unanticipated 20% reduction in the money supply in period 10. We use the model of (2.4)-(2.7) and expression (2.10), taking $\gamma = 0.8$, $\theta = 0.5$, $\alpha = -1.734$, and $\beta = 5$, so that the probability of renegotiation is equal to 0.166 at the initial rate of inflation, and the expected length of time between negotiations is 6 quarters. Under these

Figure 4.7 Impact of a 20% reduction in money stock with different costs of adjustment



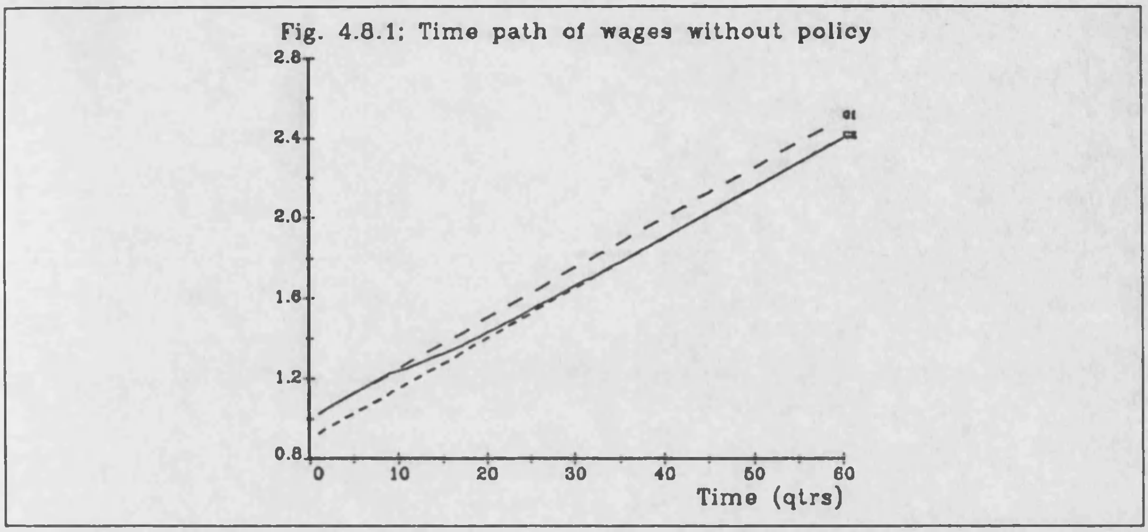
Model parameters: w1: a=-1.734, b=5; w2: a=-1.511, b=5; w3: a=-1.609, b=0 circumstances, the (expected) evolution of aggregate wages is given by the second order difference equation described at (2.12), and is plotted in Figure 4.7.1 (labeled 'w1'). Wages converge to the lower level associated with the reduced money stock by around period 30, and as this is some 20 quarters after the initial shock, it is clear that adjustment takes place over a period which is far longer than the expected duration of any individual contract. The accumulated area between this time path of wages and the 'optimal' wage time path which could be achieved if all agents responded fully and instantaneously to the money shock is plotted in Figure 4.7.3, with a substantial associated accumulated loss built up over the eight years following the shock. (Note that this corresponds to a real output loss since output is reduced, through a real balance effect, while prices remain high relative to the nominal money stock). This compares unfavourably with the time path of wages denoted 'w2', which corresponds to the same scenario, but with the parameter 'a' set equal to -1.511. With this higher figure for 'a', the probability of negotiation at the initial rate of growth of wages is 0.25, and the expected length of any contract is 4 quarters. This reduction in inertia is illustrated clearly in Figure 4.7.1, as the wage path associated with these parameters moves more rapidly towards its eventual growth path, and the accumulated loss associated with this response is correspondingly lower (as shown in Figure 4.7.3).

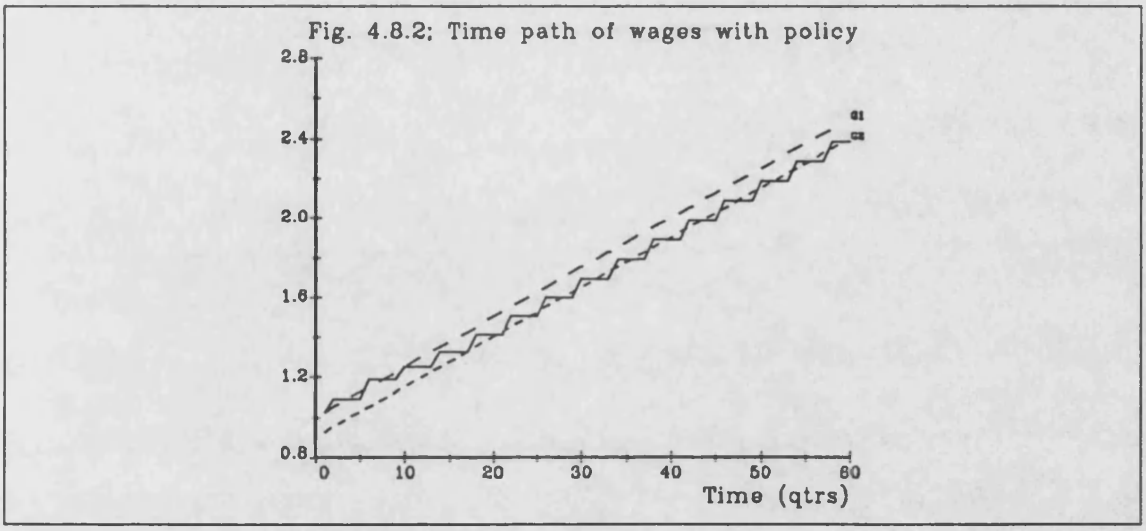
It should be recalled that the underlying microeconomic framework explaining the decision to enter negotiation is that of an '(s,S) rule', and that in this framework, the reduction of negotiation costs serves to compress the (s,S) band. Another effect of the reduction in adjustment costs in our simple algebraic model is through an increase in the size of the parameter 'b' therefore, so that renegotiation probabilities not only increase at any given rate of inflation, but also increase more rapidly as inflation rises. However, it is clear from figure 4.7.2 that an increased responsiveness of renegotiation probabilities to wage inflation is a mixed blessing. For example, during the disinflation described in wage path 'w1', wage inflation falls to around 3% per annum in the first year and rises only slowly back to a rate of 10% per annum. This has a corresponding effect on renegotiation probabilities, which fall from 0.166 to 0.153 (with the expected length of contracts rising from 6 to 6.5 quarters). In this way, the degree of inertia is exacerbated by the process of disinflation, and clearly this detrimental feedback will be larger as the responsiveness of renegotiation probabilities to wages increases. The line denoted 'w3' in Figure 4.7.3 illustrates the gains to be achieved if the feedbacks from wage inflation to negotiation probabilities can be severed altogether: here the parameters 'a' and 'b' are set equal to -1.609 and 0 respectively. Hence, the probability of negotiation remains at 0.166 at all levels of wage inflation, eliminating the detrimental slowdown in negotiation frequency observed previously during the period of disinflation. As shown in the Figure, the total accumulated loss associated with this final time path is substantially below that corresponding to 'w1'. The point to be made, therefore, is that govenment should recognise not only the direct impact of policy on negotiation frequency but also its effects on the responsiveness of this frequency to macroeconomic adjustment, and the means by which reductions in negotiation costs are achieved through policy should be modified accordingly.

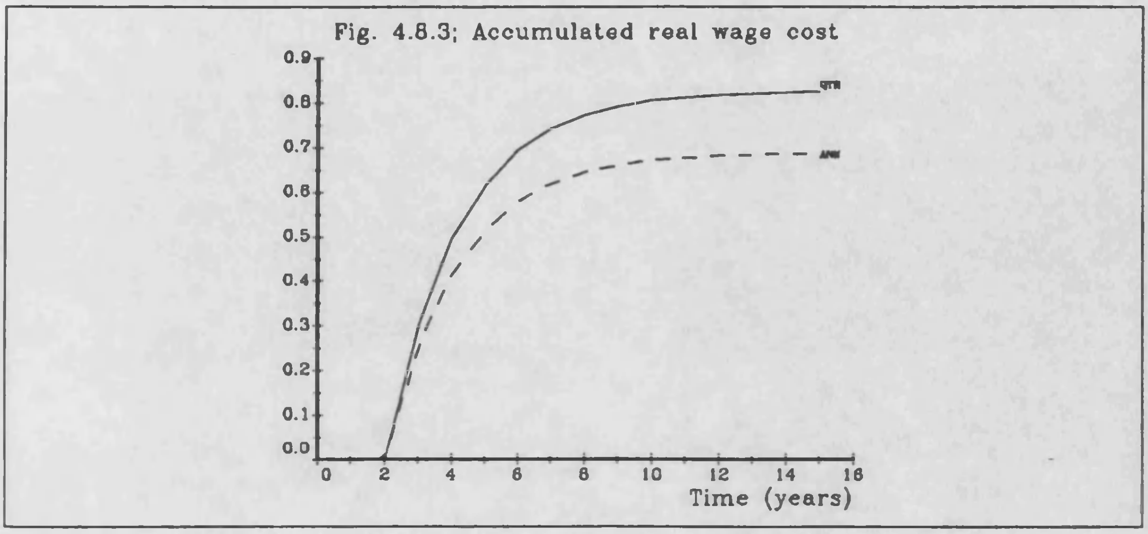
The possibility of a government being able to increase the speed of adjustment in the economy through a direct reduction in adjustment costs is obviously an attractive one, although in practice it is not clear how these reductions can be brought about. The empirical work of the previous section shows that goverments have been able to influence the timing of wage settlements in the past through periods of incomes policy, but to the extent that these have been successful policies, they have generally involved the (potential) imposition of *higher* adjustment costs to reduce the number of settlements. We did, of course, also discover important industry-specific intercepts in the empirical work which we associated with the costs of adjustment which would differ across industries because of differences in the bargaining structures in the different industries. This is the area in which governments may be able to exert some downward influence on adjustment costs therefore, influencing the level at which negotiations take place through institutional reform, for example, or reducing the possibility of costly strike activity through legislation, etc. This is an area of some importance, and while the presence of significant industry-specific intercepts can be interpreted in this way, it is clear that further analysis of wage-setting practices and procedures, using data at the level of the individual firm, is required to establish the feasibility of governments to reduce adjustment costs at this micreconomic level.

A second strand of policy open to government is one in which the government accepts a given degree of inertia at the micro level, but attempts to manage this inertia to the benefit of the macroeconomy. A good example of such a policy would be one in which the government has intervened to coordinate the timing of wage settlements across the different sectors of the economy. In figure 4.8, we illustrate the time paths of wages with and without a coordinating policy of this sort. The wage path in Figure 4.8.1 shows once more the evolution of aggregate wages if negotiations can occur in any quarter, exactly as in the discussion above. This is compared to the time path of wages in Figure 4.8.2 in which negotiations in all sectors are constrained to take place in a particular quarter of each year. Hence, negotiations can take place in the diagram in quarters 2, 6, 10, 14, and so on, with nominal wages fixed in between settlements. The dynamics of the aggregate wage in the context of a coordinating policy are of precisely the same form as previously, with renegotiation occuring in any industry in a particular year with a fixed probability. The evolution of wages over time will be described by a second order

Figure 4.8 Impact of a 10% reduction in money stock with and without policy







Model parameters: **Qtrly** (without policy): a=-1.734, b=5; **Annual** (with policy): a=0.193, b=5 difference equation of the same form as previously, but now showing the relationship between w_{t-4}, w_t, and w_{t+4}. The speed of adjustment will depend once more on the parameters of the model, and in particular on the (annualised) probability of negotiation. The parameters for 'a' and 'b' in the annualised version of (2.10) are set equal to 0.193 and 5 respectively in generating Figure 4.8.2. Given this choice of parameters, the probability of renegotiation remains equally responsive to wage inflation as in the 'no policy' scenario, while the overall probability of negotiation in any year is 0.666 at the initial rate of inflation.

Figure 4.8.3 illustrates the gains to be achieved through the use of a coordinating policy of this sort. Once more, the plots show the accumulated difference between the real wage under the actual wage and that which would be achieved if adjustment was complete and instantaneous (and represents a real welfare loss in that there is unemployment while this difference exists). The gains displayed in the Figure are not the result of a reduction in the level of inertia in wage setting, but are the result of coordination of the timing of the government's management of macroeconomic policy instruments with the timing of the wage setting decisions of the private sector. With the probability of renegotiation in the 'no policy' scenario equal to 0.166 (each quarter), and the (annual) probability of negotiation in the 'with policy' scenario equal to 0.666, inertia is constant in the sense that the average length of wage contracts is the same in both scenarios (6 quarters) at the initial (and eventual) level of inflation in aggregate wages. As a result, the (backward-looking) characteristic root of the annualised dynamic equation achieved in each scenario are the same. In these circumstances, the gains are achieved because the government can coordinate any deflationary measures with individual wage setters, who can therefore respond relatively quickly. Such coordination is not possible in the absence of an annualised wage round as the wage negotiations of different firms take place throughout the year. By timing policy to coincide with the quarter in which settlements are struck, the government ensures that an early response to government policy is achieved, even though the overall degree of nominal inertia is unaltered. On the downside, it is clear also that if the government mistimes the implementation of its policy, then firms and unions are locked into a wage settlement which is inappropriate for the current level of nominal demand, and this framework may be more costly than the original one. Having made this warning, however, this seems a fairly straight-forward gain to be achieved through the manipulation of the timing of settlements, and one for which there is some precedent in the (apparently successful) periods of policy in which wages were frozen, or in which the number of negotiations was limited to a maximum of one per annum. Of course, if such policies also resulted in a fall in the level of negotiation costs, through a reduction in the size of the bargaining zone, for example, then there would be a still greater gain (as the expected number of new settlements in each wage round would rise).

A final policy option relating to the timing of negotiations, and potentially the most practical and powerful option, is based on the possibility of *increasing* the costs of negotiation for individual firms, but in so doing, reducing the degree of inertia at the macro level. Once more, the policy's advantage comes through the possibility of a coordinated disinflation of wages across sectors, and again there appears to be some precedent for this, as previous examples of incomes policy were able to raise costs to a level at which no negotiations took place over a number of periods. As we have noted throughout, the length of time taken for aggregate wages to adjust to the nominal shocks is considerably longer than the (expected) length of any single settlement (lasting around eight years in Figure 4.8.1, for example, where the average length of a wage contract is 1.5 years). This is because the contracts set in the two sectors are staggered over time, so that no individual sector is willing to adjust fully to the perceived shocks even when it enters into negotiations as it knows that there is a finite probability that the other sectors will not adjust also in the current period. If the stagger can be taken out of the bargaining framework, then this 'leap-frogging' will be eliminated, and adjustment will take only as long as the longest contract lasts. Hence, if the government can delay new wage negotiations by imposing extra costs, it is possible that all new settlements, or at least the vast majority of them, will occur simultaneously, and a more complete adjustment to any shock that has occured will be achieved. Of course, there is a trade-off between this gain, and the loss in adjustment that would have occured in the period of constraint. However, the illustrative models above (and those of chapter 2) have demonstrated that the build-up of inertia that can result from the stagger can be considerable, so that the gains from the policy may well offset the losses.

In the stylised framework described above, policies on the timing and frequency of wage negotiations can be constructed which would improve the economy's ability to adjust to macroeconomic shocks. The empirical evidence is that such policies could also be implemented. However, in the discussion so far, we have concentrated on a particular aspect of nominal rigidities only (namely the frequency of nominal wage change), and we have abstracted from distributional considerations (eg. firms versus unions, or sector A versus sector B) and the broader issues of wage/price determination. In the following chapters, we attempt to redress this imbalance. Specifically, in the next chapter, a complete model of the U.K. supply-side is presented in an attempt to model the dynamics of (real and nominal) wage, price, and employment determination. Subsequent chapters will then use the findings of the model in statistical analyses and in simulation exercises in an attempt to obtain a better understanding of these dynamics.

CHAPTER 5

A Disaggregated Model of the UK Supply Side

The preceding two chapters have concentrated primarily on movements in the nominal wage. In this and the subsequent chapter, the study is broadened to consider supply-side adjustment in general. Of course, the speeds of nominal wage and price adjustments provide important parameters in this process, but as the discussion of chapter 2 made clear, so too are real rigidities, i.e. those involving the (un)responsiveness of real wage and price markup decisions to economic conditions. Many of the feedbacks between variables involved in establishing these rigidities are complicated, and their practical relevance can only be investigated through a detailed analysis of the supply side.(1) In this chapter, therefore, a model of the supply side is estimated based around 38 industries which cover the whole economy excluding government sector services. The model incorporates employment, price, wage, and output demand equations for each industry, plus a series of subsidiary equations to capture the inter-relations between industries. This model will enable us to examine the process of wage determination in a broader context, allowing for feedbacks between wages, prices, output, and employment/unemployment levels, and will enable us to consider the price formation process and the links between these and policies designed to defeat unemployment.

The estimation of a model of the supply-side of the U.K. will clearly provide information on the extent and importance of nominal inertia and of real rigidities. Estimation of the individual relationships will help in the identification of the dynamic processes involved for each industry, and, having estimated the model, simulation experiments can be undertaken to highlight the dynamic properties of the model as a whole and the interactions between industries' decisions. These ideas will be examined in detail in chapters 6 and 7. In chapter 6, we analyse the information gained from the model estimation on speeds of adjustment in nominal prices at the industrial level. This provides insights into the causes of nominal price inertia which complement those gained on nominal wage inertia in the previous two chapters. In chapter 7, we describe various simulation experiments to examine the impact of different policy options for reducing unemployment and/or inflation had they been attempted over the sample period. Through these simulation experiments, we can identify more clearly the source of real rigidities, and those paths of influence which are important in determining the speed of supply side adjustment.

In this chapter, however, we concentrate solely on describing the model, in section 5.1, on estimating the model, in section 5.2, and on describing the results obtained, in sections 5.3 and 5.4. This exercise is valuable in itself, providing evidence on the reasonableness of a particular model of the supply side at the industrial level. In particular, it gives evidence on the relative importance of the various theories of wage-setting described in chapter 2, and this in turn provides indirect evidence on the validity of the explanations of real wage rigidity also described in that chapter.

5.1 A description of the model

In this section, I set out the derivation of the model which I shall ultimately estimate. The model to be used has been recently popularised by Layard and Nickell (1985, 1986), and the following description draws heavily from these papers and from a related model description in Borooah and van der Ploeg (1986). It is assumed that the industry consists of J firms producing an homogeneous product. A simple version of the model starts with a cost function of the j^{th} firm which takes the form

$$C_j = C_j(y_j, w, q, k_j) \qquad (5.1)$$

where y_j= output of j^{th} firm, j=1,....,J, k_j= capital stock of the j^{th} firm, w = price of a unit of labour input to the industry, and q = vector of other input prices to industry (materials).

The demand for the industry's product is given by

$$y = D(p, \bar{p}, pm, \sigma) \qquad (5.2)$$

where $y = \Sigma y_j$= industry output, p = price of industry output, $\bar{p}$= aggregate price level, pm = price of imported industry product, and σ= measure of cyclic variation.

The j^{th} firm chooses its output so as to maximise real profits

$$\pi_j = (p(y).y_j - C_j(y_j, w, q, k_j)) / \bar{p} \qquad (5.3)$$

The first order condition for solving this problem is

$$\frac{\delta p}{\delta y}.\frac{\delta y}{\delta y_j}.y_j + p(y) = \frac{\delta C_j}{\delta y_j}$$

$$=> \quad p[1 + \frac{\delta p}{\delta y}.\frac{y}{p}.\frac{\delta y}{\delta y_j}.\frac{y_j}{y}] = \frac{\delta C_j}{\delta y_j}$$

$$\Rightarrow \qquad p\left[1 - \frac{\theta_j}{\varepsilon}\right] = \frac{\delta C_j(y_j, w, q, k_j)}{\delta y_j} \qquad (5.4)$$

where $\theta_j = \frac{\delta \log y}{\delta \log y_j}$ = firm j's conjectural elasticity of total market output wrt own output

and $\varepsilon = \frac{-\delta \log D}{\delta \log p}$ = price elasticity of market demand

θ_j provides a means of incorporating market structure into the model, since under monopoly $\theta_j = 1$, and $p[1-(1/\varepsilon)]=\delta C_j/\delta y_j$, (5.4.1), and under perfect competition, $\theta_j = 0$, and $p = \delta C_j/\delta y_j$, (5.4.2). Under Cournot-Nash assumptions, $\delta y/\delta y_j = 1$, so that $\theta_j = y_j/y$. θ_j is also related to the degree of oligopoly power enjoyed by the j^{th} firm, α_j, where this is defined as

$$0 < \alpha_j = \frac{\text{markup over marginal cost}}{\text{price}} = \frac{p-\delta C_j/\delta y_j}{p} = \frac{\theta_j}{\varepsilon} < 1 \qquad j=1,\dots,J$$

so that oligopoly power will be large if θ_j is high, or ε low. Also, if the industry's oligopoly power, α, is measured by the weighted average of the α_j, then it turns out to be proportional to the weighted average of the individual firms' output shares, since

$$\alpha = \Sigma(y_j/y).\alpha_j = \varepsilon^{-1}\, \Sigma(\delta y/\delta y_j)(y_j/y)^2$$

It is noted that if $(\delta y/\delta y_j)$ is constant over all firms, α is proportional to the Herfindahl Index of industrial concentration, $H = \Sigma(y_j/y)^2$, and that under the Cournot-Nash assumption, $\alpha = H/\varepsilon$.

For the firm, the labour demand equation is given by the application of Shephard's lemma to (5.1) to obtain

$$n_j = \frac{\delta C_j}{\delta w} = n_j(y_j, w, q, k_j) \qquad (5.5)$$

where n_j =employment in the j^{th} firm.

The conditions under which perfect aggregation of individual units into a larger group can be carried out are stringent, and are rarely likely to hold (see Deaton and Muellbauer (1980)), relying on the idea that the firms' cost functions can be represented by particular functional forms, having separability properties, or particular inter-firm similarities. In this analysis, this issue is ignored, and the firm relationships expressed at

(5.2), (5.4), and (5.5) are simply rewritten as industrial relationships as follows:

industrial demand	$y = D_1(p/\bar{p}, p/pm, \sigma) = D_1(p/\bar{p}, (p/\bar{p}.\bar{p}/pm), \sigma)$ $= D(p/\bar{p}, pm/\bar{p}, \sigma)$	$D_1<0, D_2,D_3>0$	(5.6)
industrial prices	$p = p(\alpha, y, w, q, k)$	$p_1,p_2,p_3,p_4>0, p_5<0$	(5.7)
industrial labour demand	$n = n(y, w, q, k)$	$n_1,n_3>0, n_2,n_4<0$	(5.8)

The direction of influence in each case above is unambiguous, although there will be some scope for ambiguity in the price equation if we recognise that the markup, α, may be influenced by the variables determined endogenously within this system. In the case of perfect competition, $\alpha=1$, and there are no problems. However, under imperfect competition, α is influenced by the degree of industrial concentration and (more importantly) by the elasticity of demand, as demonstrated in the derivation above. Clearly, if the elasticity of demand depends positively on the level of industrial output, then the overall impact of demand change on prices becomes ambiguous, as this countercyclical pressure on the markup works against the procyclical effect of diminishing returns. More generally, there have been various theories of price-setting that would predict that the markup, α, is related to output levels (see Domberger (1983), Sawyer (1983) for a review). In particular, there has been some interest in theories of price setting in which, for various reasons (some of which were discussed in chapter 2), agents wish to avoid erratic movements in their prices, rather allowing the markup to adjust and accommodate any movements in factor input prices or demand variations that are seen to be temporary.(2) In this case, there may be no simple relationship between the markup and output, but it is clear that the countercyclical influence on the markup that this form of price-setting behaviour predicts will also work against, and perhaps dominate, the effects of diminishing returns acknowledged in (5.7).

Turning to wage determination, it is assumed that there is a single union involved in the negotiations on pay in each industry, and that this union can be represented by a simple utility function. As the discussion of chapter 2 made clear, such union-based models of wage determination have become very popular in recent years because of the institutional detail of the labour market that can be incorporated within them, and they have been widely examined in the context of the analysis of the rise and persistence of high aggregate unemployment rates in the UK and elsewhere. Such models have been less intensively examined in the context of disaggregated models of the labour market, however, and so it is perhaps worthwhile to examine in a little more detail the nature of these models in this context. There are two related but distinct aspects of the union-based models which determine the properties of the wage outcome. The first concerns the choice of the variables of significance to the union and of the functional form with which to represent the union's preferences, and the second concerns the bargaining framework within which negotiations are assumed to occur. We shall briefly elaborate on these below, stressing the points of particular relevence to a disaggregated model, and then set down a specific model of wage determination to illustrate the various influences on industrial wages that exist.

On the issue of the choice of the variables of interest in a union utility function and its functional form, we note that typically in the literature, the union is assumed to value higher real (consumption) wages and higher levels of employment (and occassionally, higher levels of union membership identified separately from employment levels). These magnitudes are generally measured against 'reference' levels of the real wage and employment, and it is these 'reference' levels through which many of the interactions between sectors of the labour market are incorporated in a disaggregated model. The precise choice of variables, and indeed the functional form of the union's objective function can be derived explicitly, assuming that individual workers' preferences follow conventional axioms, and aggregating over these workers through assumptions on the institutional framework of the union (i.e. it's voting system and the internal organisation through which individuals make their views known to union officials). Alternatively, the choice of influential variables, and of the functional form, can be made more arbitrarily, hoping simply to capture what the investigator believes to be the most important features of the union's preferences in a general form.(3) In the context of a disaggregated model of the labour market, it is likely that the latter approach is more useful. Clearly, it is possible to accommodate interpersonal comparisons in individual workers' utility functions (see, for example, Becker (1974)), so that the significance of wage relativities, or of wage 'norms', or of the notion of 'fair play' in wage setting can be justified. However, in practice, it would be difficult to identify the precise nature of these interactions. For example, it is reasonable to assume that an individual's ultility may be influenced not only by his real wage, but also by his wage level relative to the incomes obtained by others. However, it is not clear whether his reference group would include all workers, or just those in employment, or just those with comparable skills and training, etc., or whether the reference group's income would include non-labour income, non-pecuniary 'perks', and so on. Equally, we have mentioned previously the possibility that a particularly well-publicised wage settlement in an industry can have widespread effects on the bargaining behaviour of others throughout the economy at that time, as can government announcements of their intentions on public sector pay. These examples again illustrate the difficulties that would be encountered in explicitly identifying the social interactions within an individual's utility function, this time because of the difficulties in modelling information collection. Of course, all of these difficulties would be further compounded in the process of aggregating over individuals to obtain a simple utility function with which to model the union representing them. For these reasons, in this exposition, we shall simply assume that certain variables are of significance to the union without attempting to provide a formal derivation of the model.

The second aspect of the union based models determining the form of the wage outcome mentioned above is the bargaining framework assumed to operate in the industry. This is potentially of some significance here, given the emphasis placed on bargaining costs in the discussion of the previous chapters. For example, the assumption of the 'monopoly union' model of wage determination (in which unions unilaterally set wages, and firms unilaterally set employment levels) reduces the role of 'bargaining' to one through which the firm simply reveals to the union the precise position of it's labour demand schedule. More realistically, the 'right-to-manage' model (in which firms set employment, but bargain with unions over wages), or the 'efficient bargain' model (in which both employment and wages are bargained over) incorporate the act of bargaining explicitly into the labour market framework. These models require some further assumptions on the bargaining process, therefore, as described previously in chapter 2 when discussing the sources of costs in adjusting nominal wages.

The following description of a 'right-to-manage' model solution illustrates these points, and can be used to provide an indication of the important influences on wage determination. In this the union is represented by a utility function of the form

$$u = u(\ w,\ \hat{p},\ n,\ w^d\ ) \qquad u_1,u_3>0,\ u_2,u_4<0 \tag{5.9}$$

where w and n are as previously defined, $\hat{p}$ = consumer price deflator and w^d = the 'reference' wage level against which the union judges it's own wage for comparability purposes (as discussed above). Note that $\hat{p} = (\ p'(1+t1)(1+t3)\ )/(1-t2)$, where p' = (pre-tax) price to home market = $f(\overline{p},\ p^*)$, p^* = aggregate price of imports, t1 = rate of employers' tax, t2 = rate of direct tax, t3 = rate of indirect tax. Here, then, the terms (t1, t2, t3, $\overline{p}/p^*$) are the components of the "wedge" between the real producer wage (of interest to the firm) and the real consumer wage (of interest to the union). Assuming that the firm has a utility function U over profits, and that it makes its employment and pricing decisions to maximise profits in the light of the wage settlement (the 'right-to-manage' institutional assumption), the outcome of the wage bargain solves the following maximisation:

$$\max_{w} \quad [\quad U(\,\pi(w, \tilde{n}, \tilde{p}, y, q, k, \overline{p}))\quad]^{\theta}\,[\quad u - \overline{u} \quad]$$

where $\tilde{n}$ and $\tilde{p}$ are the optimally chosen levels of employment and prices given in (5.8) and (5.7) respectively, θ is a measure of the bargaining strength of the firm relative to the union, and $\overline{u}$ is the "fall-back" level of utility achievable by the union in the event of the disaggreement (strike) outcome (a zero fallback level of utility is implicitly assumed for the firm here). This solution is a generalisation of the Nash bargaining solution which has some appeal because it is possible to derive such a solution from within a game-theoretic framework, working with plausible axioms on the bargainers' behaviour, and at the same time provide an interpretation of the solution in terms of the bargaining process that takes place between the firm and the union in arriving at the solution (see, for example, Svejnar (1986)). Now, assuming that the union's "fallback" utility level is given by

$$\overline{u} = \overline{u}(\, w^{a}, \hat{p}, w^{d}\,)$$

where w^a represents the level of pay achievable by union members should a strike occur (a "fallback" wage), then this provides an expression for nominal wages as follows:

$$w = g(w^{a}, w^{d}, y, q, k, \overline{p}, \text{wedge}, \alpha, \theta) \qquad g_1,g_2,g_3,g_4,g_5,g_6,g_7,g_8>0, \quad g_9<0 \qquad (5.10)$$

The terms "y, q, k" in expression (5.10) are present simply because of their influence on the labour demand constraint, and correspond to the "internal" pressures on wages described in chapter 2. The "external" pressures exerted on wages come via the aggregate price level, the wedge term, the reference wage, w^d, the fallback wage term, w^a, and the determinants of firm/union bargaining strength.

Of course, in order to operationalise such a model, we need also some indication of the determinants of w^a, w^d, and θ, and here we will assume the following:

$$w^{d} = h^{1}(\,\overline{w}, INC, un, \overline{un}, RR, w(-1), \overline{p}) \qquad (5.11.1)$$

$$h^1_1,h^1_5,h^1_6,h^1_7 > 0,\; h^1_3,h^1_4 < 0,\; h^1_2 \gtrless 0$$

$$w^{a} = h^{2}(\,\overline{w}, \text{costs}) \qquad (5.11.2)$$

$$h^2_1 > 0,\; h^2_2 < 0$$

$$\theta = h^3(\text{ costs}, \bar{w}, \bar{p}) \qquad (5.11.3)$$

$$h^3_1, h^3_3 > 0,\ h^3_2 < 0$$

and 'costs' are the variables affecting negotiation costs to the union listed previously in Chapter 4 (page 92), including

$$\text{costs} = h^4(\text{UP, INC, un}, \overline{\text{un}}, \text{RR, bargaining system }) \qquad (5.11.4)$$

where $\bar{w}$ = aggregate wage level, INC = a measure of the intensity of downward pressure put on wages through incomes policy, un = local unemployment rate, $\overline{\text{un}}$ = aggregate unemployment rate, RR = replacement ratio, UP = a measure of union power, and other terms are as defined previously. Clearly, these representations are not the only ones possible, but they do illustrate the more important of the 'external' influences on wages. Certainly the reference wage, w^d, will be influenced by the level of aggregate wages, although as discussed above, this relationship may not be a simple one. Further, w^d might be influenced also by unemployment benefits and the rate of unemployment since these affect the costs and expected duration of unemployment should the union member choose, or be forced to leave employment with his current employer. (Note that here aggregate and local unemployment rates may both be important, given that the likelihood of obtaining a job within the same industry, for which the worker will hold some relevent skills, may be higher than that of obtaining a job in any other industry). Equally, the effects of incomes policy on the industry relative to the economy as a whole, and of previous wage levels (in real terms and relative to other wages) will also play a part in the union's comparability exercises. In (5.11.2), the determinants of the fallback wage include those variables listed previously as affecting the costs of negotiation on the grounds that these are precisely the variables which we suggested would influence the firm's and union's willingness to accept and to endure a strike (disaggreement) outcome. We also include here the aggregate wage level since this may provide a proxy for any earnings to be obtained through temporary work during the strike period. Obviously, these variables also influence the relative power of the firm and union, as described in (5.11.3).

We should note at this stage that the disaggregated model of (5.6)-(5.11) differs substantially from the union-based models usually considered in the literature relating to more aggregated analyses of the labour market. For example, a rise in the aggregate price level will exert pressure on industrial wages through a variety of routes in this model: directly, through the union's attempts to counter the reduction in its members' real wages, and indirectly through w^d, as this rises in anticipation of rising aggregate wages, and through θ, as relative bargaining strengths are affected. Indeed, more generally, we can accommodate a variety of paths of influence on wage setting for any of the variables described above because of the extreme flexibility of the union-based models of the labour market in the disaggregated context. It is for this reason that the model description should be considered as illustrative of the sort of influences working in the labour market rather than as a complete description of reality, and is best seen as a means of interpreting empirically observed phenomenon.[(4)]

While the model of (5.6)-(5.11) provides a single coherent explanation of the workings of an industry's supply side, we should mention here some reservations regarding its use. First, we note that the assumed bargaining process that underlies the Nash solution is a stylised one, relying on particular rules of play by the two parties in terms of the sequence of offers and counter-offers, and their concession behaviour. Moreover, the occurance of strikes, or lock-outs, is difficult to accommodate within this framework without assuming informational assymmetries in an ad hoc way. This does not sit easily with the (more realistic) discussion of the bargaining process covered in Chapter 4, especially given the importance attached to such occurances in the discussion of the costs of negotiation. Moene (1988) notes the difficulties of using the Nash bargaining model without paying attention to the strategic elements in bargaining behaviour and the general bargaining environment, and provides a more comprehensive discussion of the way in which a union's threat behaviour can affect fall-back utilities. These issues go beyond the scope of our work, but should be borne in mind when relating the applied work to the model description.

A second reservation on the above model derivation concerns its static nature. Throughout the work, we have emphasised costs of adjustment which explain and justify the observed stickiness in wages and prices. However, where such stickiness exists, current decisions have long lasting effects, and in recognition of this, wage, price, output and employment setting decisions will be the result of a game played over time. So, for example, the static labour demand relationship considered in out model description above would be replaced by a dynamic decision rule, as the firm maximises its (expected) discounted future stream of profits. In turn, the union would maximise its expected discounted future utility stream given the firm's dynamic decision rule. In these circumstances, a time-consistent open-loop Nash equilibrium solution would be more appropriate, with forward-looking expectations playing a major role in the wage, price, output and employment outcomes. Again, we mention this reservation as a warning, noting that the model derivation is merely illustrative of the important influences in the process of wage determination, rather than providing a complete representation of reality.

Despite these reservations, the model derivation set out in this section provides a useful framework with which to examine the evolution of the labour market in a disaggregated setting. In the following section, we translate the stylised model into a form that can be investigated empirically, and apply this model to disaggregated data available for the UK economy. Before coming to the results of this empirical exercise, however, we briefly review some of the difficulties involved in the translation of the stylised model into a form that can be investigated empirically, and provide some justification for our approach to the econometric modelling of the supply side relationships outlined above.

5.2 Estimating the model

Modelling disaggregated supply side relationships

In what follows, the stylised model presented above will be investigated using data for 38 industries taken from a data set maintained by the Cambridge Growth Project (CGP). The industrial classification is based around the 1968 SIC, and is described in Table 5.1; the sample covers the years 1954-1981. Industry 4 (Petroleum and natural gas) has been excluded from the estimations on the grounds that the data period for this industry is so much shorter, and that the industry might be expected to behave erratically during its infancy. Aggregate variables to be used, where appropriate, have been built up from the disaggregate figures, so that the aggregate time paths are fully consistent with the industrial ones.

It is perhaps pertinent at this stage to consider the advantages of working at the level of disaggregation defined in Table 5.1, and to consider whether this is an appropriate level of disaggregation with which to examine supply side relationships. Of course, the 'appropriate' level of disaggregation will depend in practice on the issues that are under investigation. If an investigator is interested in economy-wide questions, then a higher level of aggregation is likely to be more appropriate than if questions relate to firm-specific institutions. In this analysis, we have a range of questions that we hope to address. On the one hand, we want to use the results as a guide to which of the theoretic explanations for price and wage rigidities, based at the micro level, are supported by the evidence, and this suggests a low level of aggregation. On the other hand, we are also interested in the macroeceonomic consequences of rigidities, and whether there is evidence to support the idea that there is a build-up of inertia at the macro level through interactions between sectors. This interest indicates a higher level of aggregation is necessary.

Given these arguments, the decision to use the CGP data is justifiable on the grounds that this databank provides the most disaggregated dataset which covers the UK economy comprehensively and on a consistent basis. It is clear that more disaggregated datasets, looking at company accounts or (like that discussed in chapter 4) looking at industry-wide bargaining arrangements, are the most appropriate if we want to look only

Table 5.1

Thirty-nine sector Industrial Classification based on 1968 SIC

	Industry title	1968 SIC MLH
1	Agriculture	001,002,003
2	Coal mining	101
3	Mining nes	102,103,109
4	Petroleum and natural gas	104
5	Food	211-219,221,229
6	Drink	231,232,239
7	Tobacco	240
8	Coal products	261
9	Petroleum products	262,263
10	Chemicals	271-279
11	Iron and steel	311-313
12	Non-ferrous metals	321-323
13	Mechanical engineering	331-339,341,342,349
14	Instrument engineering	351-354
15	Electrical engineering	361-369
16	Ship building	370
17	Motor vehicles	381
18	Aerospace euipment	383
19	Other vehicles	380,382,384,385
20	Metal goods nes	390-396,399
21	Textiles	411-419,421-423,429
22	Leather, clothing, etc.	431-433,441-446,449,450
23	Bricks	461-464,469
24	Timber and furniture	471-475,479
25	Paper and board	481-484
26	Printing and publishing	485,486,489
27	Other manufacturing	491-496,499
28	Construction	500
29	Gas	601
30	Electricity	602
31	Water	603
32	Rail	701
33	Road	702-704
34	Other transport	705-707,709
35	Communication	708
36	Distribution	810-812,820,821,831,832
37	Business services	861-866
38	Professional services	871-879
39	Miscellaneous services	881-899

at the microtheoretic explanations of rigidities, since this is the level at which decisions are taken. However, these do not cover comprehensively the whole of the UK economy, and are therefore not suitable for looking at the macroeconomic aspects of rigidities. The CGP databank can be used in this context, and because of the relatively high degree of disaggregation, it can also be used to provide (indirect) evidence on the microeconomic questions that we wish to address.

Of course, there remains the question of whether the analysis could take place at a higher level of aggregation and yet still be able to adequately reflect the macroeconomic properties under investigation. A four sector split, looking at the Primary sector, Heavy and Light Manufacturing, and Services, for example, would still comprehensively cover the economy, and may be less susceptible to industry-specific shocks than the data of the CGP databank. Certainly it is true that the analysis of a smaller number of sectors is more easily managed and that the discussion of results can become unwieldy with a large number of sectors. However, there are good arguments why, a priori, the dataset with the greater degree of disaggregation is preferable. The model derivation discussed in the previous subsection illustrates clearly the sophistication and the volume of the feedbacks between sectors in the process of adjustment of the supply side, and as we aggregate up, we progressively eliminate these important interactions. Moreover, if there are differences in the form of the relationships across the sectors, then the properties of the model will alter if there are changes in the relative importance of particular sectors over time. These changes will only be captured by the analysis if the sectors involved are explicitly identified.

Further, these arguments are supported by empirical evidence on the statistical properties of the CGP dataset. A research programme on the usefulness of disaggregation in econometric modelling carried out at Cambridge on this dataset has established a number of statistical procedures for investigating this issue; see, for example, Pesaran, Pierse, and Kumar (1989), [PPK], and Lee, Pesaran and Pierse [LPP] (1990a, 1990b). While this econometric programme is not central to the work of this thesis, the two main elements of the analysis can be mentioned here in support of the use of the level of disaggregation described in Table 5.1. The first of these elements is the development of criteria on which to choose whether to use micro or macro equations to predict aggregate variables. Such criteria are developed in PPK and in LPP (1990b) and aim to establish whether the predictions of an aggregate variable obtained by aggregating over the fitted values of disaggregated equations are statistically superior to those obtained from the corresponding aggregate equation. The criteria developed in these papers relate to the estimation of a single relationship, and are not appropriate in the analysis of a system of equations of the sort set out in (5.6)-(5.11) above. However, in the papers it was demonstrated that disaggregated labour demand equations estimated according to the CGP classification were superior to their aggregate counterpart in predicting aggregate employment levels. Since this relationship constitutes one element of the system of equations of interest here, this suggests strongly that the system as a whole should be analysed at a disaggregated level.

This suggestion is compounded by the findings of the second element of the research which recognises that heterogeneity in the form of relationships across sectors may generate biases in the estimation of the relationship using more aggregated data. This possibility is considered explicitly in LPP (1990a, 1990b). Here, statistical tests for the presence of aggregation bias are developed and applied to labour demand equations estimated for the UK over the CGP industrial classification. In the 1990b paper, for example, a mean wage elasticity of -0.5 is obtained over the preferred set of industrial equations, and this is compared (statistically) to an elasticity of -1.0 obtained in the estimation of an aggregate relationship based on the same data. The proposed test statistic firmly rejected the null hypothesis of no aggregation bias in the estimation of this wage elasticity. Other elasticities were also considered, but these did not appear to be affected by aggregation bias. Nevertheless, this provides good evidence that aggregation over the sectors described in Table 5.1 is likely to lead to inaccuracies in the estimation of the responsiveness of the variables of interest to changes in the explanatory variables. This is obviously undesirable in both the micro and macro analyses of rigidities to be undertaken on the basis of the model estimation.

The decision to study the labour market disaggregated by **industry** has been made with the implicit assumption that disaggregation across this dimension will be the most appropriate means of studying inertia at the micro level and its accumulation at the macro level. Such an assumption implies that changes in the structure of the labour market across other dimensions are either insignificant in their effects on wage and price rigidities, or can be accommodated within the industrial analysis of the labour market. So, while we recognise that there are important differences in the labour market across the regions of the UK, between male and female labour, between youths and adults, across different occupational groups, and so on, it is implicitly assumed in our analysis that, to the extent that they are significant in the relationships of interest, these differences are reflected in the disaggregated industrial equations.

As an illustration of these difficulties, we note that in the ten years following 1970, the earnings of women rose by around 15% relative to men, while the relative employment of women (in terms of hours worked) rose from 43% to 53%. These figures illustrate clearly the substantial changes in work practices that took place over the period, and the fact that we will not distinguish between male and female labour in this study means that we cannot capture the impact of all of these changes within our analysis.

However, it can be argued that many of the important features will be incorporated through the use of industrial data. In Borooah and Lee (1988), for example, we show that while institutional and legislative changes were important in explaining the rise in relative earnings over the period (through the Equal Pay and Sex Discrimination Acts and through the effects of the flat-rate incomes policies of that time), the primary explanation for the rise in relative employment was the change in the structure of employment towards industries which use female labour relatively intensively. Given the stability over the past twenty years of the ranking of industries in terms of the intensity with which male and female labour are employed, it may be reasonable to assume that our industrial disaggregation will accommodate many of the changes that have arisen in the labour market through this route, accepting that the (differential) effects of the industrial legislation will be among the factors incorporated into the residual error in any statistical work.

Of course, similar comments apply to the regional, age, and occupational dimensions, as different industries concentrate in particular regions, as some industries are more inclined to take on and train young workers, and as particular occupational groups are found to a greater or lesser extent in different industries. However, there has perhaps been less stability in the links between the industrial classifications and these other dimensions than has been the case with the male/female split, and this will reduce the reliability of empirical work which concentrates exclusively on the industrial dimension. As an illustration, we note that throughout the 1970's and 1980's, there was a substantial shift in the occupational structure of employment, as the number of workers in the groups 'plant and machine operatives' and 'craft and skilled manual occupations' declined, and as the 'professional' and 'associate professional' groups expanded. Through the 1970's, much of this shift was attributable to changing industrial structure, reflecting the growth in service sector employment and the relative decline in manufacturing employment, so that this aspect of changing occupational structure will be accommodated within our analysis. Since 1981, however, a much greater part of the occupational shifts reflect changing occupational structures within industries, as technological and organisational innovations impinge on the production process (see Lindley and Wilson (1989)). While our data set does not cover the latter period, these comments illustrate the difficulties involved in empirical work: those changes brought about within industries, as individuals are 'upgraded' to positions of greater responsibility, possibly at higher rates of pay and in more pleasant working conditions, for example, will not be captured within an empirical analysis disaggregated across industries alone. Of course, this will reduce the reliability of any applied work to the extent that changes of this sort represent the significant changes that take place in the labour market over time.

Chart 5.1

Summary of Variable Definitions

The following list summarises the variable definitions provided in the text. Precise definitions, and sources of data, are provided in the Data Appendix.

y = output	w = (nominal) wages
q = price of material and fuel inputs	k = capital stock
p = price of output	n = employment
un = industrial unemployment rate	pm = price of imported industry product
unr = average industrial unemployment rate experienced over the previous two years	α= oligopoly power in the industry
	θ= rel. firm/union bargaining power

INT = composite variable (derived from the labour demnad eqn) measuring the pressure on wages due to factors internal to the firm

p^* = aggregate price of imports	I components of the wedge
t1 = (aggregate) 'employers' tax' rate	I between the real consumption
t2 = 1- (aggregate) rate of direct tax	I wage and the real producer
t3 = (aggregate) rate of indirect tax	I wage

σ= measure of (aggregate) cyclic variation

comp = (aggregate) measure of international competitiveness

RR = replacement ratio

UP = measure of union power

inc = strength of the downward pressure exerted on wages through the successive periods of incomes policy

Variables refer to logarithms of industrial magnitudes unless otherwise stated. A 'bar' indicates that the variable is an aggregate magnitude. Hence,

$\bar{p}$ = aggregate price = weighted average of industrial prices
= $\Sigma\ \theta_i$ p, where θ_i are weights given by industrial output levels

$\bar{w}$ = aggregate wage = weighted average of industrial wages
= $\Sigma\ \mu_i$ w, where μ_i are weights given by industrial employment levels

and so on.

Operationalising the model

These comments have important implications for the translation of the theoretic model of the industry set out in (5.6)-(5.11) into a model which can be investigated empirically, and for the measurement of the variables of interest in the model. Such a translation is given in (5.12)-(5.15) below, which shows the 4-equation system which we will estimate for each industry.

$$n = a_0 + a_1 n(-1) + a_2 n(-2) + a_3 w + a_4 q^e + a_5 k + a_6 y + a_7 t \qquad (5.12)$$

$$p = b_0 + b_1 p(-1) + b_2 p(-2) + b_3 w + b_4 q^e + b_5 k + b_6 y + b_7 t \qquad (5.13)$$

$$\begin{aligned} w &= \gamma_0 + \gamma_1 w(-1) + \gamma_2 (a_4 q^e + a_5 k + a_6 y + a_7 t) + \\ &\qquad \gamma_3 \bar{p} + \gamma_4 wedge + \gamma_5 w^d + \gamma_6 w^a + \gamma_7 \theta \\ &= c_0 + c_1 w(-1) + c_2 \bar{w}^e + c_3 (a_4 q^e + a_5 k + a_6 y + a_7 t) + \\ &\qquad c_5 inc + c_6 unr + c_7 \bar{p}^e + c_8 wedge + c_9 RR + c_{10} UP \end{aligned} \qquad (5.14)$$

$$y = d_0 + d_1 y(-1) + d_2 (p/\bar{p}^e) + d_3 (pm/\bar{p}^e) + d_4 \sigma + d_5 t \qquad (5.15)$$

Here variables are as defined previously (and as described in summary in Chart 5.1), and "(-i)" means that the variable is lagged i periods. Coefficients will be expected to take the signs as shown by the partial derivatives in (5.6)-(5.11), although b_6 is ambiguously signed, following the earlier discussion on the cyclic influences on the price markup. An "e" superscript on a variable means that the variable is assumed to be unobservable at the time at which decisions are made, so that expectations have to be formed. Hence, in the model above it is assumed that material prices at time t are not observed until after each industries' employment, pricing, wage, and output decisions are made, so that it is their expected value which enters into an individual industry's labour demand and price equation. Equally, expectations of aggregate prices and aggregate wages to hold in the current period also have to be formed, and it is these variables which enter the wage and output equations. Expected values for these variables will be generated by subsidiary equations explaining the variables in terms of "relevant", observable variables. The implications of this estimation procedure are discussed below.

While the form of the equations at (5.12)-(5.15) is obviously closely related to the stylised model of (5.6)-(5.11), in the light of the discussion above, we should briefly comment on the limitations of this linear representation and on the difficulties encountered in quantifying the labour market features of interest in the model.

For example, in what follows, we shall measure employment, n, simply by the numbers employed in the industry (including employees in employment and the self-employed). The measure of 'wages', w, is obtained on a comparable basis, dividing the total industrial labour costs (wages and salaries plus employers' NIC's) by the number employed, adjusting for the effects of overtime by deflating this figure according to the number of hours actually worked in excess of 'normal' hours (see the Data Appendix for more details). While these figures provide us with workable definitions of the terms in (5.12)-(5.15), measuring labour input and its cost in terms of a "normal man-week", it is clear that such figures will not capture adequately all of the changes in composition and character of the 'employed', or its cost, that have occured over the sample period. Hence, we have already mentioned the rapid rise in the relative importance of women in the labour market, and clearly this element of realism is lost in our definitions. Similar problems are encountered if we recognise the growing significance of part-time working, or, most recently, of self-employment in the provision of labour services. Both of these developments are likely to have been engendered by a greater premium placed on flexibity in the workplace, this being driven in turn by the introduction of new technologies and work practices. These developments create problems in the measurement of 'employment', however, due to the difficulties of comparing the labour services of the part-time employee compared to the full-time employee, or of comparing the input of an employee performing a particular function compared with a self-employed contractor performing the same function, for example. Moreover, the costs incurred by the firm in obtaining these labour services will differ according to the nature of the person employed. So, for example, the firm substantially reduces it costs by subcontracting work as there is no longer any obligation on it to provide redundancy pay, health insurance, holiday pay, paid sick leave and so on. Similarly, labour costs to the firm can be reduced by the employment of a greater number of part-time workers relative to full-time workers since the former do not receive the fringe benefits and non-wage costs enjoyed the latter. Obviously, these sophistications will not be picked up by the simple measure of 'wages' described above, but data limitations make it infeasible to attempt to adjust these figures to accommodate these issues across our industries.

In a similar vein, the extent to which a "normal man-week" remains a consistent measure of labour input over the sample period is unclear, as the substantial reductions in the "normal" working week that occurred over our sample period (falling by around 10%) would be (at least partially) offset by changing production techniques influencing the "intensity" of work (through changes in the use of shift work, for example). Our treatment of overtime payments is rather simplistic, treating hours worked in excess of "normal" as exogenously-determined. Of course, in reality, the length of the "normal" working week will be determined through the firm/union bargaining process, with the union valuing a reduced working week, other things equal, and the firm recognising the role of overtime work as a means of obtaining flexibility in labour input (setting the cost of overtime premia against the presence of fixed labour costs, through flat-rate payroll taxes and hiring and firing costs, and so on). While this aspect of firm/union bargaining is frequently ignored, on the grounds that the level of "normal" hours are adjusted so infrequently, there have been considerable changes over the length of our sample, and it is recognsed that the omission of an explicit treatment of hours worked is a weakness of our analysis.

This brings us to the related issue of productivity growth. This concept was ignored in the stylised model derivation of the previous section, but is obviously of some significance in the real world. Productivity growth is described as the autonomous growth in output that would occur without growth in input quantities, and is associated with changes in managerial efficiency, in working practices, and in production technologies generally. Ideally, we might obtain a direct measure of technological change, looking at the level of expenditure on research and development, or the number of patents or product designs over the sample period, for example. Reliable series of this sort, however, are not readily available, and would still fail to address some of the difficulties associated with the quantification of technological innovation. For example, it has been argued that work in many industries has become increasingly technical and demanding, requiring the quality of labour inputs into production to improve. This may provide some explanation for the shift in occupational structures within industries which was described above. One possible means of measuring this change might be provided by the numbers of workers in possession of formal qualifications in the industry over time. Certainly this number has grown progressively over recent years, and this may reflect the proposed improvement in the quality of labour. On the other hand, this growth may simply reflect the fact that, as unemployment rises, workers attempt to improve their attractiveness to employers by obtaining these qualifications, even if the work carried out when employed is essentially unchanged from previously.

Clearly there are some difficulties associated with modelling changing production technology. In the model of (5.12)-(5.15), a simple time trend is included in the labour demand, price and wage equations to accommodate the effects of productivity growth, but again we should acknowledge the limitations of the model in this respect. Here, we implicitly assume that there is a trend productivity growth rate in each industry which is constant over the sample period, and exogenously determined. Both of these assumptions can be criticised: for example, the assumption of a constant growth rate has been widely investigated in the UK (see for example Mendis and Muellbauer (1983), Muellbauer (1986)), examining whether there have been periods in which productivity growth has slowed down (following the oil price shocks of the early 1970's, for example) or accelerated (during the early years of the Thatcher administration, for example). These suggest that a more sophisticated specification may be necessary to fully accommodate the effects of the changing rate of technological progress, and it's incorporation into production techniques, in an econometric analysis of the supply side.

Equally, the assumption that productivity growth is exogenously determined can be criticised on a number of grounds. First, it is clear that in reality, unions are actively involved in discussions on training, recognising the implications of training for the long run employment and pay prospects of its members. As such, a more realistic model of labour market behaviour than that considered above might include the provision of training (measured through the level of expenditure on training) and its effect on efficiency explicitly in the union's and the firm's objective functions (see Borooah and Lee (1986) for a model of the labour market in which such considerations are considered). Secondly, as the model was derived in the previous section, we have abstracted from the issue of utilisation rates. Clearly in practice, both employment and capital may be under-utilised and the extent of the under-utilisation is likely to vary over the cycle (again, see Muellbauer (1986)). And third, we note the considerable effects that macroeconomic conditions may have on worker effort. For example, we might assume that employees will work more intensively the higher the probability of being caught shirking, the higher the probability of being dismissed as a consequence, and the greater the cost of job loss to the worker. The second and third of these influences will depend on precisely those factors we have described as affecting the 'reference' and 'fallback' wage notions which affect the wage bargain, and will cause the level of worker effort to change over time. Thus, for example, movements in unemployment rates will have "worker discipline" effects so that productivity may rise in times of recession. Moreover, since the strength of this effect is likely to depend on the institutional environment of the worker (if the presence of a union reduces the probability of dismissal, for example), the extent to which productivity can be affected in this way will differ between industries. (see, for example, Green and Weisskopf (1990)). This highlights the point that productivity innovations are endogenously determined, and also that the extent of the potential biases involved in ignoring this endogeneity will differ from industry to industry.

A complete analysis of productivity effects would go beyond the scope of this work. The simple time trend introduced to capture the effects of technological change provides the model with some degree of flexibility, however, and clearly, in estimation, this effect can differ between industries. Nevertheless, we acknowledge the limitations of this approach, and note that results should be treated with appropriate caution.(5)

Finally in this subsection, we should note some of the difficulties encountered in quantifying the pressures thought to be important in the wage equation. We have already discussed, both above and in Chapter 3, some of the data problems associated with the use of local (industry-specific) unemployment rates. In addition to the measurement problem, however, there is also the issue of the persistence of the effect of the unemployed on wage setting. The arguments that have been presented so far for the inclusion of the local unemployment rate in the wage equation have primarily emphasised the idea that higher rates reduce the probability of reemployment should a union member leave his current employment (so that higher unemployment reduces both the reference wage and the relative bargaining power of the union). However, it seems reasonable to suppose that members of the union who have become unemployed (but retained union membership) might also exert some direct influence on their unions to moderate their pay claims. In this case, local unemployment rates might continue to exert influence on wages for some time. For this reason, we use the average industrial unemployment rate over the previous two years, denoted 'unr', in the industrial wage equations of the applied work. This definition was chosen in the belief that such a measure would more adequately capture the downward influence of local unemployment on wages than the current rate.

A second difficulty in estimating the wage equation of the disaggregated industrial systems relates to the quantification of the effects of incomes policy. We have already commented, in the previous two chapters, on the various forms of incomes policy that were implemented in the UK throughout the 1960's and 1970's, differing according to their legal status (statutory or volunatary), their terms ('freeze', 'flat-rate ceiling', or 'proportional ceiling'), and their severity (comparing the rate of inflation and the declared 'norm' set down by the policy). As shown in chapters 3 and 4, these different periods of policy had different implications for different industries, and we might therefore attempt to model separately the effects of each period of policy using time-specific dummies. Such an approach would use up a considerable number of degrees of freedom in the current exercise, however, and for this reason, we prefer to employ a single measure of the pressure exerted on wages by incomes policy here. Such a measure is given in Whitley (1986); here a variable is described which provides a quantitative and continuous measure of the impact of incomes policy reflecting both the extent of the downward pressure on wages exerted by policy (as indicated by the implicit or explicit 'norms' of the policy relative to inflation), and the attitudes of the government and the unions towards the policy. Of course, the use of an aggregate measure of this sort is very reasonable in the context of an analysis of the aggregate wage, and will provide an important explanatory variable in our analysis of the determinants of the expected aggregate wage. However, since we know that different industries respond differently to the successive forms of policy, it is important that we also include this variable separately in the industrial wage equations, as suggested in (5.11.1) above.

Despite the reservations raised above, and the acknowledged difficulties associated with the measurement of the labour market variables of interest, the model set out in (5.12)-(5.15) provides a useful system with which to examine the the supply side at a disaggregated level, and the rigidities generated through the interaction between sectors. We turn now to the estimation of these industrial systems.

The empirical work

The first stage in the estimation process is to generate time series for the expected variables, $\bar{p}^e$, $\bar{w}^e$, and q^e for each industry. This is done in a series of subsidiary regression exercises, carried out separately to the estimation, for each industry, of the 4-equation system described at (5.12)-(5.15).(6) This procedure has implications for the model which should be made explicit. Specifically, it is noted that the current aggregate wage, for example, depends on all of the individual industries' wages in the current period, so that a rationally-formed expectation of the aggregate wage based on full information would be influenced by the determinants of wages in every industry explicitly, and the expectation would be given by the mathematical expectation of the aggregate wage written in terms of all of its determinant in the model. As the discussion in chapter 2 made clear however, one of the major sources of inertia in a world with many industries, producing many heterogeneous product, is the cost of gaining information. In the particular case of wage determination, we noted Okun's (1981) comment that if "it is difficult and costly to define and sample objectively a universe of reference wages, firms and workers may focus on a few key indicative wages as the basis for a pattern of emulation" (p. 94). The acceptance of informational inadequacies provides the reasoning behind the estimation procedure employed here; agents are assumed to look to particular (generally aggregate) variables to form expectations on aggregate wages and prices, and on their own industry's material input prices, in an attempt to capture the fact that, in practice, agents rely on relatively sparse, and inexpensive, information sets.

The reduced form equations used to provide estimates for $\bar{p}^e$ and $\bar{w}^e$ are presented in Table 5.2. In this, the variables are again as described in Chart 5.1, with precise definitions provided in the Data Appendix. The results presented are the outcome of a specification search in which I started by including a wide range of variables which were potentially influential on the aggregate wage and price. Given the simultaneity of the formation of expectations on wage and price inflation, a single set of potentially exogenous variables was used in the specification search for each equation. This set included, in addition to the variables listed in Table 5.2, $\overline{un}(-1)$, and changes in $\bar{w}(-1)$, in $\bar{p}(-2)$, in the replacement ratio, in the rate of indirect taxation, and in the log of $\overline{un}$; these extra terms were not found to contribute to the fit of either equation. Estimated coefficients in these equations are generally well-determined, and take the expected signs,

Table 5.2

Reduced form aggregate price and aggregate wage inflation equations (1956-1981)

Dept.var:

$\Delta\overline{p}$ = aggregate price inflation		$\Delta\overline{w}$ = aggregate wage inflation	
cons	-0.0132 (1.089)	cons	0.0258 (2.500)
$\Delta\overline{p}(-1)$	0.6060 (3.593)	$\Delta\overline{p}(-1)$	0.6496 (3.636)
$\Delta t2$	-0.8178 (1.801)	$\Delta\overline{un}(-1)$	-1.6443 (1.7963)
ΔUP	0.0334 (0.961)	inc	0.0084 (1.796)
tim	0.0030 (2.529)	$\Delta t1$	1.3474 (1.768)
σ	0.4215 (1.093)	$\Delta t2$	-0.6940 (1.591)
Δcomp(-1)	0.1997 (1.849)	ΔUP	0.0703 (2.427)
		tim	0.0026 (2.603)
		σ	0.4594 (1.387)
		Δcomp(-1)	0.1704 (1.731)
R^2	0.8451	R^2	0.8923
RSS	0.01402	RSS	0.00807
Durbin t	0.591	DW	2.104

Notes

(absolute t-stats in parentheses)

"Durbin t" is Durbin's (1970) t-stat for AR(1); "DW" is the standard Durbin-Watson statistic although some of the (long run) elasticities appear rather high. The fitted values of the equations given in Table 5.2 provide our estimates for $\Delta\bar{p}^e$ and $\Delta\bar{w}^e$ to be used in the subsequent estimation of the industrial relationships.(7)

The estimated equations for the price of materials for each industry are generated relatively mechanically, and do not involve any element of specification search. The dependent variable in each case is the price of inputs to the industry from domestic sources, q. For each industry, this variable is explained in terms of its own lagged values, the expected current aggregate price and wage levels (given by the fitted values of the aggregate price and wage equations), past aggregate prices, a time trend, σ, and aggregate competitiveness. Once more, it is assumed that the fitted values of these industrial equations provides a measure of the industries' expected input price; again the idea is that a relatively sparse, and inexpensive, information set is used in the construction of these expectations therefore.

To be quite clear on the implications of the estimation procedure, we can consider the following sequence of events. At the beginning of each period, unions and firms in each industry have to form expectations on the level of aggregate prices, on aggregate wages, and on the price of inputs into their own industry that will hold over the coming period. I have chosen an intentionally restricted set of variables on which these expectations are based, in an attempt to capture the effects of high costs of collecting information. The expectations that are formed are not rational in the sense that agents are assumed to be ignorant of the parameters and structure of the model, and are assumed to hold only a limited subset of the data that is potentially available to them, remaining uninformed on other industries' developments except in so far as they effect aggregate variables. Having formed expectations on these key exogenous variables, firms and unions in each industry are able to determine industry wages and prices, output and employment, as described in the model of (5.12)-(5.15). These individual decisions can then be aggregated and summed to obtain the actual aggregate price level, aggregate wage level, and industrial input prices which hold in that period. Because expectations are formed on less-than-complete information, these actual figures may not be consistent with the expected values (although we would not expect systematic errors to be too widespread).

Of course, the main element of this process are the industrial relationships of (5.12)-(5.15), and it is to these that I now turn. Tables 5.3 to 5.6 present the results obtained by estimating the model of (5.12)-(5.15) for each of the 38 industrial groups in our dataset. Given the simultaneity of the model, it was appropriate to estimate each set of 4 equations using three-stage least squares. The endogenous variables in each system are n, p, w, and y. Lagged values of these variables, along with expected aggregate magnitudes $\bar{p}^e$ and $\bar{w}^e$ and the aggregate variables influential in Table 5.2 provided the

Table 5.3

Industrial labour demand equations 1957-1981

	cons	n(-1)	n(-2)	w	q	k	y	tim
1. Agric.	8.8970	0.5435	0.3580	0.0182	-0.0182	-0.5079	-0.4430	0.0243
	(5.0292)	(3.3689)	(2.1041)	(0.1636)	(0.0000)	(3.0858)	(2.0115)	(4.1612)
2. Coal	1.6413	1.1718	-0.0698	-0.2258	0.2258	-0.7020	0.3258	0.0287
	(2.4706)	(9.5995)	(0.4213)	(3.0280)	(0.0000)	(5.5108)	(3.0247)	(4.6042)
3. Mining	12.9578	0.1578	-0.0716	-0.8269	0.8269	-1.2066	0.3377	0.0245
	(4.4973)	(1.0160)	(0.3869)	(8.1296)	(0.0000)	(2.6183)	(3.9011)	(2.0772)
4. Petrol	0.2024	0.8951	0.0096	-0.0211	0.0211	-0.0138	0.1322	-0.0127
	(0.4758)	(4.7053)	(0.0473)	(0.3399)	(0.0000)	(1.0384)	(1.5001)	(0.3803)
5. Food	-2.3769	0.8418	-0.5839	-0.0673	0.0673	0.4559	0.7663	-0.0396
	(1.2989)	(3.8587)	(2.6989)	(0.7983)	(0.0000)	(1.2355)	(4.2074)	(2.1076)
6. Drink	7.4237	0.5302	-0.2581	-0.1544	0.1544	-0.3871	0.1313	0.0240
	(4.7641)	(3.0553)	(1.5919)	(3.5958)	(0.0000)	(2.6468)	(2.1106)	(2.4381)
7. Tobacco	1.9965	0.3369	0.2595	-0.1070	0.1070	0.5029	-0.3051	-0.0334
	(0.6601)	(1.5776)	(1.0857)	(1.8157)	(0.0000)	(1.0552)	(1.2554)	(1.0563)
8. Coal Prds	-0.4676	-0.2493	0.0669	-0.6898	0.6898	0.1992	1.0172	0.0034
	(0.2150)	(1.0365)	(0.3252)	(5.9978)	(0.0000)	(0.5261)	(5.6022)	(0.1461)
9. Petrol Prds	0.1804	0.4512	-0.0100	-0.1795	0.1795	0.4514	0.0668	-0.0374
	(0.0448)	(3.4853)	(0.0873)	(2.4494)	(0.0000)	(0.7185)	(0.3744)	(1.3579)
10. Chems	3.2837	0.7709	-0.1870	-0.1376	0.1376	-0.1938	0.2722	-0.0001
	(1.4796)	(4.2358)	(1.0392)	(1.1427)	(0.0000)	(0.9040)	(3.0895)	(0.0085)
11. Iron	0.6354	0.5903	-0.1874	0.0210	-0.0210	0.2847	0.3816	-0.0239
	(0.5720)	(4.1280)	(1.2482)	(0.1565)	(0.0000)	(2.0965)	(6.2778)	(2.9111)
12. Oth Metals	4.0444	0.6020	-0.3631	-0.0031	0.0031	-0.2377	0.5297	-0.0011
	(4.6732)	(6.9452)	(4.3863)	(0.0344)	(0.0000)	(1.9098)	(12.2793)	(0.2430)
13. Mech Eng.	1.1810	0.8750	-0.2511	-0.3030	0.3030	0.0013	0.3054	-0.0001
	(0.1338)	(4.9247)	(1.3122)	(2.0454)	(0.0000)	(0.0008)	(1.9726)	(0.0018)
14. Inst Eng.	11.1047	0.3232	-0.4092	-0.2374	0.2374	-0.9097	0.4084	0.0325
	(5.8935)	(2.0504)	(3.1369)	(2.4382)	(0.0000)	(5.0677)	(6.8902)	(3.2410)
15. Elec Eng.	1.4112	0.8239	0.0325	-0.4165	0.4165	-0.8581	0.6641	0.0304
	(1.6983)	(7.0026)	(0.2644)	(4.0758)	(0.0000)	(3.1270)	(7.6478)	(2.1605)
16. Ships	4.8960	0.8056	-0.2634	-0.4819	0.4819	-0.4060	0.2052	0.0034
	(2.0776)	(5.5877)	(1.7497)	(3.9030)	(0.0000)	(1.8954)	(2.8486)	(0.6876)
17. Motors	3.0849	0.4954	-0.0154	-0.1853	0.1853	-0.3752	0.5340	0.0122
	(4.2020)	(4.4106)	(0.1407)	(2.5686)	(0.0000)	(2.8822)	(9.8559)	(2.5747)
18. Aerosp.	8.0933	0.6084	-0.3622	-0.2730	0.2730	-0.1605	-0.0280	-0.0053
	(4.6926)	(3.6914)	(2.3704)	(2.4430)	(0.0000)	(1.3599)	(0.6242)	(1.1186)

(....cont)

(Table 5.3 cont.)

	cons	n(-1)	n(-2)	w	q	k	y	tim
19. Oth Veh.	3.6073	0.3830	0.1068	-0.1194	0.1194	-0.4927	0.5181	0.0108
	(2.0390)	(2.3075)	(0.7888)	(1.9092)	(0.0000)	(2.4240)	(7.0917)	(2.6446)
20. Metal Gds	3.4543	0.6710	-0.2543	0.0927	-0.0927	-0.1488	0.4183	-0.0032
	(2.0992)	(6.0721)	(2.1534)	(1.0777)	(0.0000)	(0.3560)	(7.9945)	(0.2438)
21. Textiles	1.4111	0.5473	0.1544	-0.7421	0.7421	-0.7337	0.7520	0.0420
	(0.6293)	(6.2239)	(1.4147)	(7.9230)	(0.0000)	(3.1955)	(15.7623)	(5.6658)
22. Clothing	-0.2524	0.5047	0.1868	-0.0464	0.0464	-0.1135	0.5250	-0.0115
	(0.1776)	(4.1369)	(1.3724)	(0.3434)	(0.0000)	(0.4713)	(6.4324)	(1.4903)
23. Bricks	2.1812	0.6543	-0.2927	-0.4007	0.4007	0.1205	0.4005	-0.0122
	(2.5977)	(5.3973)	(2.1291)	(4.2455)	(0.0000)	(0.3927)	(5.2103)	(0.7016)
24. Timber	5.1902	0.2721	-0.2804	0.1058	-0.1058	0.4901	0.2862	-0.0366
	(4.8098)	(2.9875)	(3.0184)	(1.5570)	(0.0000)	(4.8337)	(11.3711)	(6.3576)
25. Paper	-10.5209	0.3009	-0.0363	-0.5447	0.5447	2.0123	0.3663	-0.0600
	(2.6113)	(3.1054)	(0.3995)	(5.7647)	(0.0000)	(3.1459)	(5.1603)	(2.9407)
26. Printing	5.2526	1.1214	-0.4179	-0.1796	0.1796	-0.7004	0.3082	0.0216
	(2.7926)	(8.9032)	(2.9453)	(2.7539)	(0.0000)	(2.0863)	(5.2456)	(1.7622)
27. Oth Manuf	-1.1363	0.6675	0.0670	-0.1168	0.1168	-0.1695	0.6187	-0.0087
	(0.8694)	(5.8874)	(0.4885)	(0.9110)	(0.0000)	(1.7152)	(10.6574)	(1.0046)
28. Constr.	3.0764	0.9483	-0.3752	-0.1541	0.1541	-0.3361	0.4348	0.0168
	(3.8797)	(9.1076)	(3.0341)	(1.8692)	(0.0000)	(2.5178)	(6.5497)	(2.2945)
29. Gas	6.0474	0.9388	-0.7880	0.0444	-0.0444	0.2477	-0.0800	-0.0244
	(4.4856)	(3.7195)	(2.8933)	(0.7311)	(0.0000)	(2.3791)	(1.2795)	(3.6944)
30. Elec.	1.4566	0.9744	-0.2413	-0.1795	0.1795	-0.3858	0.6038	-0.0169
	(3.1365)	(7.3313)	(1.6997)	(4.5490)	(0.0000)	(4.3090)	(6.4469)	(4.7123)
31. Water	17.8763	0.2808	-0.2957	-0.4282	0.4282	-2.2726	1.4698	0.0296
	(2.4749)	(1.7140)	(2.0839)	(4.7677)	(0.0000)	(2.6859)	(4.4032)	(2.7306)
32. Rail	-36.1956	1.0049	-0.2433	-0.1804	0.1804	3.5033	0.5231	0.0043
	(1.8618)	(6.0243)	(1.4326)	(2.3824)	(0.0000)	(1.8324)	(3.4601)	(0.9015)
33. Road	0.6452	0.4342	-0.2512	-0.0672	0.0672	0.6036	0.4469	-0.0413
	(0.3452)	(1.8945)	(1.3352)	(1.5915)	(0.0000)	(3.8931)	(6.1254)	(4.3344)
34. Oth Trans	11.4489	0.8438	-0.2850	-0.0381	0.0381	-0.8516	0.0730	0.0030
	(2.9638)	(5.1161)	(1.6329)	(1.4459)	(0.0000)	(2.3866)	(0.8217)	(1.1136)
35. Comms	1.2172	0.8179	-0.1108	-0.0755	0.0755	-0.2305	0.4794	-0.0056
	(1.6749)	(6.0611)	(0.7751)	(1.4011)	(0.0000)	(3.1495)	(4.2935)	(1.0372)
36. Distn	-0.2173	0.2828	0.6907	-0.3694	0.3694	-1.0986	1.0412	0.0415
	(0.2205)	(1.6972)	(4.1168)	(5.1499)	(0.0000)	(6.0667)	(7.1288)	(6.1866)
37. Bus.Serv	7.4045	0.6326	-0.5194	0.0555	-0.0555	0.1706	0.0072	0.0105
	(4.8091)	(3.8617)	(3.1393)	(1.1840)	(0.0000)	(3.6372)	(0.1380)	(2.6079)
38. Prof.Serv	8.0547	0.4025	-0.1871	-0.1613	0.1613	-0.0066	-0.0797	0.0214
	(4.1177)	(2.3031)	(1.1166)	(2.8004)	(0.0000)	(0.1341)	(1.3810)	(4.5180)
39. Misc.Serv	1.2738	0.6286	0.1173	0.0015	-0.0015	-0.4095	0.5473	0.0114
	(0.5654)	(3.4835)	(0.5380)	(0.0254)	(0.0000)	(3.4283)	(4.7830)	(2.8288)

<u>Table 5.4</u>

<u>Industrial price equations 1957-1981</u>

	cons	p(-1)	p(-2)	w	q	k	y	tim
1. Agric.	4.7106	0.3653	-0.3513	0.5206	0.4654	0.3857	-0.8551	-0.0299
	(2.4794)	(3.0819)	(2.8238)	(4.5454)	(0.0000)	(1.7869)	(3.0001)	(4.7220)
2. Coal	2.4684	0.7444	-0.1439	0.4614	-0.0619	-0.6768	0.3741	0.0149
	(1.7317)	(5.3490)	(1.0928)	(3.4813)	(0.0000)	(2.3888)	(1.7688)	(1.4513)
3. Mining	2.4005	0.5506	-0.2086	-0.1817	0.8397	-0.2603	-0.1297	0.0122
	(1.4901)	(4.2228)	(1.9334)	(2.9946)	(0.0000)	(0.9135)	(1.8461)	(1.8946)
4. Petrol	-1.1466	0.0525	0.0605	1.3475	-0.4605	-0.0154	-0.0282	0.0605
	(4.4519)	(1.2547)	(1.7778)	(26.7104)	(0.0000)	(1.8585)	(0.4753)	(2.5354)
5. Food	-8.5283	-0.0605	0.5928	-0.9257	1.3934	3.0477	-1.4520	-0.0680
	(3.3875)	(0.4214)	(4.5337)	(6.1992)	(0.0000)	(4.3562)	(3.8186)	(3.1384)
6. Drink	13.5184	0.7018	-0.4856	0.2026	0.5811	-2.2280	-0.0730	0.1353
	(3.7096)	(5.3683)	(3.8314)	(2.2693)	(0.0000)	(3.4364)	(0.4785)	(3.0439)
7. Tobacco	13.0165	0.5941	-0.1272	0.0264	0.5067	-0.9619	-1.2121	0.0805
	(2.7166)	(5.9176)	(1.1043)	(0.4169)	(0.0000)	(1.0608)	(3.9731)	(1.3201)
8. Coal Prds	3.4487	0.3076	-0.1435	-0.3712	1.2072	-1.0281	0.5838	0.1040
	(1.2017)	(1.8969)	(1.2072)	(2.6531)	(0.0000)	(2.0910)	(2.4611)	(3.4960)
9. Petrol Prds	0.1991	-0.3468	0.2051	0.5293	0.6124	0.5207	-0.4964	-0.0230
	(0.0468)	(2.6671)	(2.5441)	(5.5268)	(0.0000)	(0.7891)	(2.9025)	(0.7944)
10. Chems	3.0741	0.2101	-0.0827	0.0356	0.8370	-0.4419	0.0838	0.0038
	(1.5616)	(1.2061)	(0.8000)	(0.2077)	(0.0000)	(1.4834)	(0.6853)	(0.4374)
11. Iron	0.8557	0.7644	-0.3677	0.1983	0.4051	-0.0638	-0.0324	-0.0024
	(0.8429)	(4.5500)	(3.0016)	(1.0981)	(0.0000)	(0.4679)	(0.4642)	(0.3489)
12. Oth Metals	-9.7189	0.3768	0.2205	-1.0565	1.4592	0.8048	0.5780	0.0092
	(4.2851)	(3.0067)	(1.8069)	(3.4951)	(0.0000)	(1.8854)	(3.9248)	(0.5789)
13. Mech Eng.	7.0355	0.4806	-0.1227	0.3854	0.2567	-0.9707	0.0342	0.0152
	(1.9362)	(3.7924)	(1.6801)	(4.9386)	(0.0000)	(1.6563)	(0.4381)	(0.9650)
14. Inst Eng.	3.3308	0.2259	0.1083	0.3278	0.3380	-0.4211	-0.1705	0.0168
	(3.9999)	(1.4178)	(1.0267)	(4.1296)	(0.0000)	(2.9994)	(3.3511)	(2.0228)
15. Elec Eng.	0.3381	0.1594	0.0667	0.3874	0.3864	-0.1643	0.1499	-0.0148
	(0.4291)	(0.6746)	(0.4629)	(3.3626)	(0.0000)	(0.9045)	(1.5455)	(1.6350)
16. Ships	9.4650	0.3431	-0.1952	-0.2262	1.0782	-0.9520	-0.5117	-0.0195
	(2.7828)	(2.2694)	(1.4315)	(0.9040)	(0.0000)	(2.2497)	(2.2881)	(1.3695)
17. Motors	1.5506	0.5128	-0.0418	-0.0181	0.5471	-0.2698	0.0245	0.0155
	(2.9256)	(2.9910)	(0.3535)	(0.2532)	(0.0000)	(2.1617)	(0.4626)	(2.7607)
18. Aerosp.	1.2106	0.0250	0.0582	0.2070	0.7098	-0.4005	0.1270	0.0190
	(1.1630)	(0.1812)	(0.6894)	(1.9274)	(0.0000)	(2.9963)	(1.9180)	(3.7062)
19. Oth Veh.	1.3653	0.2006	-0.1407	-0.0060	0.9461	-0.3678	0.0546	0.0249
	(1.0355)	(1.7757)	(1.6763)	(0.1066)	(0.0000)	(1.9385)	(0.8520)	(5.7703)
20. Metal Gds	6.2735	0.0368	0.0762	0.3283	0.5587	-0.9723	0.0301	0.0261
	(2.1465)	(0.1182)	(0.4484)	(2.0483)	(0.0000)	(2.0343)	(0.3693)	(2.0224)
21. Textiles	0.0940	0.5934	-0.1391	-0.4255	0.9712	-0.3996	0.3070	0.0244
	(0.0265)	(3.3622)	(1.0797)	(3.2440)	(0.0000)	(0.8110)	(4.2404)	(2.2247)
22. Clothing	-1.0871	0.8516	-0.2344	0.5474	-0.1646	-0.2601	0.4153	-0.0219
	(0.9339)	(3.0861)	(1.1722)	(4.9092)	(0.0000)	(1.1850)	(6.2284)	(4.4343)
23. Bricks	3.3087	0.2040	0.0783	0.3240	0.3938	-0.2149	-0.2496	0.0103
	(4.0822)	(2.0075)	(1.0269)	(3.7126)	(0.0000)	(1.2017)	(3.9091)	(1.1806)
24. Timber	-6.3151	0.5848	0.2286	0.2693	-0.0827	1.2459	0.0653	-0.0602
	(5.5712)	(2.5746)	(1.4235)	(2.2247)	(0.0000)	(5.0176)	(1.1928)	(5.3819)
25. Paper	-17.7176	0.1933	-0.1593	-0.3669	1.3329	2.7679	-0.2496	-0.0756
	(2.3988)	(1.1240)	(1.2346)	(2.4707)	(0.0000)	(2.3630)	(1.8486)	(2.0622)
26. Printing	-8.8600	0.0834	0.0947	0.4125	0.4094	1.2565	0.0410	-0.0483
	(2.6093)	(0.5507)	(0.8914)	(3.5551)	(0.0000)	(2.1728)	(0.3147)	(2.4979)
27. Oth Manuf	3.8792	-0.1483	0.2126	0.0084	0.9273	0.1571	-0.6546	0.0149
	(6.4241)	(0.9583)	(2.2734)	(0.0725)	(0.0000)	(1.3886)	(7.5290)	(2.4356)
28. Constr.	-0.2200	1.1106	-0.7336	0.1906	0.4324	-0.2125	0.1745	0.0114
	(0.1783)	(5.3937)	(3.6819)	(1.1537)	(0.0000)	(1.1311)	(1.1105)	(1.1198)
29. Gas	3.1684	1.0412	-0.4158	0.1068	0.2677	-0.1608	-0.2403	0.0019
	(3.6255)	(7.2447)	(3.1982)	(1.9257)	(0.0000)	(1.6469)	(2.7957)	(0.4312)
30. Elec.	-1.2921	0.2594	0.1873	-0.1844	0.7378	-0.0346	0.2342	-0.0112
	(2.0839)	(1.7184)	(1.5944)	(2.4528)	(0.0000)	(0.2360)	(1.3775)	(1.7311)
31. Water	-16.7479	0.5268	-0.3632	0.2741	0.5623	1.8951	0.0569	-0.0284
	(3.7316)	(4.4788)	(3.5903)	(4.1391)	(0.0000)	(3.4871)	(0.2422)	(4.1873)
32. Rail	15.0842	0.1083	0.3621	-0.0401	0.5697	-1.6808	0.2153	0.0034
	(0.8996)	(0.8267)	(3.4627)	(0.6990)	(0.0000)	(1.0323)	(1.6785)	(0.8014)
33. Road	4.0115	0.3419	-0.0261	0.5094	0.1747	0.0094	-0.5016	-0.0041
	(0.8567)	(1.8230)	(0.1347)	(3.2316)	(0.0000)	(0.0236)	(1.6683)	(0.2046)
34. Oth Trans	37.9283	0.2336	-0.2577	0.7288	0.2952	-4.0758	-0.0230	-0.0048
	(5.4878)	(1.6813)	(2.5562)	(8.3120)	(0.0000)	(5.2709)	(0.1305)	(0.9157)
35. Comms	4.8797	0.4039	-0.2960	0.7051	0.1870	0.2020	-0.8461	0.0132
	(3.9107)	(3.1265)	(3.2427)	(7.9646)	(0.0000)	(1.3694)	(4.0771)	(1.5944)
36. Distn	-3.7185	0.7162	-0.3102	0.0632	0.5308	0.0747	0.3471	-0.0141
	(3.1642)	(4.4168)	(3.2222)	(0.7771)	(0.0000)	(0.4315)	(2.0672)	(2.0463)
37. Bus.Serv	-7.7262	0.5718	-0.2415	0.9663	-0.2966	0.6395	0.3695	-0.0853
	(2.5828)	(3.8319)	(1.2937)	(4.8508)	(0.0000)	(2.9492)	(1.4067)	(3.9578)
38. Prof.Serv	3.2566	0.0669	-0.0981	0.3366	0.6946	0.0351	-0.4094	0.0009
	(5.4618)	(0.4798)	(0.8813)	(3.9537)	(0.0000)	(0.6583)	(5.6612)	(0.2308)
39. Misc.Serv	2.9593	0.0410	0.1104	0.4703	0.3783	-0.1480	-0.1714	0.0061
	(2.9047)	(0.3687)	(1.3766)	(8.3127)	(0.0000)	(1.4451)	(1.5655)	(1.7260)

(....cont)

(Table 5.4 cont.)

Table 5.5

Industrial wage equations 1957-1981

	cons	w(-1)	$\bar{w}^e$	int	inc	unr	$\bar{p}^e$	t2
1. Agric.	-7.9487	1.0828	-0.1671	-1.0333	0.0064	-5.6977	0.1568	-0.5502
	(3.1284)	(9.2737)	(1.1329)	(3.0566)	(1.4480)	(2.4350)	(0.8988)	(0.8912)
2. Coal	0.8550	-0.1690	0.6467	0.3500	0.0158	-5.6853	0.6490	-1.4464
	(0.5666)	(0.8742)	(2.9336)	(0.7053)	(1.5984)	(3.2319)	(2.3465)	(1.3042)
3. Mining	3.6586	-0.0608	-0.3390	0.8425	0.0030	2.0759	0.6304	-5.1234
	(1.0400)	(0.2949)	(1.1840)	(1.4618)	(0.2193)	(1.0251)	(1.0399)	(3.3933)
4. Petrol	-7.9227	0.1148	-4.6757	0.5660	-0.1015	81.3961	5.3655	-10.6260
	(4.5883)	(0.8545)	(3.8275)	(0.5627)	(1.6044)	(5.6212)	(4.0133)	(1.7465)
5. Food	5.5197	0.0311	0.9540	-0.6038	-0.0065	2.7800	-0.1398	-0.7968
	(1.3128)	(0.2816)	(6.4383)	(1.3664)	(1.7120)	(2.8286)	(1.3700)	(1.8043)
6. Drink	-13.4148	0.0127	3.0417	-10.7926	0.0009	5.4881	-0.9427	0.7776
	(1.6246)	(0.0762)	(5.3036)	(1.9070)	(0.0814)	(1.4383)	(1.7069)	(0.5619)
7. Tobacco	-3.5346	0.3285	0.8232	4.5155	0.0232	1.8515	-0.3017	1.1363
	(0.4217)	(2.1828)	(1.5532)	(1.3727)	(1.5065)	(0.4183)	(0.5227)	(0.5252)
8. Coal Prds	6.5229	0.4439	0.8190	-0.7448	0.0166	-14.5940	0.5511	0.5531
	(1.8443)	(1.6312)	(2.2901)	(1.8594)	(1.0393)	(1.9954)	(1.3155)	(0.2709)
9. Petrol Prds	2.6099	0.2500	0.9866	-0.5422	0.0043	-9.9695	0.0820	0.8599
	(0.8155)	(1.7714)	(3.3554)	(0.8364)	(0.5794)	(3.0110)	(0.2325)	(0.7088)
10. Chems	-0.2369	-0.1224	0.9147	-0.2004	0.0046	0.8961	0.1762	-1.2698
	(0.6123)	(1.0992)	(7.4662)	(0.4891)	(1.4080)	(0.5409)	(2.6234)	(3.3690)
11. Iron	1.3391	0.5011	0.0647	-0.4232	0.0057	2.7905	0.2175	-2.7122
	(1.1112)	(2.2678)	(0.3005)	(1.8092)	(0.7215)	(1.8006)	(1.3816)	(3.1432)
12. Oth Metals	0.2250	0.5397	0.1451	-0.3000	0.0141	-0.8738	0.2236	-2.4503
	(0.3466)	(3.6021)	(0.7853)	(1.2725)	(1.8753)	(0.6509)	(2.0133)	(3.2547)
13. Mech Eng.	-1.0092	0.3940	0.4083	0.2713	0.0023	2.0197	0.0940	-0.9762
	(0.3322)	(2.3699)	(2.0285)	(0.9934)	(0.5145)	(1.5650)	(1.1971)	(1.7335)
14. Inst Eng.	-0.0263	0.3194	0.2603	0.3008	0.0139	-0.8778	0.3345	-2.5391
	(0.0512)	(2.7637)	(1.2357)	(1.1126)	(2.6769)	(0.5084)	(2.1823)	(3.8143)
15. Elec Eng.	-0.1058	0.2282	0.0749	1.2736	0.0035	-3.8172	0.2562	-0.9660
	(0.0610)	(1.3221)	(0.4173)	(4.0205)	(0.7780)	(1.6931)	(2.1863)	(1.8422)
16. Ships	0.2483	-0.0485	0.8554	0.5841	0.0037	0.3595	-0.1355	-0.9588
	(0.2779)	(0.3420)	(5.3653)	(2.6425)	(1.0218)	(0.8907)	(1.1562)	(1.9523)
17. Motors	0.5827	0.7613	0.3314	-0.4202	0.0079	3.2516	-0.1100	-1.0821
	(1.4051)	(4.1569)	(1.7653)	(2.5758)	(1.7221)	(2.0083)	(0.9056)	(1.9343)
18. Aerosp.	3.1323	-0.4680	2.2062	2.2106	-0.0119	4.0035	-1.3124	1.3871
	(1.2197)	(1.8450)	(3.9255)	(1.9796)	(1.6472)	(2.0976)	(2.4781)	(1.5168)

(....cont)

(Table 5.5 cont.)

	cons	w(-1)	$\bar{w}^e$	int	inc	unr	$\bar{p}^e$	t2
19. Oth Veh.	-1.0966	0.3005	0.4245	-0.0007	-0.0082	6.1293	-0.1933	-3.8518
	(3.5418)	(1.9307)	(1.0901)	(0.0023)	(0.7777)	(1.9245)	(0.5268)	(3.3004)
20. Metal Gds	-0.6133	0.7418	0.0893	0.1763	0.0078	-0.8674	0.2000	-1.4618
	(0.7777)	(3.3811)	(0.4497)	(0.6388)	(1.1887)	(0.6018)	(1.7798)	(2.1791)
21. Textiles	-0.4082	-0.1073	0.9420	0.0162	0.0015	1.5274	0.0923	-1.3045
	(2.3812)	(0.8330)	(7.4788)	(0.1592)	(0.4548)	(1.5844)	(1.3623)	(2.8755)
22. Clothing	0.4188	0.1043	0.5743	-0.0895	0.0080	-1.9098	0.4567	-0.0393
	(0.7216)	(0.6731)	(4.6479)	(0.4999)	(1.8662)	(1.4951)	(4.8571)	(0.0807)
23. Bricks	-0.7030	0.0381	0.5220	0.0990	0.0056	-0.2308	0.4777	-1.4389
	(0.6016)	(0.1865)	(2.3562)	(0.3072)	(0.9133)	(0.1585)	(4.0122)	(1.9657)
24. Timber	-2.3272	0.3630	0.4538	0.5313	0.0120	-1.7713	0.3130	-0.8629
	(2.8836)	(2.4408)	(3.1216)	(2.3425)	(2.6360)	(1.2297)	(3.2029)	(1.8203)
25. Paper	-6.6841	0.6555	0.1540	0.4113	0.0162	-7.7659	0.1970	-0.3206
	(1.3150)	(5.7677)	(0.6560)	(1.4303)	(4.1276)	(3.4674)	(1.7436)	(0.6143)
26. Printing	-2.4876	0.8617	0.1259	-0.8132	0.0072	6.5240	-0.0026	-1.6350
	(1.0788)	(3.2149)	(0.4713)	(1.3178)	(1.0141)	(2.2921)	(0.0213)	(2.0210)
27. Oth Manuf	-0.5145	0.1974	0.6624	0.2029	0.0052	-3.6695	0.2844	-0.1875
	(1.0384)	(1.5377)	(4.2845)	(1.3687)	(1.3463)	(2.7972)	(3.3663)	(0.3890)
28. Constr.	-0.3119	0.3371	0.3209	-0.1579	0.0047	0.9782	0.2023	-1.9683
	(0.3781)	(1.7022)	(1.2511)	(0.3544)	(0.7796)	(1.3322)	(1.4904)	(2.6662)
29. Gas	-0.4672	-0.0132	0.9596	0.1870	-0.0061	5.6277	-0.0029	-0.8555
	(0.7163)	(0.0937)	(3.2488)	(0.2542)	(0.7813)	(1.8597)	(0.0191)	(1.0281)
30. Elec.	-0.1622	0.4674	0.5006	-0.1015	0.0190	6.0454	0.1051	-0.7643
	(0.3301)	(3.0892)	(1.9040)	(0.2388)	(3.8755)	(3.1795)	(0.9421)	(1.0248)
31. Water	0.8425	0.3278	0.9220	0.0700	0.0252	-3.7546	-0.3756	-0.0604
	(0.5593)	(3.1294)	(3.7868)	(0.4667)	(6.3577)	(1.8001)	(2.7804)	(0.1046)
32. Rail	-23.5763	0.2372	1.2674	0.6191	-0.0135	3.1973	-0.7068	1.0162
	(1.4386)	(1.4478)	(5.1590)	(1.7155)	(2.9582)	(1.3322)	(4.3933)	(1.8684)
33. Road	3.8712	0.0292	1.6704	-0.5577	0.0103	3.1454	-1.0619	-0.9445
	(0.6178)	(0.1442)	(3.6285)	(0.6687)	(1.5103)	(1.0493)	(2.8584)	(1.1717)
34. Oth Trans	-9.9283	-0.1108	1.5215	-1.3757	0.0067	1.0480	-0.5414	-0.1663
	(1.7808)	(1.1043)	(9.0220)	(1.3843)	(1.8898)	(0.6162)	(4.5503)	(0.3371)
35. Comms	-0.5304	0.0732	0.5531	0.0269	-0.0053	7.1975	0.3300	-1.0027
	(0.3021)	(0.3245)	(1.8259)	(0.0275)	(0.7044)	(2.8432)	(1.5035)	(1.1404)
36. Distn	-0.1952	0.4306	0.4597	0.6245	0.0058	-3.3484	-0.1190	-0.3019
	(0.3291)	(3.3967)	(2.9932)	(3.3474)	(1.7164)	(2.0034)	(1.8053)	(0.6308)
37. Bus.Serv	-9.9431	-0.3863	-0.0691	5.1321	-0.0073	-13.6655	1.1937	1.9758
	(2.6847)	(2.0621)	(0.1435)	(2.5447)	(1.3785)	(2.4227)	(2.2700)	(2.9489)
38. Prof.Serv	0.2438	0.5032	0.1039	1.5908	-0.0053	4.4137	-0.0983	-0.3026
	(0.3001)	(3.7563)	(0.2334)	(1.5499)	(0.6679)	(0.3636)	(0.3781)	(0.2680)
39. Misc.Serv	-2.9879	0.5342	0.5523	1.9360	-0.0017	-1.9865	-0.1394	0.1896
	(1.2764)	(3.8228)	(2.0316)	(1.8542)	(0.1529)	(0.5579)	(0.7885)	(0.1680)

Table 5.6

Industrial demand equations 1957-1981

	cons	y(-1)	p/$\bar{p}$	pm/$\bar{p}$	σ	tim
1. Agric.	5.0762	0.3748	-0.1214	0.0517	1.6413	1.1718
	(3.9931)	(2.3797)	(1.8288)	(2.1814)	(2.4706)	(9.5995)
2. Coal	3.7399	0.5659	0.3039	0.0243	12.9578	0.1578
	(2.6931)	(3.3968)	(2.0227)	(2.0976)	(4.4973)	(1.0160)
3. Mining	4.5741	0.2012	-0.7890	0.0166	0.2024	0.8951
	(6.5411)	(1.5151)	(4.8307)	(0.2948)	(0.4758)	(4.7053)
4. Petrol	0.2066	0.5374	0.0663	-0.2261	-2.3769	0.8418
	(0.2850)	(3.7006)	(0.7908)	(0.6641)	(1.2989)	(3.8587)
5. Food	8.4003	0.0353	-0.0260	0.0905	7.4237	0.5302
	(4.1946)	(0.1529)	(0.3691)	(3.5534)	(4.7641)	(3.0553)
6. Drink	2.8676	0.5454	-0.0837	0.0976	1.9965	0.3369
	(2.6696)	(3.2339)	(1.1748)	(3.1083)	(0.6601)	(1.5776)
7. Tobacco	5.1315	0.1957	-0.2401	-0.0255	-0.4676	-0.2493
	(5.7799)	(1.3722)	(4.6442)	(1.0493)	(0.2150)	(1.0365)
8. Coal Prds	3.7194	0.3234	0.4602	0.2051	0.1804	0.4512
	(3.1634)	(1.5251)	(4.0032)	(3.6423)	(0.0448)	(3.4853)
9. Petrol Prds	5.0529	0.1838	-0.7971	0.3900	3.2837	0.7709
	(9.1125)	(2.0306)	(9.9073)	(4.5265)	(1.4796)	(4.2358)
10. Chems	5.0573	0.3051	-0.0720	0.2253	0.6354	0.5903
	(4.8779)	(2.1522)	(0.5118)	(4.2024)	(0.5720)	(4.1280)
11. Iron	6.7213	0.1174	-0.5022	0.3805	4.0444	0.6020
	(5.1559)	(0.6730)	(2.3944)	(2.8108)	(4.6732)	(6.9452)
12. Oth Metals	6.6949	0.0470	-0.2346	0.2099	1.1810	0.8750
	(8.1803)	(0.4023)	(2.5981)	(5.5895)	(0.1338)	(4.9247)
13. Mech Eng.	0.0856	0.9838	-0.4371	0.0417	11.1047	0.3232
	(0.0860)	(7.7227)	(2.0687)	(0.9479)	(5.8935)	(2.0504)
14. Inst Eng.	1.8015	0.6370	0.2573	0.0959	1.4112	0.8239
	(2.6479)	(4.6290)	(1.0700)	(2.4923)	(1.6983)	(7.0026)
15. Elec Eng.	3.9995	0.4567	0.6110	0.0479	4.8960	0.8056
	(4.6309)	(3.9451)	(3.7159)	(1.9765)	(2.0776)	(5.5877)
16. Ships	1.2437	0.8516	-0.5208	0.0092	3.0849	0.4954
	(1.4765)	(7.2858)	(5.9498)	(0.1974)	(4.2020)	(4.4106)
17. Motors	5.5031	0.2051	0.1445	0.5080	8.0933	0.6084
	(3.3086)	(0.8473)	(0.4963)	(3.2121)	(4.6926)	(3.6914)
18. Aerosp.	8.2204	-0.0058	1.9230	-0.0595	3.6073	0.3830
	(5.3931)	(0.0269)	(4.6284)	(1.1107)	(2.0390)	(2.3075)

(....cont)

(Table 5.6 cont.)

	cons	y(-1)	p/$\bar{p}$	pm/$\bar{p}$	σ	tim
19. Oth Veh.	5.2088	0.3421	1.3783	0.0383	3.4543	0.6710
	(5.9157)	(2.9942)	(8.6373)	(2.0849)	(2.0992)	(6.0721)
20. Metal Gds	5.0495	0.3589	0.0446	0.1631	1.4111	0.5473
	(4.2593)	(2.4146)	(0.1737)	(2.8664)	(0.6293)	(6.2239)
21. Textiles	2.2914	0.7002	-0.2666	0.1466	-0.2524	0.5047
	(2.0652)	(4.6811)	(0.9997)	(3.0476)	(0.1776)	(4.1369)
22. Clothing	3.0151	0.5971	-0.3118	0.0934	2.1812	0.6543
	(2.4624)	(3.6220)	(1.3461)	(2.6759)	(2.5977)	(5.3973)
23. Bricks	6.7844	-0.0076	-0.8231	0.2020	5.1902	0.2721
	(8.9977)	(0.0676)	(3.9556)	(4.0599)	(4.8098)	(2.9875)
24. Timber	8.9749	-0.2944	0.1152	0.3432	-10.5209	0.3009
	(7.0059)	(1.5851)	(0.5886)	(5.0642)	(2.6113)	(3.1054)
25. Paper	5.8287	0.1555	-0.9240	0.3004	5.2526	1.1214
	(7.4920)	(1.3631)	(5.5376)	(5.1215)	(2.7926)	(8.9032)
26. Printing	6.3546	0.0814	0.1014	0.2015	-1.1363	0.6675
	(9.4601)	(0.8285)	(0.8757)	(5.1226)	(0.8694)	(5.8874)
27. Oth Manuf	5.4758	0.2724	-1.1426	0.0224	3.0764	0.9483
	(6.5627)	(2.2354)	(7.2278)	(0.5215)	(3.8797)	(9.1076)
28. Constr.	1.2976	0.8256	-0.6747	0.0928	6.0474	0.9388
	(1.7148)	(9.8919)	(7.2631)	(2.7548)	(4.4856)	(3.7195)
29. Gas	0.8660	0.8498	-0.1671	0.0293	1.4566	0.9744
	(0.9158)	(7.1448)	(1.4726)	(0.6947)	(3.1365)	(7.3313)
30. Elec.	-0.5075	1.0632	0.2864	0.0149	17.8763	0.2808
	(1.1064)	(18.3187)	(3.0690)	(2.0217)	(2.4749)	(1.7140)
31. Water	1.9589	0.6509	-0.1534	0.0445	-36.1956	1.0049
	(2.7009)	(5.2932)	(1.8753)	(2.7526)	(1.8618)	(6.0243)
32. Rail	1.1933	0.8214	0.2636	0.0110	0.6452	0.4342
	(0.9667)	(5.1658)	(1.5029)	(0.5005)	(0.3452)	(1.8945)
33. Road	1.9209	0.7030	-0.1204	0.1147	11.4489	0.8438
	(1.7995)	(4.5127)	(1.8630)	(2.9979)	(2.9638)	(5.1161)
34. Oth Trans	4.0173	0.4849	-0.4221	0.0896	1.2172	0.8179
	(4.9786)	(4.7592)	(2.7689)	(3.4079)	(1.6749)	(6.0611)
35. Comms	2.4671	0.6462	-0.1835	0.0402	-0.2173	0.2828
	(3.8134)	(7.0386)	(3.2901)	(2.8577)	(0.2205)	(1.6972)
36. Distn	6.8857	0.2457	0.4048	0.0045	7.4045	0.6326
	(10.1766)	(3.3121)	(6.9938)	(0.7264)	(4.8091)	(3.8617)
37. Bus.Serv	3.5580	0.5321	0.0563	0.0356	8.0547	0.4025
	(2.9746)	(3.3444)	(0.9848)	(1.5216)	(4.1177)	(2.3031)
38. Prof.Serv	5.4967	0.2110	-1.1945	0.2782	1.2738	0.6286
	(4.2055)	(1.2246)	(4.1717)	(3.3119)	(0.5654)	(3.4835)
39. Misc.Serv	3.4641	0.6208	-0.0048	0.0346	0.7110	0.0088
	(2.0379)	(3.4125)	(0.0340)	(1.4073)	(2.4015)	(2.4377)

Table 5.7

Estimated equation diagnostics

Industry	Value objective fn. (L)	Employment eqn Price eqn Wage eqn Output eqn	RSS	s. error regression	R^2
1. Agric.	96.6746		0.0116	0.0215	0.9948
			0.0176	0.0265	0.9973
			0.0170	0.0261	0.9991
			0.0091	0.0191	0.9849
2. Coal	96.5281		0.0175	0.0264	0.9954
			0.0618	0.0497	0.9960
			0.1015	0.0637	0.9940
			0.1022	0.0640	0.9600
3. Mining	73.5158		0.0402	0.0401	0.9557
			0.0113	0.0213	0.9987
			0.0804	0.0567	0.9948
			0.0357	0.0378	0.9668
4. Petrol	92.1953		1.0282	0.2028	0.9210
			0.4341	0.1318	0.9980
			2.2212	0.2981	0.9772
			4.0472	0.4024	0.9791
5. Food	80.3856		0.0046	0.0135	0.9814
			0.0134	0.0232	0.9985
			0.0136	0.0233	0.9992
			0.0042	0.0130	0.9876
6. Drink	88.4767		0.0110	0.0210	0.8751
			0.0433	0.0416	0.9915
			0.0880	0.0593	0.9957
			0.0118	0.0217	0.9946
7. Tobacco	86.7310		0.0395	0.0398	0.8700
			0.0586	0.0484	0.9919
			0.2006	0.0896	0.9920
			0.0130	0.0228	0.9279
8. Coal Prds	87.2913		0.0917	0.0606	0.9412
			0.1866	0.0864	0.9902
			0.2607	0.1021	0.9872
			0.0824	0.0574	0.9142
9. Petrol Prds	85.5370		0.0712	0.0534	0.9158
			0.0970	0.0623	0.9938
			0.0921	0.0607	0.9954
			0.0507	0.0450	0.9864

(cont...)

(Table 5.7 cont.)

	L	RSS	s.e.	R^2
10. Chems	88.8550	0.0070	0.0167	0.8661
		0.0186	0.0272	0.9970
		0.0111	0.0210	0.9993
		0.0247	0.0314	0.9911
11. Iron	81.7949	0.0265	0.0326	0.9771
		0.0409	0.0404	0.9961
		0.0316	0.0356	0.9981
		0.1569	0.0792	0.7649
12. Oth Metals	106.3582	0.0071	0.0168	0.9848
		0.0723	0.0538	0.9933
		0.0379	0.0389	0.9976
		0.0229	0.0303	0.8940
13. Mech Eng	99.4264	0.0102	0.0202	0.9620
		0.0041	0.0127	0.9995
		0.0173	0.0263	0.9990
		0.0246	0.0314	0.9655
14. Inst Eng	87.9474	0.0096	0.0196	0.9152
		0.0053	0.0146	0.9991
		0.0262	0.0324	0.9984
		0.0373	0.0386	0.9913
15. Elec Eng	97.9396	0.0094	0.0194	0.9199
		0.0070	0.0167	0.9989
		0.0165	0.0257	0.9989
		0.0183	0.0270	0.9906
16. Ships	90.8792	0.0121	0.0220	0.9905
		0.1469	0.0767	0.9763
		0.0096	0.0195	0.9994
		0.0841	0.0580	0.8087
17. Motors	93.1323	0.0086	0.0185	0.9694
		0.0144	0.0240	0.9984
		0.0320	0.0358	0.9981
		0.0774	0.0556	0.9316
18. Aerosp.	79.1975	0.0180	0.0268	0.9823
		0.0561	0.0474	0.9954
		0.0307	0.0350	0.9983
		0.4794	0.1385	0.0000
19. Oth Vehs	78.5596	0.0263	0.0324	0.9906
		0.0315	0.0355	0.9974
		0.0668	0.0517	0.9948
		0.1552	0.0788	0.8912
20. Metal Gds	87.5548	0.0080	0.0178	0.9511
		0.0163	0.0255	0.9984
		0.0219	0.0296	0.9985
		0.0723	0.0538	0.7499

(cont...)

(Table 5.7 cont.)

	L	RSS	s.e.	R^2
21. Textiles	115.7184	0.0096	0.0196	0.9955
		0.0329	0.0363	0.9936
		0.0252	0.0317	0.9986
		0.0448	0.0423	0.8646
22. Clothing	90.1669	0.0084	0.0183	0.9930
		0.0081	0.0180	0.9984
		0.0160	0.0253	0.9990
		0.0326	0.0361	0.8416
23. Bricks	86.2477	0.0094	0.0194	0.9838
		0.0087	0.0187	0.9991
		0.0374	0.0387	0.9979
		0.0321	0.0358	0.9608
24. Timber	126.3911	0.0057	0.0151	0.9439
		0.0165	0.0257	0.9982
		0.0241	0.0311	0.9984
		0.0513	0.0453	0.9050
25. Paper	85.3788	0.0139	0.0236	0.9582
		0.0367	0.0383	0.9960
		0.0210	0.0290	0.9990
		0.0315	0.0355	0.9107
26. Printing	88.3784	0.0052	0.0144	0.9546
		0.0191	0.0276	0.9982
		0.0203	0.0285	0.9987
		0.0112	0.0212	0.9855
27. Oth Manuf	90.8167	0.0058	0.0152	0.9652
		0.0221	0.0298	0.9971
		0.0136	0.0233	0.9992
		0.0482	0.0439	0.9728
28. Constr.	85.2625	0.0077	0.0175	0.9443
		0.0261	0.0323	0.9977
		0.0201	0.0283	0.9985
		0.0181	0.0269	0.9477
29. Gas	93.1742	0.0181	0.0269	0.9732
		0.0238	0.0309	0.9943
		0.0541	0.0465	0.9969
		0.0259	0.0322	0.9950
30. Elec	88.1626	0.0117	0.0216	0.9823
		0.0276	0.0333	0.9960
		0.0322	0.0359	0.9985
		0.0175	0.0264	0.9933
31. Water	98.6698	0.0382	0.0391	0.9163
		0.0313	0.0354	0.9969
		0.0301	0.0347	0.9980
		0.0069	0.0166	0.9882

(cont...)

(Table 5.7 cont.)

	L	RSS	s.e.	R^2
32. Rail	84.7460	0.0134	0.0232	0.9950
		0.0101	0.0201	0.9986
		0.0148	0.0243	0.9992
		0.0182	0.0270	0.9050
33. Road	78.1239	0.0033	0.0115	0.9744
		0.0767	0.0554	0.9920
		0.0306	0.0350	0.9983
		0.0187	0.0274	0.9777
34. Oth Trans	95.9489	0.0060	0.0155	0.9207
		0.0251	0.0317	0.9966
		0.0276	0.0332	0.9984
		0.0140	0.0237	0.9892
35. Comms	88.6131	0.0045	0.0134	0.9650
		0.0166	0.0258	0.9984
		0.0443	0.0421	0.9973
		0.0046	0.0135	0.9983
36. Distn	86.3651	0.0045	0.0135	0.9746
		0.0102	0.0202	0.9986
		0.0108	0.0208	0.9993
		0.0030	0.0109	0.9942
37. Bus.Serv	73.5898	0.0049	0.0140	0.9945
		0.0421	0.0410	0.9944
		0.0075	0.0173	0.9995
		0.0100	0.0200	0.9962
38. Prof.Serv	96.8328	0.0092	0.0192	0.9747
		0.0175	0.0265	0.9981
		0.0498	0.0446	0.9971
		0.1000	0.0632	0.9315
39. Misc.Serv	80.8692	0.0053	0.0145	0.9256
		0.0083	0.0183	0.9992
		0.0595	0.0488	0.9959
		0.0110	0.0210	0.9711

Table 5.8

Tests on restrictions in industrial systems

		Value of minimised objective function				
		R	U_1	$(R-U_1)$	U_2	$(R-U_2)$
1	Agriculture	96.6746	76.8193	19.8553	84.5307	12.1439
2	Coal mining	96.5281	80.8458	15.6822	85.0016	11.5264
3	Mining nes	73.5158	70.9138	2.6019	69.2308	4.2850
5	Food	80.3856	79.4958	0.8898	76.2861	4.0995
6	Drink	88.4767	85.5285	2.9482	80.8528	7.6238
7	Tobacco	86.7310	77.5558	9.1752	80.3356	6.3955
8	Coal products	87.2913	80.6044	6.6869	83.3166	3.9747
9	Petroleum products	85.5370	82.8008	2.7362	84.1354	1.4016
10	Chemicals	88.8550	86.3575	2.4975	85.1746	3.6804
11	Iron and steel	81.7949	75.1254	6.6696	76.6428	5.1521
12	Non-ferrous metals	106.3582	99.2055	7.1526	79.0785	27.2797
13	Mechanical Engineering	99.4264	90.9970	8.4294	91.8031	7.6234
14	Instrument Engineering	87.9474	85.9149	2.0325	77.1049	10.8425
15	Electrical Engineering	97.9396	97.4993	0.4403	85.9477	11.9919
16	Ship building	90.8792	86.8102	4.0690	78.5411	12.3382
17	Motor Vehicles	93.1323	89.5607	3.5716	83.1914	9.9409
18	Aerospace euipment	79.1975	71.6462	7.5513	62.8739	16.3236
19	Other Vehicles	78.5596	74.0106	4.5490	74.6767	3.8829
20	Metal goods nes	87.5548	85.9540	1.6009	74.2130	13.3418
21	Textiles	115.7184	115.3965	0.3219	101.3062	14.4122
22	Leather, clothing, etc.	90.1669	83.7527	6.4142	71.6521	18.5148
23	Bricks	86.2477	79.7671	6.4806	73.0914	13.1563
24	Timber and furniture	126.3911	106.0004	20.3907	95.1125	31.2786
25	Paper and board	85.3788	83.6123	1.7666	80.9016	4.4772
26	Printing and publishing	88.3784	83.8097	4.5687	72.9316	15.4467
27	Other Manufacturing	90.8167	85.8266	4.9901	86.0894	4.7273
28	Construction	85.2625	82.1878	3.0747	75.7841	9.4784
29	Gas	93.1742	92.7327	0.4415	85.3596	7.8146
30	Electricity	88.1626	87.8166	0.3459	87.1297	1.0328
31	Water	98.6698	92.7842	5.8855	93.2222	5.4476
32	Rail	84.7460	81.3307	3.4153	74.9042	9.8418
33	Road	78.1239	74.9756	3.1484	74.4859	3.6380
34	Other Transport	95.9489	93.6919	2.2570	82.3833	13.5656
35	Communication	88.6131	83.8859	4.7272	73.7878	14.8254
36	Distribution	86.3651	85.2587	1.1065	78.9645	7.4006
37	Business services	73.5898	73.0020	0.5878	66.7217	6.8681
38	Professional services	96.8328	94.9893	1.8435	89.4515	7.3813
39	Miscellaneous services	80.8692	75.7834	5.0858	76.8708	3.9984

Notes

R is the restricted value of the minimised objective function (as in Tables 5.3-5.6),
U_1 is the value of minimised objective function with price homogeneity lifted,
U_2 is the value of the minimised objective function with additional explanatory variable in the wage eqns.

additional instruments used in the estimation. Hence, the feedbacks from industrial prices to demand, from output levels to employment and prices, and from wages to prices are explicitly acknowledged in the estimation. Further, the cross-equation restrictions implied by the joint determination of wages and employment in the face of "internal" pressures (shifting the labour demand curve) are also incorporated, imposing the restriction that the (q^e, k, y, and t) terms enter the wage equation in the same way as they enter the labour demand relation. The internal pressures are denoted INT = ($a_4q^e + a_5k + a_6y + a_7t$) in the descriptions of the estimated wage equations in Table 5.5.

The results described in Tables 5.3-5.6 represent the outcome of a relatively simple specification search. Given the number of estimated relations, it is not feasible to undertake a very detailed search for each of the industries in turn, so that the same specification has been estimated for every industry. This has the advantage that, in comparing estimated relationships, any differences found can be interpreted as resulting from different characteristics of the industries (rather of the estimated relations). Two sets of experiments were undertaken, however, to ensure that the general specification employed did not exclude possibilities that are important to many industries. Specifically, the price homogeneity of each system was investigated, and experiments on the inclusion of additional explanatory variables in the wage equation were considered. For these, a "quasi" likelihood ratio test was employed, comparing the values of the minimised objective function for each system under restricted and unrestricted conditions. (see Berndt and Jorgenson (1980) for details). For the systems described in Tables 5.3-5.6, the value of the minimised objective function is provided in Table 5.7, along with selected estimated statistics.

The test on price homogeneity is very important, of course, since the theory on which the model is based predicts such a property. Explicitly, price homogeneity in the labour demand equation requires $a_3=-a_4$ (so that wage levels relative to other input prices are relevant to the employment decision), while long run homogeneity in prices in the price equation requires $b_1 + b_2 + b_3 + b_4 = 1$ (so that an x% increase in all input prices should, other things being equal, generate an increase of x% in prices). These restrictions are expected to hold if the cost function is (reasonably) homogeneous in prices. On the other hand, while the theory underlying the model would suggest that unions are concerned with real wages, there remains the possibility that the wage equation is not homogeneous in nominal magnitudes because of the ambiguities of the determinants of the fallback wage. For this reason, no homogeneity restrictions have been imposed on this equation.

The price homogeneity restrictions described above have been imposed to obtain the system estimates presented in Tables 5.3-5.6 (so that no t-statistic is reported for the coefficient on q in the labour demand or price equations), while results obtained for the industrial systems estimated without price homogeneity imposed are given in Tables A5.3-A5.7 of the Appendix. The tests on the restrictions are summarised, however, in Table 5.8. These demonstrate that from the total of 38 industries, price homogeneity was accepted in 27, rejected at the 5% level in 8, and rejected at the 1% level in 3, where (R-U_1) is compared to $X^2(2)$.(8) One possible explanation for the rejection of price homogeneity in some industries might be based on the problems involved in the formation of the material input price measure. As I noted earlier, this was constructed from industrial price movements using weights obtained from a single input-output table (that of 1979). Since there may have been significant changes in the composition of material inputs into some industries over time, the constructed input price measure might contain inaccuracies, and these might be the cause of our failure to find homogeneity.(9) Given that the homogeneity restriction is accepted in the majority of industries, however, and given that the theory suggests so strongly that price homogeneity be imposed, the restricted estimates shown in Table 5.3-5.6 represent our preferred equations, and it is on these that subsequent analysis is founded.

The second set of experiments carried out to bring us to our preferred set of system estimates in Tables 5.3-5.6 involved comparison of these estimates with those in which an extended set of explanatory variables was included in the wage equation. This follows from our earlier discussion in which it was noted that, while there were many potential influences on the industrial wage (as shown in expression (5.14)), many of these would also influence the expected aggregate wage $\overline{w}^e$, so that they might not show independently of their influence on this aggregate measure in estimates of the industrial wage equations. The model search began therefore with all of the potentially influential variables included in the wage equation; this included, in addition to those shown in Table 5.5, the other elements of the wedge, and measures of union power and the replacement ratio. For each of these variables, there were some industries for which the addition of one of these extra variables significantly improved the fit of the wage equation. On the other hand, for those four variables that have been dropped, there were only ten occasions in all industries in which the variable was significant and of the expected sign, so that their exclusion seems justifiable. Once more there is a summary of the "quasi" likelihood ratio test statistics, this time testing for the joint significance of the four excluded variables, provided in Table 5.8, where (R-U_2) here is to be compared with $X^2(4)$. In this table we note that the exclusion restrictions are accepted in 24 of the 38 industries, rejected at the 5% level for 6, and rejected at the 1% level in 8 industries.(10) While this number of rejections may begin to raise questions on the validity of the imposed restrictions, the inclusion of any one of the excluded variables provided little overall improvement, while the inclusion of all of them reduced significance levels on all of the variables (because of collinearity) and, as explained above, added little to the economic interpretation of the results. The restricted results constituted the best set of estimates that could be obtained working with a single specification for each industry therefore.(11)

Having discussed at some length the estimation procedure employed to obtain the preferred set of system estimates, and noted the potentially difficult industries, I now turn to the estimates themselves to consider whether the coefficients obtained are economically sensible.

5.3 Discussion of results

As the discussion above made clear, one of the major difficulties in working with disaggregated data and its analysis is the problem of presentation and discussion of results: while it is generally possible to make broad statements about the direction of influence of a particular explanatory variable, for example, there are almost invariably some industries for which one statement or another is untrue, so that often the thrust of an argument is lost under a series of qualifications. Of course, finding 'exceptional' results in some industries does not invalidate the conclusions derived from the majority of results, since some variation is to be expected. The difficulties arise in assigning statistical significance to the unexpected results obtained. These difficulties were apparent above in the discussion on the specification search employed to obtain our preferred estimated systems. How many industries have to fail a test on a particular set of restrictions for the set to be abandoned, and what if these failures result from different subsets of the restrictions for each industry? These difficulties become still more apparent when considering the estimated coefficients across the 38 industries, and so in the following discussion I shall attempt to keep to a minimum the number of qualifying remarks, and instead provide an overview of the results obtained. A useful presentational device is employed in Chart 5.2 in which the "average" long run industrial employment, price, wage, and output relationships are set out. Long run coefficients (obtained by deflating the estimated short run coefficients by [1 - Σcoeffs. on ldvs]) are considered so as to abstract from the dynamic adjustments and to focus attention on the direction and order of magnitude of the different influences. The coefficients represent the mean of the long run coefficients calculated over the 38 industries (excluding some "outlying" industries to be defined below). The statistics in parentheses show the mean value of the t-statistics on the corresponding short-run coefficients, also calculated over these industries. These representative relationships demonstrate that, in general, the estimated coefficients are of the expected sign and are of a reasonable order of magnitude. However, there are a number of variables which show significantly in only some industries, and others for

Chart 5.2

Summary of industrial systems

$n_{it} = a_0$	$- 0.31\ w_{it}$	$+ 0.31\ q^e_{it}$	$- 0.41\ k_{it}$	$+ 0.84\ y_{it}$	$- 0.01\ t$
(s.r. t)	(2.05)	(-)	(0.79)	(4.95)	(0.10)
$p_{it} = b_0$	$+ 0.33\ w_{it}$	$+ 0.67\ q^e_{it}$	$- 0.37\ k_{it}$	$+ 0.03\ y_{it}$	$+ 0.01\ t$
(s.r. t)	(2.89)	(-)	(0.70)	(0.27)	(0.26)
$w_{it} = c_0$	$+ 0.82\ \overline{w}^e_t$	$+ 0.40$ INT	$+ 0.85\ unr_{it}$		
(s.r. t)	(2.52)	(0.53)	(0.43)		
		$+ 0.011$ inc	$+ 0.06\ \overline{p}^e_t$	$- 0.03\ t2$	
		(0.89)	(0.56)	(1.17)	
$y_{it} = d_0$	$- 0.11\ (p_{it} - \overline{p}^e_t)$	$+ 0.19\ (pm_{it} - \overline{p}^e_t)$	$+ 1.82\ \sigma$	$+ 0.03\ t$	
(s.r. t)	(0.77)	(2.50)	(2.59)	(2.88)	

Coefficients represent the mean long run coefficients obtained across the industrial results of Tables 5.3-5.6. The values in parentheses are the mean t-values on the corresponding (short run) coefficients.

which there is contradictory evidence on the direction of influence. This shows in some of the low average t-values reported. The wide diversity of results obtained warrants some attention, and the individual equations are therefore considered in more detail below.

The labour demand, price and output equations

Looking first to the estimated labour demand equations presented in Table 5.3, it is noted that the estimated relations are generally of the form that might be expected. A negative coefficient is obtained on the wage term in 31 of the industries, 23 of which are significant, while none of the 7 positive coefficients are significant. Negative coefficients are obtained for the capital stock in 25 industries (20 significant), while 7 of the (unexpected) 13 positive coefficients are significant. This variable is strongly trended for many industries and may interact with the time trend therefore. Indeed, of the 23 industries for which the time trend shows significantly, only 7 have a negatively signed coefficient, and 5 of these coincide with one of the significantly positive capital stock coefficients. Finally, output levels show extremely strongly in the labour demand equations, taking a positive coefficient in 33 industries, and of these 29 are significant. Hence the direction of influence is by and large as we would expect in these equations, and as predicted by theory.

The inclusion of the second lagged dependent variable in the labour demand equations is important in 17 industries; 15 take a negative sign, implying that there are non-trivial dynamic adjustments underlying these equations. It is noted here that the (absolute value of the) sum of the coefficients on the lagged dependent variable lies comfortably between zero and one for most industries. However, industry 2 (Coal mining) shows dynamic instability with the sum of its coefficients exceeding one, while industries 1 (Agriculture), 15 (Elec. Eng.), and 36 (Bus. Serv.) have coefficients whose sum is relatively large (exceeding 0.8).

To provide an overview of these results, and also to see the variability in the results that have been obtained across industries, the estimated (long run) elasticities obtained in Table 5.3 are summarised in three histograms in Figures 5.1-5.3. Hence, in Figure 5.1, the long run employment elasticity with respect to wages, given by the estimated value of $a_3/(1-a_1-a_2)$, have been calculated for each industry, and the industry has then been classified to one of eight intervals to form a distribution of industries. In this case, the histogram classifications cover the interval [-1.26,0.64], which has been estimated to include all elasticity values lying within three standard deviations of the mean elasticity. Those elasticities which lie outside this interval have been classified as outliers, being industries with extreme values for a_3, or with coefficients on the lagged dependent variables which are, in sum, close to one, so that the long run elasticity is very large. These industries are noted at the head of each histogram, and are classified into the

Fig 5.1 Long run employment elasticity wrt wages

Mean:
-0.72671
-0.31015 (Dropping outliers)

Outliers include
2 2.21272
15 -2.89935
21 -2.48741
36 -13.89580

4	2	6	7	10	7	1	1
				38			
				35			
				34			
			31	33	39		
		32	28	22	37		
		30	27	19	29		
36		26	18	14	24		
21		25	17	7	20		
16	13	23	10	6	12		
15	3	8	9	5	11	1	2

-1.26 -1.02 -0.78 -0.55 -0.31 -0.07 0.16 0.40 0.64

Fig 5.2 Long run employment elasticity wrt capital

Mean:
-1.16016
-0.41235 (Dropping outliers)

Outliers include
1 -5.15812
2 6.87800
15 -5.97258
32 14.69401
36 -41.33223

3	3	4	9	10	5	1	3
				38			
			35	37			
			28	29			
			27	23			
			19	22			
			17	20	33		
		39	16	18	24		
36	31	34	14	13	11		32
15	26	30	10	12	9		25
1	21	3	6	8	5	7	2

-3.68 -2.87 -2.05 -1.23 -0.41 0.41 1.22 2.04 2.86

Fig 5.3 Long run employment elasticity wrt output

Mean:
1.69734
0.83509 (Dropping outliers)

Outliers include
1 -4.49853
2 -3.19184
15 4.62212
36 39.17383

2	1	7	12	6	3	5	2
			33				
			25				
			24				
			23				
			20				
		38	16				
		37	14	28			
		34	13	26		39	
		29	12	19		32	
		18	11	17	35	30	
2		9	10	8	31	27	36
1	7	6	3	5	22	21	15

-1.52 -0.93 -0.34 0.25 0.84 1.42 2.01 2.60 3.19

most extreme intervals in the histograms. Also provided at the head of each histogram is the mean long run elasticity, estimated once with all 38 industries, and once excluding the outlying industries. Hence in Figure 5.1 we see that the distribution of wage elasticities is (vaguely) normal-shaped, with a peak occurring in the interval [-0.31,-0.07], but with considerable variability also displayed. The mean elasticity obtained with all 38 industries is -0.73, but this value is dominated by the estimated elasticity from industry 36 (Bus. Serv.), whose value of -13.90 results from the estimates of the coefficients on its lagged dependent variables, the sum of which, as noted earlier, lie close to one. Excluding the outlying industries, we obtain a mean elasticity of -0.31. This figure is in line with that found in LPP (1990a,b), as described earlier, and is particularly interesting in view of the estimates of the wage elasticities of labour demand obtained in more aggregate studies, which have generally been higher than those reported here. As noted previously, the average disaggregated wage elasticity found in LPP was shown to be significantly lower than that obtained from a corresponding aggregate equation. Further, it was also significantly smaller than unity, which is important since many recent studies carried out at the aggregate level have come to a concensus view in which the long run wage elasticity is thought to be around this level (see, for example, the discussion in H.M. Treasury (1985)). There is good evidence, therefore, that the heterogeneity in wage elasticities across industries illustrated in Figure 5.1 will generate significant aggregation biases in work carried out at the aggregate level. Certainly, these results confirm that further attention should be paid to the issue of aggregation in this context, especially given the significance that some policy-makers currently attach to wage adjustment in searching for a solution to unemployment.(12)

Figures 5.2 and 5.3 show similar results for the elasticity of labour demand with respect to capital stock and output movements. Again, the distribution of estimated coefficients is uni-modal, centered around an elasticity which is correctly-signed and which is of a reasonable order of magnitude. In both cases, the mean elasticity obtained with the outlying industries omitted provides a sensible statistic, taking a value of -0.41 and 0.84 for capital and output elasticities respectively. Here too, however, there is considerable variability between industries, as the histograms, generated to cover three standard deviations either side of the mean, are required to cover the intervals [-3.68,2.86] and [-1.52,3.19] for capital and output elasticities in turn.

The price equations described in Table 5.4 are also by and large as we might anticipate from the theory. The estimated long run elasticities here are presented in Figures 5.4-5.8, showing in turn the elasticity of prices with respect to wages, other input prices, capital, and output. (Obviously, since price homogeneity has been imposed, Figures 5.4 and 5.5 simply provide a mirror image of each other). As mentioned

Fig 5.4 Long run price elasticity wrt wages

Mean:
0.19071
0.32915 (Dropping outliers)

Outliers include
5 -1.97894
12 -2.62359

2	1	5	7	8	10	1	4
					39		
					34		
				38	33		
			36	31	26		
			32	29	23		
		30	27	28	15		
		25	19	20	14		37
		16	17	18	13		24
12		8	10	11	9		22
5	21	3	7	6	1	35	2

-1.21 -0.87 -0.54 -0.21 0.12 0.45 0.78 1.11 1.44

Fig 5.5 Long run price elasticity wrt material prices

Mean:
0.80929
0.67085 (Dropping outliers)

Outliers include
5 2.97894
12 3.62359

4	1	10	8	7	5	1	2
		39					
		34					
		33	38				
		26	31	36			
		23	29	32			
		15	28	27	30		
37		14	20	19	25		
24		13	18	17	16		
22		9	11	10	8		12
2	35	1	6	7	3	21	5

-0.44 -0.11 0.22 0.55 0.88 1.21 1.54 1.87 2.21

Fig 5.6 Long run price elasticity wrt capital

Mean:
-0.00361
-0.37030 (Dropping outliers)

Outliers include
5 6.51555
24 6.67808

2	1	5	14	9	2	2	3
			39				
			29				
			28				
			23				
			22				
			21	38			
			20	36			
			19	35			
			18	33			
		16	17	30			
		13	15	27			
		8	14	11			25
34		7	10	9	37	31	24
32	6	2	3	1	26	12	5

-3.98 -3.02 -2.07 -1.11 -0.15 0.80 1.76 2.72 3.67

Fig 5.7 Long run price elasticity wrt output

Mean:
-0.10735
0.03607 (Dropping outliers)

Outliers include
5 -3.10412
7 -2.27390

2	2	4	8	12	6	2	2
				34			
				31			
				28			
				26			
			39	20			
			38	19			
			25	18	37		
			23	17	36		
		33	14	15	32		
		29	9	13	30		
7	35	27	6	11	24	8	22
5	1	16	3	10	21	2	12

-1.57 -1.19 -0.82 -0.44 -0.07 0.31 0.68 1.06 1.44

previously, the high correlation between wages and other input prices means that the estimates of the coefficients on these may be unreliable(13), and in fact we note that in 14 industries, one or other of the estimated coefficients on these variables are negative. On the other hand, as we see from Figures 5.4 and 5.5, the mean long run wage and material input price elasticities are (excluding outliers) 0.33 and 0.67 respectively; these are very reasonable figures and demonstrate well the relative importance of labour and non-labour inputs to the value-added at each stage of the production process.(14)

Once more, the estimated coefficients on the capital stock in the equation are influenced by the correlation between this variable and the time trend; of the 38 industries, 24 have a negative coefficient on the capital stock (11 significant), while 14 have an (unexpected) positive coefficient. However, of these only 8 are significantly different to zero, and 7 of these are in industries in which the time trend takes a significantly negative coefficient.

More interesting are the estimated coefficients on the output term in the price equation. These have an ambiguous expected sign, because, while there may be upward pressure exerted on prices from increases in marginal costs through diminishing returns, these may be partially offset, or dominated, by changes in the markup of prices over marginal costs, which may move countercyclically. As it transpires, the results of Table 5.4, illustrated in Figure 5.7, indicate that both influences are important, with their relative significance differing between industries to provide some degree of variability in estimated coefficients. The overall spread of the histogram, covering three standard deviations either side of the mean, ranges from -1.57 to 1.44, and 20 of the industries take a positive coefficient, while output shows negatively in 18. However, among these, there are only 20 significant coefficients (7 positive, 13 negative), so that the offsetting influences of the cycle on prices are self-cancelling in nearly half of our industries. In this sense, then, real rigidities in pricing behaviour are very significant, since, with input prices given, industrial prices on average appear to be unresponsive to demand shifts. Cyclic effects were found among the determinants of *expected* aggregate prices (in Table 5.2), but these feed into wage determination, and industrial prices are not influenced by this means. As was discussed with reference to Blanchard's (1987) paper in chapter 2, the effects of nominal rigidities on supply side adjustment will be exacerbated by this lack of responsiveness and the policy interventionist's case thereby strengthened.

Skipping to the output demand equations in Table 5.4, and summarised in Figures 5.8-5.11, we obtain once more a set of reasonable equations. As noted previously, industry 18 (Aerospace) performs very badly, providing no explanation for output demand in this industry, and we note here that industries 13 (Mech. Eng.) and 30 (Electricity), are also problematic in that their estimated equations are unstable (taking coefficient values of

Fig 5.8 Long run demand elasticity wrt relative prices

Mean:
-1.12204
-0.11030 (Dropping outliers)

Outliers include
13 -26.98085
16 -3.50866
28 -3.86848
30 -4.52973

4	1	5	8	12	4	2	2
				39			
				37			
				26			
				24			
			35	20			
			34	17			
			33	12			
		38	31	10			
30		29	23	7	36		
28		25	22	6	14		
16		9	21	5	8	32	19
13	27	3	11	1	2	15	18

-2.73 -2.13 -1.52 -0.92 -0.32 0.29 0.89 1.49 2.09

Fig 5.9 Long run demand elasticity wrt import prices

Mean:
0.25642
0.19383 (Dropping outliers)

Outliers include
13 2.57222

1	3	13	7	7	4	1	2
		39					
		37					
		35					
		32					
		31					
		27					
		19	34	38			
		16	29	25			
		15	26	24			
		5	23	20	33		
	36	3	22	14	21		
	18	2	12	10	11		17
30	7	1	6	8	9	28	13

-0.24 -0.11 0.01 0.13 0.25 0.37 0.49 0.61 0.74

Fig 5.10 Long run demand elasticity wrt aggregate demand

Mean:
4.37141
1.81848 (Dropping outliers)

Outliers include
13 112.53204
30 -11.88373

2	1	5	11	11	4	2	2
			36	39			
			35	34			
			33	32			
			31	29			
			27	26			
			10	25			
		38	9	24			
		37	8	23	22		
		19	7	15	20		
30		17	5	12	11	21	28
16	18	2	1	6	3	14	13

-4.25 -2.73 -1.22 0.30 1.82 3.34 4.85 6.37 7.89

0.98 and 1.06 on their respective lagged dependent variables). The explanatory variables in the equations perform generally as expected, however: 24 industries take a negative coefficient on the relative price term, $p/\bar{p}$, 17 of which are significant, although there are also 15 positive coefficients (7 of which are significant). Still more clear is the importance of international price competition and aggregate demand levels, with mean long run elasticities of 0.19 and 1.82 respectively. The price of foreign industrial output (relative to $\bar{p}$) shows positively in 36 cases, 27 of which are significant, while the deviations from trend gdp, σ, takes a positive coefficient in 34 industries, 23 of which are significant. In neither case are there any wrongly-signed coefficients which are significant.

The wage equations

Finally we turn to the estimated wage equations, which in some ways are the most interesting set of results, providing direct insights into the relative importance of the different influences on wage-setting behaviour discussed earlier, and therefore shedding light on the possibilities open to government to influence wages and hence unemployment rates. As the discussion of chapter 2 and the model derivation of section 5.1 above demonstrate, two (possibly complementary) sets of influences on wage-setting can be identified working within the framework of a labour market model in which trade unions are important. The first set of influences are those "internal" to the firm which directly affect the circumstances in which wage bargaining takes place. Changes in material prices, in available capital, in the demand for the industry's output or in productivity will affect the firm's demand for labour, and hence the constraint subject to which the union negotiates a wage to maximise its utility. The influence of internal pressures is captured here by the INT variable ($= -a_3q + a_5k + a_6y + a_7t$). The second set of influences are those generated outside the firm ("external" influences). Within this classification, three categories of influence have been mentioned. First, there are outside influences exerted on a union's wage-setting behaviour via the direct effect these have on the union's utility function. These include, for example, the effect of changes in the aggregate price level, or in one or more of the components of the 'wedge', which affect directly the real consumption wage from which unions derive utlity. Secondly, there are influences exerted on the reference wage which is of importance because of comparability considerations. Significant among these are, for example, variables determining the opportunities available to union members outside their own industry (this influence relates to expression (5.11.1) in the previous section). And thirdly, there are the external factors which influence the bargaining stance of the firm and union, affecting their fallback positions in the bargain and their relative bargaining strengths (these relate to the expression of (5.11.2) and (5.11.3)). It will be difficult to discriminate between the relevance of these three categories in terms of the variables which show significantly in the estimated industrial wage equations, because there is no clear one-to-one correspondence between the variables and the categories of explanation, but certainly some insights on their relative importance can be gained.

Looking to Table 5.5 and Figures 5.11-5.16, it is clear that, in the split between internal and external pressures, it is the latter which have performed most satisfactorily in explaining industrial wages. Figure 5.8 demonstrates that, excluding the outlying industries, the mean estimated coefficient on the "insider" variable is around 0.4, so that, on average, it takes its expected positive sign. However, of the 22 industries which take a positive coefficient on this variable, only 7 are significantly different from zero, which compares to 5 significant coefficients out of 16 which take (unexpected) negative coefficients. On the basis of these results, then, one could argue that the influences on wages that are internal to the firm in fact generate only weak pressures on industrial wage settlements.(15)

In contrast, the variables entered to capture the external influences on wages have performed relatively well. As mentioned in the last section, a variety of potential external influences were considered at the outset, but those that failed to contribute to the fit of the equations were dropped in a specification search to leave the five external influences $\overline{w}^e$, INC, unr, $\overline{p}^e$, and t2. Of these, $\overline{w}^e$ clearly provides the single most important explanatory variable in the industrial wage equations: this variable shows positively in 36 industries (24 significantly), and has a mean long run elasticity of 0.86. The incomes policy variable, INC, also performs well, taking its expected positive sign in 30 industries (10 significantly). Given that the effect of policy on expected outside wages is already accommodated in the $\overline{w}^e$ term, this variable reflects differences in the extent to which wage-setters believe the policy can, and will, be enforced in their industry relative to the labour market as a whole. Hence, for example, we might expect the industries with strong government links to be more likely to impose wage restraint during periods of policy than those in which production takes place in many small firms (where policing the policy is most difficult).

The local unemployment rate term, unr, performs rather disappointingly on the whole; the coefficient on this variable is insignificantly different to zero in half of the industries, and of the remaining 18, 10 take the expected negative sign while 8 take a positive sign.(16) While different results might be obtained using more complicated unemployment measures, taking into account the long term unemployed, for example, these results indicate that the most important influence on wages from the unemployed is through the aggregate unemployment rate, which generates a depressing effect on expected aggregate wages levels, and that local unemployment rates generally fail to exert significant downward influence. Since only changes in the unemployment rate showed in the equation explaining the formation of aggregate wage expectations, the model also

Fig 5.11 Long run wage elasticity wrt aggregate wages

Mean:
0.88361
0.82423 (Dropping outliers)

Outliers include
6 3.08085

2	5	9	10	5	4	2	1
			36				
		35	30				
		28	29				
		25	27				
		23	26				
	38	22	24	39			
	20	19	21	34	32		
	15	14	16	31	18		
37	12	13	10	9	17	33	
3	11	2	5	7	8	1	6

-0.32 0.02 0.36 0.70 1.03 1.37 1.71 2.05 2.39

Fig 5.12 Long run wage elasticity wrt internal pressure

Mean:
0.42076
0.39994 (Dropping outliers)

Outliers include
1 12.47973
6 -10.93160
7 6.72421
26 -5.88132

2	1	7	12	9	2	1	4
			35				
			31				
			30				
			29	36			
			28	32			
		34	27	25			
		33	23	24			
		12	22	20			
		11	21	16			39
		9	19	14			37
26		8	10	13	18		7
6	17	5	2	3	15	38	1

-3.44 -2.48 -1.52 -0.56 0.40 1.36 2.32 3.28 4.24

Fig 5.13 Long run wage elasticity wrt incomes policy pressure

Mean:
0.00852
0.01083 (Dropping outliers)

Outliers include
1 -0.07729

1	1	6	11	8	2	7	2
			39				
			37				
			23				
			21	36			
			16	34		31	
		38	15	33		30	
		35	13	28		20	
		29	10	27		17	
		19	9	22		12	
		18	6	11	24	8	26
1	32	5	3	2	14	7	25

-0.04 -0.03 -0.02 -0.01 0.01 0.02 0.03 0.04 0.05

Fig 5.14 Long run wage elasticity wrt unemployment rate (local)

Mean:
2.50927
0.85276 (Dropping outliers)

Outliers include
1 68.81334
8 -26.24297
25 -22.54251
26 47.18324

3	1	6	8	10	6	2	2
				34			
				33			
			24	32			
			23	28			
		39	22	21	38		
		36	20	18	35		
		31	16	13	29		
25		27	14	7	19		
9		15	12	5	11	30	26
8	37	2	10	3	6	17	1

-16.68 -12.30 -7.91 -3.53 0.85 5.24 9.62 14.00 18.39

Fig 5.15 Long run wage elasticity wrt aggregate prices

Mean:
0.00820
0.05960 (Dropping outliers)

Outliers include
1 -1.89372

1	4	0	6	6	9	9	3
					35	25	
					30	24	
					28	23	
			39	38	27	22	
			34	36	21	14	
	33		31	29	15	12	
	32		19	26	13	11	37
	18		17	16	10	3	20
1	6		7	5	9	2	8

-1.51	-1.20	-0.89	-0.57	-0.26	0.05	0.36	0.68	0.99

Fig 5.16 Long run wage elasticity wrt direct tax rates

Mean:
-1.37777
-1.31045 (Dropping outliers)

Outliers include
1 6.64518
26 -11.82447

1	6	2	4	16	8	0	1
				36			
				35			
				34			
				33			
				31			
				29			
				27			
				25	39		
				22	37		
	20			21	32		
	19			16	18		
	17		30	15	9		
	12		24	10	8		
	11	28	23	5	7		
26	3	14	13	2	6		1

-7.56	-6.00	-4.43	-2.87	-1.31	0.25	1.81	3.38	4.94

incorporates an element of unemployment hysteresis, and emphasises the role of expectation formation in explaining this phenomenon.

Finally among the external influences on wages, we note that $\bar{p}^e$ and t_2 show significantly in a number of industries. The variable t_2 takes its expected sign in 31 industries (18 significantly) showing the direct tax rate to be an important determinant of wages at the industrial level.(17) The expected aggregate price, $\bar{p}^e$, does not appear to perform very well in the results reported in Table 5.5, taking its expected sign in only 23 industries (12 significantly), but this can partly be explained by its strong correlation with $\bar{w}^e$, and certainly its exclusion from the equations reduces the fit of the system (as measured by the objective function) in very many industries.

To take an overview of the results of the wage equations, then, it appears that in most industries, external influences generally outweigh internal ones. Moreover, while we recognise that there is some ambiguity in interpreting the results, the performance of the incomes policy variable, set against the poor performance of the local unemployment variable suggests that, among the external influences, comparability considerations might be more important than competitive pressures across sectors.

5.4 Concluding comments

The work described in this chapter provides us with a tool for the analysis of a variety of issues involving the supply side of the economy, as well as illuminating some issues in its own right. The theoretical background to the model has been clearly set out, and its advantages and disadvantages noted. In particular, it was recognised that the theoretical description of the model is based at the level of the firm, while the empirical work has been conducted at the industrial level. The validity of this procedure is by no means obvious, as the conditions for perfect aggregation are unlikely to be satisfied. In these circumstances, we must be cautious in interpreting coefficients in the estimated model, as they will not have a one-to-one correspondence with the true elasticities that would be obtained in estimations at the level of the decision maker. One illustration of the importance of these qualifications was provided by the estimated elasticities of labour demand with respect to wages, which were seen to be somewhat lower in the estimated industrial equations than are generally achieved in more aggregated relations. If this finding results from some aggregation bias, then it is possible that bias from this same source arises in moving from the level of the firm to the more aggregate industry level too.

It has also been noted that the structure of the model has been imposed on the data, rather than tested against a series of alternative models of the supply side. Obviously this is a little unsatisfactory, and each of the four equations of each industrial system could be replaced with an alternative specification, based on a different view of the way in which the employment, pricing, wage-setting, or output decisions are made. On the other hand, there are advantages to be gained from estimating a system based on a single consistent framework, as carried out here. In particular, it has been possible to incorporate important cross-equation restrictions in the estimation of the system (such as those involving exogenous shifts in the labour demand equation, which also influence wages), as well as the feedbacks from one equation to the another. Moreover, the system itself is a fairly general one, incorporating as a sub-model many of the alternative specifications that might be proposed. (For example, it is noted by Layard and Nickell (1985), that the model allows for the influence of both "Classical" and "Keynesian" unemployment, because of the incorporation of imperfect competition and the sensitivity of the price markup to demand change). So, while the model has indeed been imposed on the data, it appears to be sufficiently general for it to accommodate a wide range of views on the functioning of the supply-side, and it provides a fairly broad framework within which to compare these opposing views and to investigate further some of the properties of the industrial systems and their interactions.

The results themselves showed the model to be fairly robust, performing well in most industries. As is sure to be the case when estimation involves around 160 equations and 700 variables, there are some results which are not anticipated, some of which cannot be explained. (For example, while the interaction between highly correlated, trended variables provides an explanation for some of the unexpected results, the positive relative price effect obtained in some of the industries' output demand equations remains unexplained). However, the fit of the equations is very good in most cases, and the estimated coefficients are generally of the expected sign and order of magnitude.

Most interesting of the estimated results are those of the industrial wage equations in which two sets of influences are incorporated. Of the two, the internal, industry-based explanatory variables performed disappointingly compared to the external variables. This is in contrast to the results of, for example, Blanchflower and Oswald's (1987) or Nickell and Wadhwani's (1989) analyses of survey data in which internal features, such as profitability and productivity, appeared to be the most important influences on pay bargaining in a large sample of British firms. The strength of the external variables' performance in our analysis does not, however, necessarily point to the existence of a classical competitive model of the labour market, in which free mobility of an homogeneous workforce works towards the gradual elimination of pay differentials between sectors. Rather, having worked through the wage-setting process within a union-based framework, it has been argued that these external pressures may influence pay claims through their effect on the industries' "reference wages", the derivation of which may be an extremely complicated affair. Certainly, we have argued that the alternative wage, available outside the industry, may be important, and of course this would become very important in a perfectly competitive labour market. On the other hand, the issue of comparabilities has also been raised, and the influence of the framework and background against which bargaining takes place has also been noted. The good showing of the incomes policy variable relative to the local unemployment rate variable perhaps indicates that an "institutional" view of the labour market, stressing comparabilities, may have the more important role to play in understanding wage-setting behaviour than a view which emphasises the effects of competition in the labour market. However, by far the clearest source of influence on industrial wage setting came through the expectations on the aggregate wage level. This finding highlights the importance of understanding the process by which agents' aggregate wage expectations are formed, and in particular the way in which the effects of disaggregate wage setting decisions accumulate to influence this process. Certainly, this study provides good evidence to reassert the significance of wage-wage comparisons in wage bargaining.

These results have implications for our earlier discussion, in chapter 2, on the causes of real wage rigidities and the policy prescriptions necessary to eliminate them. In this discussion, it was noted that expansionary policy, for example, may generate upward pressure on real wages, both internal to the firm, by increasing the demand for the industry's product, and external to the firm, by raising inflationary expectations or by reducing unemployment. The policy interventionist's case is strengthened to the extent that labour market institutions close down these paths of influence.

There were a variety of explanations provided in chapter 2 for why internal pressures may not result in real wage adjustment, and obviously, in the light of the poor showing of INT in the estimated wage equations, the results obtained here provide these with some credence. Among these, we noted the argument, best illustrated in McDonald and Solow's (1981) paper, in which "non-market" influences on the labour market (such as a convention of "fair shares") may react to offset changes in labour market conditions to keep the real wage relatively constant. Equally, the presence of a group of insulated "insiders", responsible for wage setting decisions, may result in real wage rigidity as the union's behaviour is dominated by the desires of this privileged group (papers by Carruth and Oswald (1986) and Borooah and Lee (1987) are cited to describe rigidities of this form). Clearly, given the poor showing of INT, the results obtained here are perfectly consistent with the belief that real wage rigidities may exist because of these sorts of bargaining procedures and labour market institutions.

Two explanations were considered for why rising unemployment may not generate downward pressure on real wages. The first also called on the idea of the presence of "insiders". Because of their superior position in terms of on- the-job training, these insiders may have no incentive to take into account the growing number of potential entrants to their industrial workforce among the unemployed. Alternatively, it was argued that real wage stability might be observed in the presence of high unemployment if a large proportion of these are long-term unemployed, who effectively drop out of the labour market and cease to influence the alternative wage. Again, the poor showing of the unemployment rate, and indeed the presence of a positive coefficient on this variable in some industries, provides some support for these arguments.

Given the strength of the influence of expected aggregate wages in the industrial wage equations, however, it might be argued that the "kinked" indifference curve scenario, associated with Oswald (1986), has been given most significance by the results obtained here. In this, wage rigidities will become more pronounced as aggregate wage expectations, around which aspirations may be formed, become less responsive to demand change. As it turns out, the clearest influence of aggregate demand shifts on wage setting comes through their impact on aggregate wage expectations, as shown by the significance of σ in Table 5.2. However, the presence of lagged variables in this Table also demonstrates the significance of informationally-inexpensive, but backward-looking data in expectation formation. If the responsiveness of wages to output is to be improved, therefore, it would appear that policy directed at the area of expectation formation and wage guidelines (as discussed in sections 2.5 and 2.6 with reference to Taylor's (1983a,b) and Meade's (1981) papers) might be most profitable.

There clearly exists some scope for developing the ideas raised above, working within the framework that has been set up. In particular, direct measures of wage expectations (such as those derived from questionnaire data, as in Carlson and Parkin (1975), for example) would provide a more reasonable indicator of $\bar{w}^e$. This would enable us to accommodate some of the less-easily-measured influences on expectations in the industrial wage equations, and might allow some of the influences already included in the equations (which currently also help generate $\bar{w}^e$) to show more strongly. Another development which will not be pursued here is the possibility of "explaining" the distribution of coefficients obtained in these estimated equations in terms of the characteristics of the bargaining process and the structure of production in the different industries. So, for example, I mentioned above two of the characteristics of an industry which might be important in explaining the responsiveness of wages to incomes policy in different industries (as captured by the coefficient on INC). In the same vein, and perhaps more interesting, might be an investigation of the characteristics of those industries for which the "insider-outsider" or the "comparability-based" explanations of wage-setting gain support. For example, we might expect that the "insider-outsider" scenario is more likely to hold either where there is a single strong union covering all of the employees in an industry, or where it is relatively difficult to replace the existing workforce with new entrants, in industries involving a good deal of training, for example. If we could classify industries according to these characteristics, therefore, we could then investigate whether there exists an association between industry with these properties and those with large coefficients on the variable INT. This would provide an obvious (indirect) test of the hypothesised description of wage-setting. While involving some considerable work in deriving and measuring accurately the characteristics of an industry's bargaining and production processes, this extension to the work described here could provide us with valuable insights into the validity and usefulness of the theory underlying the models. Certainly it is clear from the empirical work that a more complete understanding of the formation of union aspirations, and of the influences on aggregate wage expectations, demands an increased research effort through which to understand the true basis for wage-setting behaviour.

CHAPTER 6

Investigating Price Rigidities using the Industrial Dimension

In the following two chapters, the results of the disaggregated supply-side model are taken up to investigate directly the causes of rigidities in prices and wages. The analysis in each chapter will make use of the information that has been obtained by estimating the model across 39 industries, since these results both provide an extra dimension over which competing hypotheses on the causes of inertia can be examined, and also make it possible to identify the important interactions that exist between industries which may generate inertia. The analysis of this chapter concentrates on explaining the causes of price inertia, using the estimated price equations of the disaggregated model to obtain a measure of the degree of price inertia experienced in the different industries. There is then an attempt to explain these findings in terms of the nature and characteristics of the industries.

In section 2.2 of chapter two, it was noted how the existence of costs of adjusting prices could generate (possibly complicated) dynamic time paths for prices, and that there had been a variety of commentators suggesting possible sources for such costs. Despite this interest, however, there have been relatively few attempts to establish the relevance of these suggestions empirically, certainly compared to the work that has looked at wage inertia. An important exception to this generalisation, however, is Domberger's (1979) analysis of the influence of market structure on price responsiveness in a sample of twenty-one manufacturing sectors in the U.K.. In this, price inertia in each sector is measured by the size of the coefficient on the one lagged dependent variable (ldv) in an estimated price equation for the sector. These measures are then used in a second stage of the analysis in which the degree of price inertia is itself explained, through regression analysis, in terms of an index of industrial concentration for the sector and a dummy variable which captures the hypothesised distinction in the speed of price adjustment in engineering and non-engineering sectors.

Domberger's two stage procedure provides a direct means of comparing the price responsiveness of the different sectors, and of investigating the factors which effect this responsiveness, and so it is precisely this methodology that will be employed here. However, while the methodology is similar, the analysis differs in a number of important respects. First, it is noted that in order to allow for more complicated dynamics in the price equation, a second ldv has been allowed in the estimated industrial price equations of chapter five (a decision that was vindicated by the presence of a significant coefficient on this variable in 15 industries). In these circumstances, it is less clear how price responsiveness is to be measured; certainly it is not sufficient to consider only the coefficient on the first ldv, as used in the Domberger paper. A second obvious difference between the analysis here and that of Domberger shows in the level of disaggregation of the data used. Ideally, the work would be carried out at the level of the decision maker, looking at individual firms' decisions to change prices just as specific wage negotiations were considered in chapter four. Given that some degree of aggregation is necessary, however, it has to be recognised that there are difficulties involved in choosing an "optimal" level of aggregation, and that these difficulties will be compounded when looking at the dynamic adjustments of these aggregates (see, for example, Lippi's (1987) discussion of the problem of aggregation in modelling dynamic processes). Certainly there is no reason to expect that an intermediate level of aggregation, such as that used by Domberger, would be more appropriate than the industrial level employed here. In any event, it is noted that any aggregate of firms will bring together a (sometimes wide) diversity of products under a single classification, so that, by the nature of the data, only very broad comments about the characteristics of the industries can be made. In these circumstances, it is an advantage to have aggregates which cover as wide a spectrum of characteristics as possible, and from this point of view, the industrial data set used here, covering the whole economy, provides a very useful resource. Moreover, and this constitutes a third and most important difference between Domberger's analysis and that presented here, the wide coverage of the current data set will enable us to investigate rather more characteristics of the sectors, and their influence on price responsiveness, than was possible on his less diverse data.

It is the issue of the measurement of industrial characteristics that is addressed in the section below, recalling some of the suggested sources of price inertia noted in chapter two, and attempting to quantify these ideas in terms of measurable industrial characteristics. Section 6.2 provides an analysis of the relationships between these measures, and section 6.3 summarises the results obtained.

6.1 Quantifying industrial characteristics

As noted above, Domberger's (1979) analysis primarily considered the impact of industrial concentration on price responsiveness. In doing so, he attempted to discriminate between two diametrically opposed views. On one side, his own view is that industries with relatively few firms, or in which there are large dominant firms, experience low subjective costs of adjusting prices because of the ease of communicating pricing intentions, so that there is a positive link between concentration and responsiveness. On the other hand, the more traditional view, associated with the "administered price" hypothesis, argues that industries in which firms are not subject to the rigours of competition will demonstrate price inertia, as firms in these industries are able to engage in collusive action to avoid price competition and sustain relatively high profit levels. Domberger's results supported the former of these views, and obviously it is important to test this finding on the more aggregated data set used here.

To do this, various measures will be employed to capture the degree of market power enjoyed by firms in an industry. The first corresponds directly to Domberger's measure, and uses a weighted average of the concentration ratios (i.e. the proportion of an industry's output produced by the five largest firms in the industry) of the three-digit industries that make up the industrial classifications. These figures can be derived for the 22 industries in the manufacturing sector in any year from the Census of Production, and they are set out for two years, 1968 and 1979, in Table A6.1 of the Appendix (denoted "conc68" and "conc79" respectively). It is noted here that these variables give an indication of the degree of concentration in the 22 industries at a particular point in time. In fact, it is frequently observed that the 1970's was a period of extensive merger and take-over activity which may have caused the degree of concentration in each industry to alter significantly. If price responsiveness is indeed influenced by the degree of industrial concentration, then this merger activity suggests that the price setting relationships of the industries, represented by their price equations, will have changed over time, so that a single price equation would not be adequate to explain price behaviour over the whole period (tests of structural stability would investigate this possibility). This idea is pursued no further here, given that the primary interest is in inter-industry comparisons, rather than the time series behaviour of any particular industry, but this point does raise the issue of whether the industries can be unambiguously classed according to their degree of market power, or whether, through merger activity, for example, industries have changed in character over the period. As a partial answer to this question, one can compare the figures obtained for the two years in Table A6.1 to see whether there has been any significant re-ranking of industries over this important period. As it turns out, there is some evidence that concentration ratios altered during the period; the observed fall in concentration ratios supporting the stylised fact that the extensive merger activity of the 50's and 60's came to an end, and was reversed, in the mid-70's. However, this seems to have been an economy-wide experience, and relatively little re-ranking of industries occurred. Spearman's ρ for the two concentration measures, showing their rank correlation, is 0.893, so that it seems reasonable to argue that industries can be characterised as high or low concentration industries according to either of these measures.

In fact, the concentration ratios, conc68 and conc79, provided in Table A6.1, and derived directly from the Census data, may be misleading in the sense that they take no account of international trade considerations. This point is made clearly in Kumar (1985), in which a variety of adjustments to Census concentration ratios are considered in an attempt to investigate the influence of international trade on these ratios. Kumar concludes that the impact of trade on the reported concentration ratios is "far from unambiguous, and that in certain cases concentration ratios based on Census data may be misleading" (p. 125). For this reason, the measure of industrial concentration that will be used in the analysis is that given in Table A6.1 denoted "conc"; this measure takes up the 1979 Census concentration ratio, conc79, and adjusts for imports and exports to obtain a more accurate measure of domestic concentration (precise details of the adjustment are given in the Data Appendix).

Having eliminated the influence of foreign trade from the measure of industrial concentration, it is recognised that this influence must nevertheless be included in the analysis of the determinants of price responsiveness. In an open economy such as the U.K., few industries are completely without the threat of import penetration or competition over exports, so that consideration of domestic market conditions alone could miss important influences on overall market power. To capture the extent to which an industry is vulnerable to foreign competition, the ratio of imports and exports to total domestic demand ("imrat" and "exrat" respectively) will be used in the second stage of the analysis; as these ratios increase, so the vulnerability of the industry to international trade rises, and market power is reduced. The inclusion of these three separate measures (conc, imrat, and exrat) enables us to discriminate whether the different sources of competition have differential impacts on price responsiveness, and counter to some extent Winter's (1983) criticism of Domberger's analysis that important international influences on competition had not been included.

In view of the difficulties that have been outlined in the use of the above measures of market power, it might be that a measure which is more directly related to the production of an industry's output would provide a better indicator of the market structure of the industry. With this idea in mind, the industries' capital-output ratios will also be used as a possible explanatory variable in the second stage of the analysis; a high capital-output ratio represents a significant barrier to entry into an industry, so that these would be found in industries where firms hold a relatively high degree of market power.

It is clearly necessary to investigate the contribution of market power to the explanation of price inertia, given its importance in the historical debate. However, the discussion of chapter two makes it very clear that there are other potentially important determinants of inertia, and in particular, Gordon's (1982) discussion of the role of uncertainty in a world of many, heterogeneous products was noted. Gordon's arguments emphasise the ease with which information can be extracted from observable shocks and incorporated into pricing decisions when there is uncertainty; relatively high uncertainty will be associated with relatively sluggish price responsiveness. These ideas can be investigated in the two stage analysis by using (separate) measures of uncertainty over demand and over costs for the 22 industries. Of course, as discussed in chapter four, there is rarely an obvious measure of uncertainty, although the variability of the variable is often seen as a reasonable proxy. Here, then, relative demand and cost uncertainty will be measured simply in terms of the variance of nominal demand (output price*output) and of input costs over the sample period. Again, details of the construction of these variables are provided in the Data Appendix, and the variables themselves, denoted "vardem" and "varcost", are set down in Table A6.1.

Finally here, Gordon's, and subsequently Blanchard's (1983, 1987), comments on the importance of an industry's position in the chain of production as an influence on the speed of price adjustment in that industry are recalled. This influence has an ambiguous direction; Gordon's information-based ideas argue that producers of final goods will learn about change earliest, and therefore respond relatively quickly, while Blanchard's analysis emphasised the point that the price of final goods will be influenced by the costs of inputs that may have been produced substantially earlier, so that they will incorporate a larger element of inertia. Again the importance of these arguments can be investigated, this time using information contained in the input-output tables on the division of total sales between that going to other industries, and that going to satisfy final demand. The variable "prodpos" shows the proportion of output taken up by intermediate demand, so that a value close to zero indicates the production of final goods, while "primary" industries would take a value close to one. Again, details are provided in the Data Appendix and Table A6.1

Finally in this section, the measurement of industrial price inertia itself is considered. As noted in the introduction, this measure will be based on the coefficients on the ldv's in the estimated industrial price equations of chapter five. In the Domberger paper, there was a clear one-to-one correspondence between inertia and the one ldv in his estimated price equations; with this coefficient lying in the interval [0,1], it is obvious that price responsiveness is unambiguously lower as the coefficient approaches unity, since the weight on last period's price level rises, and past price decisions dominate. In the price equations of chapter five, however, there are two ldv's, and the measure of inertia is less clear-cut. Some justification was provided for the inclusion of two ldv's in section 2.2, where it was noted that a standard quadratic cost function could be generalised by the form

$$C = a(p_t - p_t^*)^2 + b(p_t - p_{t-1} - g_t)^2$$

Here, costs are incurred if the price level deviates from its target level, p_t^*, and if price growth, $p_t - p_{t-1}$, deviates from a trend growth rate, g_t. As an illustration, it was noted that if $g_t = p_{t-1} - p_{t-2}$, cost minimisation would generate a price equation of the form

$$\begin{aligned} p_t &= (a/(a+b)).p_t^* + 2(b/(a+b)).p_{t-1} - (b/(a+b)).p_{t-2} \\ &= (1-\phi)p_t^* + 2\phi p_{t-1} - \phi p_{t-2} \qquad (6.1) \end{aligned}$$

which captures the idea that a larger part of any adjustment in prices takes place relatively quickly to set up institutions which reduce the cost of successive growth. The dynamics of this equation are described by the roots of the corresponding characteristic equation, which are given by $\phi \pm \sqrt{(\phi^2 - \phi)}$. The expression in brackets is necessarily less than zero since ϕ lies in the interval [0,1], so that the roots are complex expressions, and one could expect to observe cycles in the time paths of prices in such an industry. More generally, the trend rate of price growth over which costs are incurred might be represented by a less obvious function of recent price growth (i.e. $g_t = g(p_{t-1}, p_{t-2}, p_{t-3},...)$), while from the discussion above, the target price level may itself also depend on recent price levels (i.e. $p_t^* = f(X_t, p_{t-1}, p_{t-2})$). For these reasons, some rather complicated price dynamics might be expected to be captured by the two ldv's in the estimated price equations, and this is indeed observed, with many industries showing cyclic adjustment, and some experiencing "overshooting". These considerations make the task of obtaining a single measure of price inertia very difficult indeed.

Table 6.1 provides a brief summary of the dynamic properties of the estimated price equations set out in Table 5.5 of the previous chapter. As this table demonstrates, industries can be classed into one of four groups, according to the value of the (two) roots of the associated characteristic equation. It is noted here that both roots must be less than unity in absolute value to ensure convergence in the time path of prices, and that this is true of all 38 of the estimated equations.(1) In 16 industries, the equations have two real and distinct roots; 2 of these have two positive roots, indicating that convergence will be monotonic, while the remaining 14 have one positive and one negative root. A great variety of movement is possible with these industries, therefore, although it is noted that in 11 cases the positive root dominates, so that the monotonic movement (eventually) swamps the improper oscillations generated by the negative root. This is not the case in industries 5 (Food), 9 (Petrol prds), and 27 (Oth Maunf), however, where convergence will be accompanied by rather unrealistic jumps around the new equilibrium. The remaining 22 industries each have complex roots to their characteristic equations, indicating that the time path of prices in these industries could be traced along a

Table 6.1

Dynamic properties of industrial price equations of Table 5.5

Industries with real and distinct roots ($\Delta > 0$)	5 (Food), 9 (Petrol Prds), 12 (Non-ferr.Mets) 14 (Inst Eng), 15 (Elec Eng), 17 (Motors) 18 (Aerosp.), 20 (Metal Gds), 23 (Bricks) 24 (Timber), 26 (Printing), 27 (Oth Manuf), 30 (Elec), 32 (Rail), 33 (Road), 39 (Misc.Serv)
of which:	
$\lambda_1 > 0, \lambda_2 > 0$	17, 33
$\lambda_1 < 0, \lambda_2 > 0$	5, 9, 27
$\lambda_1 > 0, \lambda_2 < 0$	the remainder
Industries with complex roots ($\Delta < 0$)	1 (Agric.), 2 (Coal), 3 (Mining), 6 (Drink), 7 (Tobacco), 8 (Coal Prds) 10 (Chems), 11 (Iron), 13 (Mech Eng), 16 (Ships), 19 (Oth Vehs), 21 (Textiles), 22 (Clothing), 25 (Paper), 28 (Constr), 29 (Gas), 31 (Water), 34 (Oth Trans), 35 (Comms), 36 (Distn), 37 (Bus. Serv), 38 (Prof.Serv)

Characteristic equation: $p_t + \alpha p_{t-1} + \beta p_{t-2} = 0$, where α = -(coefficient on p_{t-1} in Table 5.5), β = -(coefficient on p_{t-2} in Table 5.5)

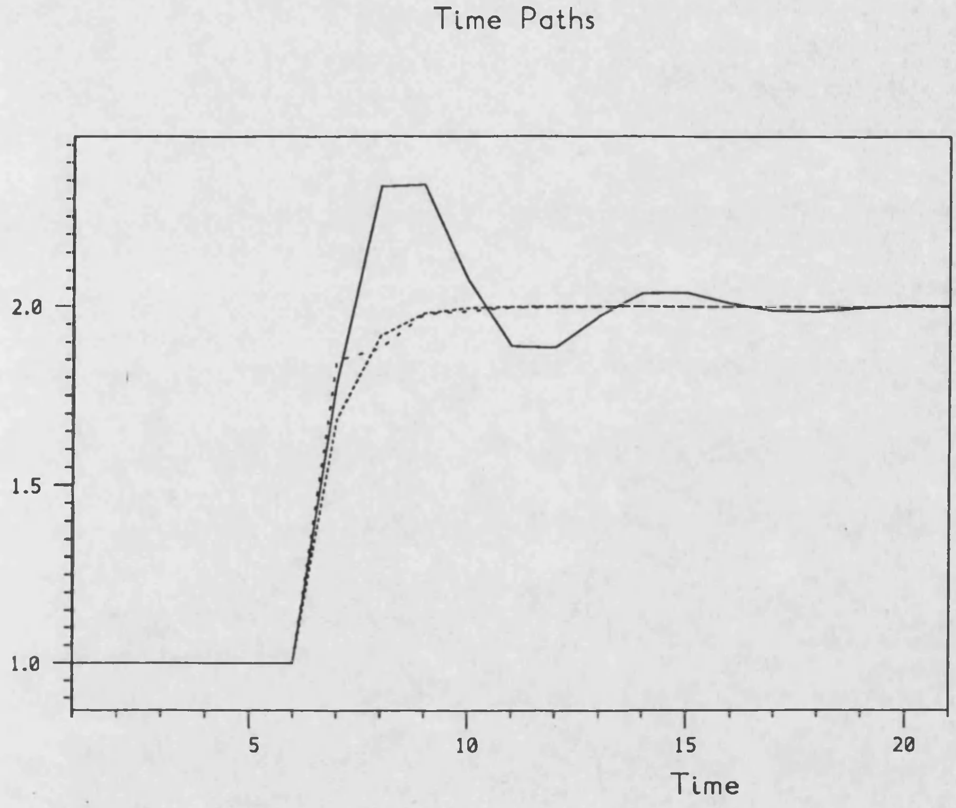
Discriminant = $\Delta = \alpha^2 - 4\beta$, and λ_1, λ_2 = roots of characteristic equation, λ_1 is the dominant root, i.e. $|\lambda_1| > |\lambda_2|$

sinusoidal function with damped oscillations.

An illustration of the different ways in which prices might evolve under these various dynamic forms is given in Figure 6.1, where the time paths of the price equations of three representative industries (industries 6 (Drink), 33 (Road), and 39 (Misc Serv)) are plotted. Working with the homogeneous price equation $p_t = b_1p_{t-1} + b_2p_{t-2} + (1-b_1-b_2)X_t$, where b_1 and b_2 are taken from Table 5.5, the time path of prices is shocked from its original level at an arbitrary point in time (denoted here as period 7), following a sequence of periods without shocks and in which $p_t = 1$ (i.e. $p_t= X_t= 1$, t=1,..,6). Ultimately, prices rise to a new equilibrium level of 2 ($X_t= 2$, t=7,...). The paths taken to converge on this new level vary considerably, however. The most easily interpreted time path is that of industry 33, whose immediate reaction to the increase in X_t is the slowest of the three industries. The characteristic equation for this industry has two positive roots, and the evolution of prices is therefore smooth; prices rise monotonically and at a diminishing rate (as would be obtained where there was just one ldv), and the vast part of the convergence to the new equilibrium has taken place within 3 periods. The time path of industry 39 is rather erratic in comparison, starting with the largest price rise of the three industries in the period of the shock, a sharp fall in the rate of growth in the next period, and a slight resurgence in the following period. This movement will be typical of the evolution of prices in those industries noted in Table 6.1 for which the characteristic equation has one positive and one negative real root. Here it is noted that ultimate convergence takes a little longer than in industry 33, despite the initial surge. Most dramatic amongst the three is the time path of industry 6, whose intermediate initial growth in the period of the shock continues into the next period to overshoot its ultimate equilibrium level. Prices fall over the next three periods, and the cycles continue until convergence is achieved after approximately 10 periods. This is precisely the sort of time path that might be expected where the characteristic equation corresponding to the industry's price equation has complex roots, as obtained above in the description of equation (6.1), for example. (In the case of (6.1), it can be easily shown that the price level will overshoot in the period following the shock if $\phi^2 < 0.5$; this might be reasonable in many cases).

Figure 6.1 illustrates clearly the idea that there are a number of possible alternative views of price responsiveness. The speed of adjustment of prices to the shock in the Figure might be judged in terms of the responsiveness of prices in the period of the shock only (i.e. the immediate response in period 7 in the above illustration), in terms of the adjustment in prices in the initial periods (say periods 7 and 8), or in terms of the speed with which convergence to the new equilibrium is achieved. In the case where there is only one ldv in the price equation, as in the analysis of Domberger described above, these three alternative views coincide. In this analysis, the character of the whole time

Figure 6.1



——— shows time path of industry 6
- - - - - shows time path of industry 33
— — — shows time path of industry 39

path of prices in a sector are captured by the coefficient on the one ldv, as both the size of the immediate change in prices following a shock and the rate of growth of prices in subsequent periods are fully represented by this one coefficient. In the more general case with two ldv's, however, these views do not coincide since in this case, as is clear from the Figure, prices in one industry can rise at a faster or slower rate than those elsewhere at different times, so that the appropriate measure of price responsiveness depends on the time horizon over which adjustment is considered. So, for example, for the three alternative views mentioned above, the ordering of the three industries considered here would be (32, 6, 33), (6, 33, 32) or (33, 32, 6) respectively.

In order to make use of the industrial price equations and to proceed with the analysis of the causes of price inertia, three possible measures of price inertia are considered for use in the second stage of the empirical analysis. These are set out below:

(i) π_{1i} = price inertia in industry i
= -(change achieved in the first two periods following a shock as a proportion of total adjustment)
$= -(1+b_1)(1-b_1-b_2)$

(ii) $\pi_{2i} = \Sigma_{t=T}^{\infty}(p_t - p_t^*)^2$ T = period of shock

(iii) $\pi_{3i} = \Sigma_{t=T}^{\infty}[1/(t-T+1)]\ (p_t - p_t^*)^2$ T = period of shock

In some sense, the first two of these set out the extremes of the measures that might be used. Measure π_1 emphasises the initial responsiveness of prices, concentrating on the adjustment achieved in the first two periods following a shock. This measure is intuitively sensible as inertia is equated with the stickiness of prices in moving from its initial equilibrium position in the face of a shock which requires adjustment. Measure π_2, on the other hand, concentrates on the convergence criterion, (i.e. the speed with which the new p^* is achieved), defining inertia in terms of the inability of prices to move to this new position. π_2 represents the opposite extreme in the sense that the industry's prices at all times following the shock, stretching infinitely into the future, are used in constructing the measure. Clearly, both of these measures have their appeal, and π_3 represents a compromise between the two. Again, the convergence criterion is used as its base, but here the contribution of the deviation of p_t from its new equilibrium is weighted according to the time passed since the occurrence of the shock (with declining weights 1, 1/2, 1/3, 1/4,...). Although the choice of weights here is *ad hoc*, it is clear that this measure raises the significance of the initial adjustments emphasised in π_1, so that one might expect π_3 to lie somewhere between this figure and π_2. In fact, for the 22 industries of the manufacturing sector, on which the empirical work of this section will primarily be based, Spearman's ρ can be calculated to obtain

$$\rho(\pi_1, \pi_2) = 0.594, \quad \rho(\pi_1, \pi_3) = 0.650, \quad \rho(\pi_2, \pi_3) = 0.947.$$

These are all significantly greater than zero (the critical value at the 5% level is 0.48, and is 0.61 at the 1% level), indicating that there is a close relationship between the ranking of the industries produced by the three measures. Further, the correlation coefficients between the measures are 0.725, 0.784, and 0.942 respectively, so that the measures show a close cardinal relationship too. On these grounds, then, the analysis described below uses the single "compromise" measure, π_{3i}, as the indicator of price inertia in the industries; although one must bear in mind the fact that this single measure emphasises particular aspects of the responsiveness of prices over time, and is not the only possible indicator, the evidence is that this measure provides similar figures, both quantitatively and qualitatively, to those of the alternative measures considered.

6.2 The analysis

The preceding discussion raises a variety of hypotheses which can be investigated econometrically. As the discussion makes clear, many of the ideas involved are very difficult to measure, and by their nature, therefore, may be more susceptible to qualitative rather than quantitative investigation. On the other hand, the measures described above do provide figures to which quantitative techniques can be applied, so that sole reliance on qualitative methods would waste information. In what follows then, a series of analyses which make use of both type of technique are presented, starting with a simple qualitative analysis which uses the measures as indicators of the character of the industries, and moving to quantitative methods which use the measures as they stand. In anticipation of the results obtained, it is noted at the outset that, in view of the character of the data, results obtained through qualitative methods are in some sense more reliable, since these are less dependent on the precision of the measures of the industrial characteristics that are used. However, such results are less clearly defined and are more limited in the questions that they can address than those obtained through quantitative methods.

With these comments in mind, the first stage of the analysis of the determination of industrial price dynamics involves splitting the industries into broad groups for each of the characteristics of interest. In this analysis, attention is restricted to the 22 industries of the manufacturing sector (industries 5-26 listed in Table 5.1) since data for the concentration variable is only available for these industries. To group the industries, the range of values over which each of the characteristic variables of Table A6.1 varies was split into two or three intervals, and the 22 industries categorised as "high", "medium", or "low" level industries for each variable according to the interval into which they are observed to fall. The intervals were necessarily chosen rather arbitrarily, but where possible, they correspond to the 'natural' groupings in the observed data series. Where no obvious breaks occur, intervals were chosen to obtain groups which are roughly equal in number. It is for this reason that some variables are split into two, and some into three intervals.

To illustrate the difficulties involved in choosing appropriate intervals, consider the inertia variable to be explained, π_{3i}. (In what follows, the 3 superscript, necessary to distinguish this measure from its alternatives in the discussion earlier, will be dropped). As shown in figure 6.2, for this variable, 15 of the 22 industries are closely grouped together in the interval [0,16]. There is then a small gap before industry 21 (Leather), and a large interval between industries 17 (Motors) and 5 (Food). In choosing the intervals for classifying industries, there is a trade-off between grouping together just the most obvious/natural outliers (so that industries 5 (Food), 22 (Leather), 12 (Metals) and 24 (Timber) would constitute the "high" inertia group), and attempting to obtain a more equal split of industries which will make the analysis of the categorical data more reliable. In this case, one could emphasise the first split at around π=0.20 to obtain the larger "high" inertia grouping including industries 7 (Tobacco), 17 (Motors), and 21 (Textiles) also. Given the importance of the classification of the dependent variable both of these classifications are considered in the following analysis. (This will also provide an idea of the sensitivity of the analysis to the chosen definitions of the classifications). Details of the choice of interval for the remaining explanatory variables are provided in Table A6.2 of the Appendix.

Next, a series of two-way contingency tables were constructed showing the cross-classification of the industries according to the degree of inertia and each of the potentially influential industrial characteristics. Simple contingency table statistics were then computed to investigate the association between price inertia and the characteristics in turn. These are reported in Table 6.2, which shows the standard χ^2 test of the independence of the two classifications, Goodman and Kruskal's γ-statistic (which is a measure of the association between the classifications analogous to a correlation coefficient), and Kendall's τ (which also quantifies the degree and direction of association, but with an underlying probability distribution which enables a test of the significance of the statistic to be carried out).

This analysis provides some evidence to support the existence of an association between inertia and a number of the potentially influential explanatory variables. Most obvious is the (negative) association between price inertia and an industry's capital-output

Figure 6.2

Histogram showing distribution of π by industry

].00,.04]		].08,.12]		].16,.20]		].24,.28]		].32,.36]		].40,.44]		>.44
9												
26												
8												
16												
10												
20												
19			11		17							
18	23		13		7				22			
25	15	6	14		21				5	12		24

π

Table 6.2(a)

Dependent variable: πgrp1 — "low" inertia where $\pi < 0.20$; πgrp1=0
"high" inertia where $\pi > 0.20$; πgrp1=1

Explanatory var.	χ^2	df	sig	γ	τ	sig
conc	0.43	2	0.81	-0.17	-0.09	0.34
kout	7.45	2	0.02	-0.63	-0.38	0.04
prodpos	1.15	2	0.56	-0.39	-0.21	0.15
imrat	0.00	1*	1.00	0.20	0.09	0.34
exrat	2.36	2	0.31	-0.51	-0.26	0.10
vardem	3.02	2	0.22	-0.53	-0.27	0.09
varcost	3.35	1*	0.07	-0.85	-0.49	0.01

Table 6.2(b)

Dependent variable: πgrp2 — "low" inertia where $\pi < 0.33$; πgrp2=0
"high" inertia where $\pi > 0.33$; πgrp2=1

Explanatory var.	χ^2	df	sig	γ	τ	sig
conc	2.04	2	0.36	-0.65	-0.29	0.08
kout	16.02	2	0.00	-1.00	-0.62	0.00
prodpos	0.28	2	0.87	-0.11	-0.05	0.41
imrat	1.44	1*	0.23	0.77	0.38	0.04
exrat	1.40	2	0.50	-0.55	-0.23	0.13
vardem	1.50	2	0.47	-0.41	-0.17	0.21
varcost	2.75	1*	0.10	-1.00	-0.47	0.02

Notes
"*" values adjusted for Yates correction in 2x2 contingency tables.

ratio. With industries grouped according to either of the inertia classifications, there is strong evidence to reject the hypothesis of "no association" considered by the χ^2 test. Instead, an unambiguously negative association is demonstrated by the γ-statistic, indicating that inertia falls as the capital-output ratio, proxying market power, rises. This negative association is confirmed with a significantly negative estimate of Kendall's τ.

In comparison, the alternative measure of domestic market power, conc, shows less convincingly; χ^2 statistics in table 6.2(a) and (b) are insignificant, although the sign on γ is negative in both cases, and there is weak evidence (i.e. significant at the 10% level) that Kendall's τ is significantly less than zero in 6.2(b). Similarly weak evidence is obtained for the variables 'exrat' and 'imrat', for which χ^2 tests are consistently insignificant. However, tests on Kendall's τ indicate the possibility of a negative association between industrial inertia and an industry's reliance on exports, and a positive link between inertia and import penetration.

Relatively good evidence is provided for an association between inertia and 'varcost'; the χ^2 test statistic is significant at the 10% level in both table 6.2(a) and (b), and the test on Kendall's τ shows a negative relationship which is significant at the 1% and 5% levels in (a) and (b) respectively. While rather weaker, there is also some evidence of an association between inertia and 'vardem', again negative, indicating that prices are more responsive in industries which face more uncertainty over input price and demand change. Finally here, it is noted that there is little evidence of any relationship between inertia and an industry's position in the production process from the results of table 6.2.

The results of table 6.2 show the simplest tests of association between inertia and the explanatory variables; by dealing with groups of industries, the method makes least use of the measures of industrial characteristics that we have constructed, and insofar as it is believed that these measures are only indicative of the character of the industry, this might be as far as the analysis should be taken. On the other hand, transforming the measures to obtain categorical data wastes information since the constructed measures would allow us both to rank industries more precisely and to quantify the similarities and differences between all industries over these dimensions. Table 6.3 takes the analysis one stage further, therefore, and presents Spearman's rank correlation, ρ, and the standard (Pearson) correlation coefficient, r, between π and each of the explanatory variables in turn.

Looking to the rank correlation results of column (1) first, it is noted that the strong negative association picked up by the categorical data analysis between inertia and 'kout' and 'varcost' are confirmed, both coefficients being significant at the 5% level. Coefficients on 'conc', 'exrat', and 'vardem' take the same signs as previously, but are

Table 6.3

Correlation between π and explanatory variables

Explan. var.	ρ	r_1	r_2
conc	-0.18	-0.30 (0.09)*	-0.27 (0.12)
kout	-0.47 **	-0.19 (0.20)	-0.41 (0.03)**
prodpos	0.00	-0.03 (0.44)	-0.01 (0.49)
imrat	-0.02	0.22 (0.16)	0.19 (0.20)
exrat	-0.23	-0.36 (0.05)**	-0.43 (0.03)**
vardem	-0.22	-0.20 (0.18)	-0.20 (0.20)
varcost	-0.49**	-0.41 (0.03)**	-0.39 (0.04)**

Notes

ρ = Spearman's rank correlation; 10% sig level (ρ) = 0.28

5% sig level (ρ) = 0.36

r_1 = Pearson's correlation coefficient; n=22 (industries 5-26)

r_2 = Pearson's correlation coefficient; n=21 (industries 5-26, excl. ind 8)

"*" indicates significance at 10% level

"**" indicates significance at 5% level

not significant at the 10% level, while there appears to be no association between inertia and 'imrat' or 'prodpos'.

The correlation coefficients of columns (2) and (3) make full use of the information contained by the industrial measures. Column (2) uses data for all 22 manufacturing industries once more, while column (3) drops industry 8 (Coal Products) from the sample. The reason for this is apparent if the results for 'kout' are considered, where despite the evidence found so far, the negative association found is reported to be insignificant. Consideration of the data in Table A6.1 of the Appendix shows an extremely high value for 'kout' for industry 8, and the result obtained is dominated by this outlier. Omitting this observation provides the more consistent result of column (3), again providing evidence of a strong negative relationship. Similarly strong results are also obtained for 'varcost' and 'exrat', and weak evidence to support the negative association between inertia and 'conc' is also obtained.

The final stage of investigation here is shown in Table 6.4, where the results of a simple OLS regression analysis are presented.(2) This analysis again uses the industrial character measures as a direct representation of the properties of the industry, but takes the work a stage further than the Pearson correlation coefficients in allowing for interactions between the variables. Of course, in running a regression analysis, a linear relationship is implicitly imposed between the variables involved, and in an attempt to obtain the highest degree of explanatory power in the regression, data transformations were also considered (to allow for potential non-linearities). To avoid excessive data-mining, a simple rule was employed that, for each explanatory variable x, either x, log(x), or exp(x) would be included in the regression, choosing that alternative which is most strongly related to π in terms of Pearson's r. As the table indicates, this procedure suggested that log(kout) and log(conc) be used, along with the levels of the other explanatory variables.

Column (1) of table 6.4 shows the results of a simple OLS regression in which all of the potentially influential variables are included, and it is immediately clear that the negative relationships between price inertia and the capital-output ratio and export reliance show very strongly. Indeed, if we employ a specification search in which variables which do not contribute to the fit of the equation (i.e. $|t| < 1$) are successively dropped, column (2) is achieved, where 60% of the variability in industrial price inertia is explained in terms of these two variables alone.

Of course, 'kout' was initially included in the list of potentially important variables as an alternative measure of market power to that based on 5-firm concentration ratios ('conc'). In fact, the correlation coefficient between these measures is 0.67, so that there is a close correspondence between the variables, and one would not expect both to

Table 6.4

OLS regression analysis of industrial price inertia

Dependent variable: π_i

n=21; manufacturing industries 5-26, excluding industry 8.

	(1)	(2)	(3)	(4)	(5)
const	0.154 (0.42)	0.078 (0.97)	0.558 (1.63)	0.489 (1.66)	0.125 (1.14)
log(conc)	-0.008 (0.08)		-0.117 (1.30)	-0.146 (1.86)	-0.179 (2.35)
log(kout)	-0.194 (2.07)	-0.216 (4.39)			
prodpos	0.030 (0.20)		0.080 (0.50)		
imrat	0.119 (0.40)		0.343 (1.10)		
exrat	-0.780 (2.30)	-0.793 (2.81)	-0.780 (2.07)	-0.805 (2.31)	-0.841 (2.37)
vardem	-0.038 (0.19)		-0.063 (0.28)		
varcost	-0.150 (0.20)		-0.860 (1.16)	-0.656 (1.32)	
R^2	0.612	0.606	0.484	0.433	0.375
adj R^2	0.404	0.562	0.263	0.333	0.305
RSS	0.3322	0.3376	0.4418	0.4855	0.5353

Note

t-ratios in parentheses

show significantly in the regression results of column (1). Columns (3)-(5) show an equivalent specification search in which 'kout' is omitted from the outset, therefore, and in these the variable log(conc) does take a significantly negative coefficient. Once more, 'exrat' shows itself to be highly significant, and, as column (4) demonstrates, in the absence of 'kout', 'varcost' also contributes to the fit of the equation.

Finally in this section, before summarising and discussing these results, it is noted that while there has been little evidence to suggest that an industry's position in the production process effects the speed of price adjustment so far, it might be argued that this is because attention has been limited to the manufacturing sector; any relationship that may exist between these variables may show more clearly if the distinction between primary, manufacturing, and tertiary sectors was made, say. In order to investigate this idea, a final cross-classification of industries was considered to include industries from the primary and service sectors too. Classifying the industries to the three sectors as shown in Table A6.2, the results obtained for each of the inertia classifications described above were as follows:

Table 6.5

Contingency table analysis of inertia and position in the production chain

Explanatory variable: SECTOR = 1 if industry in primary sector
= 2 manufacturing sector
= 3 if service sector

	χ^2	df	sig	γ	τ	sig
Dependent variable: πgrp1	1.43	2	0.49	-0.14	-0.07	0.34
Dependent variable: πgrp2	2.40	2	0.30	-0.62	-0.25	0.07

These results confirm those of table 6.2 based on the manufacturing sector alone: namely, that, insofar as an association exists, the relationship between inertia and 'prodpos' is a negative one, so that industries producing relatively more final goods demonstrate more price inertia than those at the beginning of the chain. However, the results of table 6.2 and 6.5 indicate that the evidence for this relationship is, at best, only weak.

6.3 Summary of results and concluding remarks

This sequence of analyses provides results to build up a good picture of the relationship between the industrial characteristics that have been considered and price inertia. It has been noted that the measures of these characteristics are in some cases rather imperfect representations of the properties of the industries that they attempt to describe. One reason for this is the aggregate nature of the data used, which in some cases groups together firms which face a wide variety of different environments. In these circumstances, one might prefer to use the measures as indicators of broad characteristics of the industry only, and attention might then be concentrated on the categorical data analysis of the contingency tables and the rank correlations that were reported. The results of the first of these provided evidence that prices are more responsive to shocks in industries in which firms have a high degree of domestic market power, as proxied by a high capital-output ratio, and where input price variability is high. The rank correlation results confirmed these findings, and further suggested that a high level of demand variability, a high concentration ratio, and a heavy reliance on exports might also be related to price responsiveness, although these associations were relatively weak.

The latter two of these in particular increased in significance when measures of industrial characteristics were used directly to obtain Pearson's correlation coefficients and OLS regression results. Export reliance showed most strongly in both of these, and the regression analysis demonstrated that, if export reliance is taken into account, the measure of domestic market power derived from concentration ratios was also highly significant. These results illustrate the advantage of the more quantitative techniques, which are able to investigate more sophisticated relationships, such as the interactions between variables, although they obviously rely more heavily on the particular measures of industry characteristics employed. (3)

To link these findings to the earlier discussion, it is noted that Domberger's discovery of a positive link between market power and price responsiveness is confirmed here, but only in the domestic market. This positive relationship was justified in terms of the ease of communicating pricing intentions and coordinating price movement in highly concentrated industries, and is illustrated in the work of the previous section through the consistently negative links between inertia and 'kout' and the significantly negative coefficient on log(conc) in Table 6.4(5). However, this is not the end of the story as far as market structure is concerned; market power is of course much reduced if there is a large export element in a firm's output so that the firm has to compete internationally. Moreover, in a world market, there is much less scope for communication between producers to facilitate coordination of price movements, so that Domberger's information-based ideas are less appropriate in these circumstances. Instead, the 'administered price' theories of price inertia seem rather more relevant here, predicting that prices become more responsive as competition rises. The evidence presented here supports this case, finding that greater degrees of market power obtained through a low reliance on exports, are related to more stable prices in the face of shocks. This is an interesting finding that extends those of Domberger, but which provides further support for the argument that market structure is a primary determinant of industrial price responsiveness.

There is also some evidence that greater uncertainty over input prices (and, to a lesser extent, demand) is also related to greater price responsiveness, although, in view of Gordon's (1982) discussion, this appears counter-intuitive. The argument there is that prices will be slower to respond to shocks where signals for change are obscured by high variability in the signals. This finding remains unexplained, then, although a justification might be obtained in terms of firms' awareness of input price change and cost consciousness: firms facing relatively volatile input prices might become more sensitive to these movements than otherwise, and install institutions which respond more quickly to change, other things being equal, than in other industries.

These findings have interesting implications for the macroeconomy and for the design of economic policy. The corollary of price inertia in an industry is a profit squeeze, as price increases fail to match cost increases. This, together with the more obvious relative price effects which result from the differential speeds of price adjustment across industries, means that substantial **structural** change may be brought about, both in the short run and the long run, through the presence of price inertia. Specifically, we have noted that those firms operating in highly concentrated industries will respond more quickly in raising prices when faced with increased costs than those firms in more competitive industries. This will have two offsetting effects: on the one hand, as costs increase across all industries, prices will rise in more concentrated industries relative to those in more competitive ones. To the extent that there is a substitution effect in demand, this will cause demand to shift from the output of the concentrated industries towards that of the more competitive ones. Obviously, this effect may be reversed in the long run, as prices in the competitive industries more gradually reflect the cost changes, but to the extent that changes in real magnitudes persist (as in the case of unemployment hysteresis, for example) this will represent a long term structural consequence of nominal inflation. On the other hand, the squeeze on profits that is implied for the more competitive industries in the above scenario may have an offsetting impact on the economy's structure. A protracted period of low profitability could reduce the level of investment in firms in the more competitive sectors, resulting in a long run shift in the structure of production towards the more highly concentrated industries. Of course, there are a variety of reasons why policy makers may have a view on the desired structure of the economy, so that these implications should be taken into account in forming macropolicy. Not least among these, however, is the significance of particular industries relative to others in terms of employment generation. Certainly, it would be unfortunate if policy makers ignored this consequence of inflation, allowing industrial demand to fluctuate 'arbitrarily' across sectors, and passively accepting the employment consequences that result.

A related issue involves the propensity of firms to introduce new technologies in order to reduce costs. Given that firms in more competitive industries are less able to pass on cost increases in the form of price increases than those in more concentrated industries, it is possible that these firms will be more willing to look for innovative ideas in order to reduce costs. Certainly there is a widespread belief that monopolies and cartels are less efficient than their competitive counterparts, as enshrined in the concept of X-inefficiency. Hence, while there is a macroeconomic argument which would call for policies aimed at the reduction of price inertia, so that adjustments to shocks could take place quickly and relatively painlessly (in terms of real magnitudes), it is clear that a policy which promoted a move towards increased industrial concentration would not be unambiguously beneficial. Indeed, pricing policies of the past have usually been concerned not only with price developments, but also with the encouragement of cost reductions through technical innovation. Hence, the National Board for Prices and Incomes, set up by the Labour Government in 1965, saw its primary function as providing a detailed analysis of the cost structure of enterprises that were referred to it so as to identify any potential for the absorbtion of cost increase through efficiency gains rather than through a price pass-on. Equally, the UK Price Commission, set up in 1973, operated an 'allowable cost' rule. In this, increases in some costs could be passed on in prices, but a productivity deduction was also enforced, by which a given proportion of any increases in wage costs was excluded from this pass-on in order to encourage the introduction of technological improvements and best-practice techniques. While we have not presented evidence in this thesis to examine the effectiveness of these policies on price setting, in view of the success of incomes policies on controlling the timing of wage change (evidence of which was provided in chapter 4), it seems likely that direct policy intervention of this sort might also be useful in controlling the speed of adjustment of prices. Certainly, a policy on prices would provide a useful counterpart to a wages policy, and one which would be necessary if policy is to address the sort of structural issues noted above.

The analysis of this chapter provides information on the determinants of the timing of price change within an industry, and this complements the work of chapters 3 and 4 on nominal wage change. However, the discussion above acknowledges the important feedbacks, highlighted in chapter 5, between wage, price, employment and output decisions made within an industry, and between these decisions made across industries. From this discussion, it is clear that a complete analysis of the causes and consequences of nominal and real rigidities requires an analysis of adjustment in the context of the full disaggregated system as set out in the previous chapter. It is to such an analysis that we turn in the next chapter.

CHAPTER 7

Wage and price rigidities in a dynamic disaggregated model of the U.K. supply side

In this chapter, we once more take up the results of the disaggregated supply-side model described in chapter 5, but here we consider the model as a whole, and, through dynamic simulation exercises, we attempt to identify the interactions between industries that are influential in determining the time paths of prices and nominal wages in response to an exogenous shock. In so doing, the exercises will also show the determinants of the time path of real wages, and, in view of the interest in wage responsiveness and the related hysteresis debate, particular attention will be paid to the interaction between this variable and the level of unemployment generated through the disaggregate model.

The analysis primarily intends to demonstrate the importance of feedbacks and interactions between sectors of the economy in determining the extent of wage and price inertia. To this end, analysis will revolve around three simulation experiments making use of the model developed in chapter 5. Simulations are believed to be the most appropriate tool of analysis here because of the complexity of the model: even ignoring the problems created by the large number of relationships involved (4x40 plus), the summation of variables across industries to obtain aggregate magnitudes, on which expectations are formed, introduces non-linearities which make algebraic analysis extremely difficult.

The first two of the simulation experiments concentrate in turn on the contribution of disaggregation on two elements of unresponsiveness that have been discussed repeatedly through the work. The first considers a single exogenous shock to the system, and attempts to identify the determinants of the speed at which nominal magnitudes (prices and nominal wages) respond to this shock by building up the response through a series of simulations successively incorporating more of the feedbacks that may influence price and wage change. Complementing this, the second experiment emphasises real wage rigidities, and considers the feedbacks between the rate of unemployment and the real wage, and what is meant by the concept of the "natural rate of unemployment" in a model such as this. The third simulation concentrates on the structural changes that accompany these adjustments, and argues the case for a coordinated industrial strategy for employment and pay. These experiments are described below in sections 7.2, 7.3 and 7.4. First, however, section 7.1 describes the method by which the simulations are obtained.

7.1 The simulation method

The approach taken in the following analysis is to first obtain a dynamic simulation of an estimated version of the model described in the previous chapter which will track the time paths of actual industrial employment, prices, wages, and output over the sample period. The effects of shocks to the exogenous elements of the model can then be examined by comparing this "base" (actual) simulation with a new simulation obtained by incorporating the shock.

As a first step in this task, the model presented in chapter 5 has been reestimated to obtain a more parsimonious set of industrial equations, as presented in Tables 7.1-7.4. These tables represent the result of a specification search on the equations presented in chapter 5 (Tables 5.3-5.6) in which variables have been dropped in order to ensure that the model simulations behave reasonably.(1) To this end, two sets of variables have been omitted: those whose coefficients take t-values which are (in absolute value) less than unity, and those whose coefficients take an "incorrect" sign (in the sense that it cannot be justified theoretically) even with t-values in excess of unity. The exclusion of the first of these sets is relatively uncontentious; while the inclusion of uninfluential variables leaves point estimates of coefficients unaffected, the inclusion of these variables can introduce unnecessary inaccuracies into dynamic simulations since the statistical (in)significance of the coefficients is not taken into account in simulation exercises. The inclusion of unimportant variables can result in poorly determined coefficients; hence, the equations of tables 5.3-5.6 include in many instances coefficients which are relatively large in absolute terms, but which are statistically not significantly different to zero. Because their lack of significance is ignored, however, these coefficients can have a disproportionate influence on the simulation results, introducing (possibly destabilising) variability.

To exclude variables whose t-values exceed unity is, of course, less easily justified, since their omission will reduce the fit of the overall model, and may introduce bias in the remaining coefficient estimates (the standard problem of specification error). On the other hand, as the discussion of chapter 5 made clear, the primary source of unexpectedly-signed coefficients in the model estimates appears to be through the presence of collinearity since, as is noted in Johnston (1972, pp162-4), strong collinearity between variables may cause estimation errors of (approximately) equal and opposite magnitudes for the coefficients on the collinear variables. Hence, for example, there are 14 industries in Table 5.4 in which either the industrial wage or the material input price variable takes a negative coefficient in its price equation. This is obviously difficult to justify on economic grounds, but may be explained in terms of the high degree of correlation between these two explanatory variables. In these circumstances, estimation may be better able to identify the sum of the coefficients on the collinear variables than it

Table 7.1

Industrial labour demand equations 1957-1981

	cons	n(-1)	n(-2)	w	q	k	y	tim
1. Agric.	8.2293	0.5122	0.2492	-0.1020	0.1020	-0.6933	–	0.0209
	(5.0848)	(3.2073)	(1.5925)	(1.1783)	–	(5.4698)	–	(4.0642)
2. Coal	1.7374	1.1225	–	-0.2608	0.2608	-0.6800	0.2633	0.0284
	(2.6392)	(15.0209)	–	(3.5983)	–	(5.9169)	(2.6395)	(5.0860)
3. Mining	12.3586	0.1687	–	-0.7016	0.7016	-1.1788	0.3005	0.0234
	(4.9377)	(2.2286)	–	(8.6786)	–	(3.0458)	(3.6656)	(2.5912)
4. Petrol	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–
5. Food	-5.3672	1.1762	-0.4715	-0.2304	0.2304	–	0.9146	-0.0096
	(2.9140)	(5.8286)	(2.4529)	(2.6407)	–	–	(6.9143)	(1.3841)
6. Drink	4.1480	0.5389	-0.1709	-0.1659	0.1659	-0.1034	0.2569	–
	(2.9180)	(3.0881)	(1.0600)	(4.1925)	–	(2.7019)	(3.4298)	–
7. Tobacco	2.7242	0.3352	0.2795	-0.1184	0.1184	–	–	–
	(1.7227)	(1.8133)	(1.2088)	(3.0571)	–	–	–	–
8. Coal Prds	-0.6153	–	–	-0.4749	0.4749	–	1.1163	0.0134
	(0.9520)	–	–	(6.1697)	–	–	(10.5617)	(3.9208)
9. Petrol Prds	4.0812	0.4511	–	-0.0662	0.0662	–	–	-0.0116
	(5.8356)	(4.8257)	–	(2.3482)	–	–	–	(4.5591)
10. Chems	2.0153	0.6921	–	-0.1578	0.1578	-0.1916	0.2933	–
	(1.0827)	(4.3747)	–	(1.9362)	–	(2.7376)	(4.5639)	–
11. Iron	1.2703	0.6827	-0.1436	–	–	–	0.3924	-0.0102
	(1.3113)	(5.0576)	(1.0030)	–	–	–	(7.4720)	(4.4130)
12. Oth Metals	4.0199	0.6123	-0.3576	–	–	-0.2561	0.5280	–
	(7.0333)	(7.3544)	(4.7413)	–	–	(12.7731)	(13.1812)	–
13. Mech Eng.	1.2587	0.8548	-0.2404	-0.3096	0.3096	–	0.3086	–
	(1.6616)	(6.0075)	(1.7856)	(6.7067)	–	–	(5.9304)	–
14. Inst Eng.	11.7476	0.3069	-0.4158	-0.2036	0.2036	-0.9815	0.3931	0.0361
	(6.2745)	(1.9477)	(3.1900)	(2.1163)	–	(5.5399)	(6.6316)	(3.6219)
15. Elec Eng.	1.5783	0.8177	–	-0.3789	0.3789	-0.8407	0.6823	0.0278
	(1.9995)	(10.2673)	–	(3.8236)	–	(3.5523)	(8.1281)	(2.2347)
16. Ships	4.3126	0.8088	-0.2479	-0.4972	0.4972	-0.3579	0.2194	0.0052
	(1.8503)	(5.7674)	(1.7512)	(4.1534)	–	(1.6527)	(3.1025)	(1.0597)
17. Motors	3.0790	0.4969	–	-0.1804	0.1804	-0.4094	0.5429	0.0133
	(4.4924)	(4.9168)	–	(2.5054)	–	(4.0604)	(11.4831)	(3.3027)
18. Aerosp.	5.7226	0.6256	-0.2679	-0.4405	0.4405	–	–	–
	(4.9821)	(3.9650)	(2.1628)	(4.8000)	–	–	–	–

(....cont)

(Table 7.1 cont.)

	cons	n(-1)	n(-2)	w	q	k	y	tim
19. Oth Veh.	7.2731	0.3850	–	-0.1446	0.1446	-0.8871	0.4599	0.0155
	(4.5971)	(5.1570)	–	(2.4168)	–	(4.8048)	(9.0212)	(4.3399)
20. Metal Gds	2.9598	0.7050	-0.2340	–	–	-0.1640	0.4169	–
	(4.2757)	(7.1439)	(2.4247)	–	–	(8.9607)	(12.9879)	–
21. Textiles	3.0643	0.5296	0.1803	-0.5625	0.5625	-0.9087	0.7178	0.0392
	(1.4475)	(6.1242)	(1.7726)	(7.4218)	–	(4.1471)	(15.7410)	(5.5460)
22. Clothing	-0.6558	0.5154	0.1573	–	–	–	0.5276	-0.0163
	(0.7402)	(4.6174)	(1.4067)	–	–	–	(9.3402)	(6.2605)
23. Bricks	2.2984	0.6714	-0.2651	-0.3986	0.3986	–	0.4245	-0.0055
	(3.0395)	(5.9094)	(2.3997)	(4.2555)	–	–	(8.7993)	(1.4424)
24. Timber	3.0975	0.3914	–	–	–	–	0.3589	-0.0094
	(4.9113)	(5.4752)	–	–	–	–	(15.1499)	(14.2727)
25. Paper	1.7578	0.3546	–	-0.2828	0.2828	–	0.5061	–
	(3.6345)	(4.8107)	–	(12.2358)	–	–	(10.2874)	–
26. Printing	4.0415	1.0933	-0.4207	-0.1652	0.1652	-0.4566	0.2866	0.0127
	(2.2306)	(8.8103)	(2.9855)	(2.5989)	–	(1.4182)	(5.0327)	(1.0729)
27. Oth Manuf	0.0075	0.5487	–	–	–	–	0.5852	-0.0226
	(0.0152)	(7.4432)	–	–	–	–	(11.7760)	(13.8344)
28. Constr.	3.0039	0.9562	-0.3794	-0.1552	0.1552	-0.3386	0.4398	0.0169
	(3.7914)	(9.1889)	(3.0664)	(1.8811)	–	(2.5347)	(6.6427)	(2.3178)
29. Gas	3.7734	0.8226	-0.2501	–	–	–	–	-0.0099
	(4.3668)	(4.9471)	(1.4363)	–	–	–	–	(4.5438)
30. Elec.	0.8545	1.1482	-0.2972	-0.1620	0.1620	-0.4140	0.5750	-0.0136
	(2.1630)	(9.3101)	(2.1242)	(4.1939)	–	(4.9123)	(6.3393)	(4.0000)
31. Water	26.2321	0.3228	-0.2838	-0.3770	0.3770	-3.3303	1.5466	0.0399
	(3.9230)	(1.9815)	(2.0069)	(4.2691)	–	(4.3210)	(4.7143)	(3.8785)
32. Rail	-1.1340	0.7898	–	-0.1050	0.1050	–	0.4287	–
	(1.2976)	(15.1589)	–	(1.6985)	–	–	(4.0934)	–
33. Road	-0.2169	1.1374	-0.2977	-0.0559	0.0559	–	0.2450	-0.0056
	(0.1188)	(8.0226)	(1.5965)	(1.3473)	–	–	(4.9694)	(2.5022)
34. Oth Trans	8.9089	0.6883	–	-0.0684	0.0684	-0.8642	0.2394	–
	(4.1448)	(6.6608)	–	(2.8942)	–	(3.5635)	(3.4285)	–
35. Comms	0.9358	0.8275	–	-0.1043	0.1043	-0.2773	0.4085	–
	(1.5030)	(13.3508)	–	(2.1611)	–	(4.8903)	(6.9204)	–
36. Distn	0.4146	0.2618	0.6557	-0.2797	0.2797	-1.1504	1.1005	0.0389
	(0.4227)	(1.5759)	(3.9288)	(3.9636)	–	(7.0394)	(8.0731)	(6.2859)
37. Bus.Serv	10.3378	0.6171	-0.6490	-0.0495	0.0495	–	–	0.0277
	(5.7945)	(4.0086)	(3.7617)	(0.9990)	–	–	–	(5.4074)
38. Prof.Serv	7.1923	0.3837	-0.1495	-0.1582	0.1582	–	–	0.0180
	(5.1047)	(2.3041)	(1.0205)	(4.1381)	–	–	–	(5.5153)
39. Misc.Serv	1.3178	0.7288	–	–	–	-0.3627	0.5204	0.0098
	(0.9970)	(8.3036)	–	–	–	(4.5317)	(5.0995)	(3.2676)

Table 7.2

Industrial price equations 1957-1981

	cons	p(-1)	p(-2)	w	q	k	y	tim
1. Agric.	3.4336	0.3877	-0.4606	0.4474	0.6254	–	-0.3171	-0.0262
	(2.0225)	(3.2937)	(4.1232)	(4.0928)	–	–	(1.5863)	(5.6159)
2. Coal	2.6010	0.7313	-0.1322	0.4222	-0.0213	-0.6655	0.3433	0.0149
	(1.8275)	(5.2792)	(1.0126)	(3.2185)	–	(2.3647)	(1.6321)	(1.4618)
3. Mining	1.4748	0.4324	–	–	0.5676	–	-0.2508	0.0066
	(7.0807)	(9.6881)	–	–	–	–	(7.0950)	(5.8929)
4. Petrol	–	–	–	–	1.0000	–	–	–
	–	–	–	–	–	–	–	–
5. Food	2.4224	0.3085	–	–	0.6915	-0.3819	–	0.0238
	(1.9111)	(5.3575)	–	–	–	(2.0191)	–	(2.7313)
6. Drink	14.4477	0.6875	-0.4455	0.2846	0.4734	-2.1803	-0.2368	0.1355
	(4.0572)	(5.2713)	(3.5599)	(3.2821)	–	(3.4736)	(1.5847)	(3.1473)
7. Tobacco	10.2554	0.4855	–	–	0.5145	–	-1.6311	0.0189
	(8.6473)	(10.5215)	–	–	–	–	(8.6128)	(8.1595)
8. Coal Prds	4.5536	0.5434	-0.1800	–	0.6366	-1.4733	1.0158	0.1214
	(2.2476)	(3.9492)	(1.7139)	–	–	(4.4402)	(5.7899)	(5.6804)
9. Petrol Prds	3.7374	-0.3536	0.1752	0.5802	0.5982	–	-0.4355	–
	(6.5649)	(2.8303)	(2.4214)	(7.4776)	–	–	(6.3122)	–
10. Chems	2.4837	0.1027	–	–	0.8973	-0.2784	–	–
	(8.1316)	(1.4201)	–	–	–	(7.8192)	–	–
11. Iron	0.8782	0.8697	-0.4312	0.1676	0.3940	-0.1067	–	–
	(1.1474)	(6.2113)	(3.7101)	(1.3081)	–	(1.1522)	–	–
12. Oth Metals	-3.2908	0.3989	0.1883	–	0.4128	-0.3350	0.6608	0.0298
	(2.4816)	(3.2185)	(1.5596)	–	–	(1.1875)	(4.6203)	(2.0320)
13. Mech Eng.	5.2933	0.4901	-0.1373	0.3827	0.2644	-0.6885	–	0.0075
	(3.1614)	(4.3384)	(1.9460)	(4.9811)	–	(3.0396)	–	(1.3738)
14. Inst Eng.	3.5435	0.2128	0.1048	0.3357	0.3467	-0.4591	-0.1756	0.0187
	(4.2998)	(1.3384)	(0.9947)	(4.2499)	–	(3.3127)	(3.4682)	(2.2676)
15. Elec Eng.	0.4267	0.2647	–	0.3846	0.3507	-0.2452	0.2014	-0.0118
	(0.5565)	(3.2980)	–	(4.0345)	–	(1.4274)	(2.5782)	(1.4012)
16. Ships	10.3928	0.2909	-0.1752	–	0.8843	-0.9466	-0.6171	-0.0296
	(3.6874)	(2.0656)	(1.4559)	–	–	(2.4049)	(3.5703)	(4.6312)
17. Motors	1.1048	0.6883	-0.1277	–	0.4394	-0.2495	0.0643	0.0134
	(2.6820)	(4.5181)	(1.1907)	–	–	(2.6333)	(1.6902)	(3.2139)
18. Aerosp.	2.2152	–	–	0.2847	0.7153	-0.5102	0.0820	0.0199
	(2.3500)	–	–	(2.9185)	–	(4.1849)	(1.3900)	(5.1693)

(....cont)

(Table 7.2 cont.)

	cons	p(-1)	p(-2)	w	q	k	y	tim
19. Oth Veh.	2.9282	0.4671	-0.3670	–	0.9000	-0.5654	–	0.0266
	(4.7806)	(4.3594)	(5.6030)	–	–	(5.2675)	–	(7.9196)
20. Metal Gds	4.7327	0.1639	–	0.2574	0.5787	-0.7081	–	0.0196
	(2.0907)	(1.4752)	–	(1.7398)	–	(2.1233)	–	(2.3051)
21. Textiles	2.5411	0.4737	–	–	0.5263	-0.5659	0.2087	0.0115
	(0.9669)	(3.4048)	–	–	–	(1.4853)	(3.7093)	(1.2610)
22. Clothing	-1.3694	0.8432	-0.2188	0.5807	-0.2051	-0.2036	0.4159	-0.0243
	(1.4700)	(3.0633)	(1.0963)	(6.3475)	–	(1.2197)	(7.0586)	(6.1959)
23. Bricks	3.4802	0.1861	0.0923	0.3352	0.3864	-0.2503	-0.2426	0.0118
	(4.5992)	(1.9093)	(1.2403)	(3.8873)	–	(1.5055)	(3.9454)	(1.4286)
24. Timber	-1.6384	0.9580	-0.2316	0.2073	0.0662	–	0.2314	-0.0052
	(3.9909)	(4.6958)	(2.0889)	(1.8483)	–	–	(4.6406)	(1.5325)
25. Paper	-0.1061	0.2822	-0.1560	–	0.8738	–	–	0.0050
	(5.1965)	(1.9449)	(1.7692)	–	–	–	–	(4.2797)
26. Printing	-1.6958	0.1236	–	0.4316	0.4448	–	0.2414	-0.0078
	(2.4153)	(1.1748)	–	(3.9212)	–	–	(2.7172)	(2.3544)
27. Oth Manuf	4.0498	–	0.1183	–	0.8817	–	-0.5559	0.0214
	(9.6387)	–	(2.4346)	–	–	–	(9.6901)	(9.7182)
28. Constr.	-0.5236	1.1415	-0.7506	0.1758	0.4332	-0.2228	0.2138	0.0120
	(0.4275)	(5.5593)	(3.7694)	(1.0692)	–	(1.1879)	(1.3732)	(1.1797)
29. Gas	3.1147	1.0117	-0.3787	0.1100	0.2571	-0.2087	-0.1696	–
	(5.4256)	(7.2135)	(3.0053)	(2.1218)	–	(2.4587)	(2.6475)	–
30. Elec.	-0.6095	0.5799	–	–	0.4201	–	0.1119	-0.0108
	(1.5122)	(10.1674)	–	–	–	–	(1.9690)	(2.7418)
31. Water	-1.5945	0.6606	-0.4425	0.3194	0.4625	–	0.2763	-0.0093
	(1.2674)	(5.9409)	(4.7086)	(5.0439)	–	–	(1.3833)	(2.4409)
32. Rail	17.1059	–	0.4528	–	0.5472	-1.9174	0.2635	0.0026
	(1.3693)	–	(11.5473)	–	–	(1.5845)	(2.3664)	(1.2673)
33. Road	4.8384	0.3991	–	0.4934	0.1075	–	-0.6053	–
	(3.3692)	(3.3739)	–	(4.6642)	–	–	(3.3109)	–
34. Oth Trans	38.9187	0.1850	-0.1972	0.7891	0.2231	-4.2030	–	-0.0055
	(6.6226)	(1.3614)	(2.0274)	(10.6022)	–	(6.5324)	–	(1.5524)
35. Comms	3.7327	0.6449	-0.4204	0.7754	–	–	-0.4398	–
	(6.4559)	(7.1645)	(6.2200)	(9.4415)	–	–	(6.4139)	–
36. Distn	-3.7835	0.7875	-0.3969	0.2742	0.3352	–	0.4422	-0.0206
	(3.4135)	(4.8659)	(4.2341)	(3.6761)	–	–	(3.7691)	(6.3932)
37. Bus.Serv	0.5764	0.6803	-0.2872	0.7951	-0.1881	–	–	-0.0237
	(4.3752)	(4.8780)	(1.6360)	(4.2305)	–	–	–	(3.4664)
38. Prof.Serv	2.8689	–	–	0.3623	0.6377	–	-0.3285	–
	(7.9396)	–	–	(9.7700)	–	–	(7.9605)	–
39. Misc.Serv	2.8338	–	0.1365	0.4736	0.3899	-0.1449	-0.1609	0.0059
	(2.8302)	–	(2.9546)	(8.7051)	–	(1.4328)	(1.5130)	(1.7020)

Table 7.3

Industrial wage equations 1957-1981

	cons	w(-1)	$\bar{w}^e$	int	inc	unr	$\bar{p}^e$	t2
1. Agric.	0.0864	1.0308	–	–	–	-4.0470	–	-0.7872
	(0.5052)	(26.1826)	–	–	–	(1.8591)	–	(2.0877)
2. Coal	1.6427	–	0.4765	0.5664	0.0179	-5.4514	0.5494	-1.3342
	(1.0212)	–	(2.4528)	(1.1837)	(1.8272)	(3.1777)	(2.4373)	(1.2421)
3. Mining	-0.6769	–	–	–	–	–	1.0100	-3.4787
	(4.0990)	–	–	–	–	–	(18.4518)	(6.1565)
4. Petrol	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–
5. Food	-0.1190	–	0.9582	–	–	–	–	-0.5781
	(2.0426)	–	(67.0567)	–	–	–	–	(2.8595)
6. Drink	0.4058	0.4027	0.7791	–	0.0211	-5.7310	–	–
	(3.5970)	(3.3513)	(5.8916)	–	(2.7923)	(3.0654)	–	–
7. Tobacco	0.1715	0.2958	0.4919	–	0.0212	–	0.5681	–
	(3.3287)	(2.5011)	(3.1505)	–	(2.3836)	–	(3.0386)	–
8. Coal Prds	1.6920	0.7228	0.7761	–	0.0194	-17.8326	–	2.6537
	(3.2991)	(3.1280)	(2.8765)	–	(1.2864)	(2.5010)	–	(1.8168)
9. Petrol Prds	0.2109	0.2584	0.8768	–	–	-5.5435	–	–
	(2.1036)	(2.3415)	(7.2461)	–	–	(2.1535)	–	–
10. Chems	-0.3235	–	0.8191	–	0.0068	–	0.1357	-1.2449
	(3.8805)	–	(15.4814)	–	(2.6434)	–	(2.5901)	(3.8883)
11. Iron	-0.5781	0.6260	–	–	0.0147	–	0.3321	-2.7607
	(3.9749)	(5.0122)	–	–	(2.8469)	–	(2.4432)	(5.3484)
12. Oth Metals	-0.5697	0.6394	–	–	0.0218	-1.9763	0.3248	-3.1148
	(4.0573)	(7.6169)	–	–	(4.5907)	(1.6021)	(3.8302)	(8.0263)
13. Mech Eng.	-1.2553	0.4267	0.3704	0.3993	0.0043	–	0.0992	-0.8758
	(1.9486)	(2.7214)	(1.9056)	(1.5965)	(1.0468)	–	(1.3346)	(1.7050)
14. Inst Eng.	-0.5822	0.3265	0.3821	–	0.0129	–	0.2107	-2.5339
	(3.6261)	(2.8588)	(2.2417)	–	(2.5098)	–	(2.0862)	(3.9912)
15. Elec Eng.	-0.4246	0.3346	–	1.4033	0.0060	-4.5481	0.2368	-1.1129
	(0.2618)	(3.1429)	–	(4.8906)	(1.8257)	(2.3356)	(2.0205)	(2.6444)
16. Ships	-0.1744	–	0.7596	0.3701	0.0065	–	–	-1.3920
	(0.3174)	–	(15.2369)	(2.9948)	(2.2898)	–	–	(4.8234)
17. Motors	-0.0497	0.7698	0.2350	–	0.0117	–	–	-0.7893
	(0.4416)	(5.0083)	(1.4420)	–	(2.9619)	–	–	(1.6732)
18. Aerosp.	-0.0241	–	1.0157	–	–	–	–	–
	(1.6164)	–	(114.8993)	–	–	–	–	–
19. Oth Veh.	-0.8509	0.5545	0.1522	–	–	–	–	-3.6005
	(4.7001)	(4.6145)	(1.6210)	–	–	–	–	(5.4626)
20. Metal Gds	-0.3673	0.7936	–	–	0.0080	–	0.1637	-1.8868
	(4.0096)	(9.3916)	–	–	(2.2670)	–	(1.7724)	(5.9243)
21. Textiles	-0.1139	–	0.9795	–	–	–	–	-0.6041
	(1.8839)	–	(66.3189)	–	–	–	–	(2.8687)
22. Clothing	0.1262	–	0.6347	–	0.0072	-1.7799	0.5100	–
	(2.2051)	–	(15.4325)	–	(2.2006)	(1.8749)	(6.7273)	–
23. Bricks	-0.2310	–	0.6456	–	–	–	0.4292	-0.9385
	(2.0295)	–	(7.7655)	–	–	–	(4.6237)	(2.2743)
24. Timber	-0.2313	0.3383	0.3478	–	0.0070	–	0.3149	-1.1608
	(2.2326)	(2.4782)	(2.7067)	–	(1.9501)	–	(4.3910)	(2.6897)
25. Paper	-1.5411	0.9065	–	0.5173	0.0124	-9.1363	0.2281	–
	(2.2340)	(15.7026)	–	(2.7457)	(3.9270)	(5.0113)	(3.5560)	–
26. Printing	-0.1848	0.9675	–	–	0.0104	–	–	-1.3241
	(1.8152)	(38.8554)	–	–	(2.4144)	–	–	(3.6536)
27. Oth Manuf	-0.5732	0.2007	0.6822	0.1988	0.0040	-3.5891	0.2993	–
	(1.0363)	(1.7687)	(6.1594)	(1.4371)	(1.1964)	(3.2268)	(3.4051)	–
28. Constr.	-0.1927	0.4311	0.4633	–	–	–	–	-0.9290
	(2.2575)	(2.7088)	(3.1566)	–	–	–	–	(2.8142)
29. Gas	-0.4146	–	0.8851	–	–	–	–	-1.8396
	(3.6323)	–	(31.7817)	–	–	–	–	(4.6107)
30. Elec.	-0.0804	0.6179	0.4418	–	0.0243	–	–	-0.8830
	(0.7460)	(4.9377)	(3.0842)	–	(6.3842)	–	–	(2.1424)
31. Water	0.0946	0.2943	1.0110	–	0.0228	-1.8430	-0.4259	–
	(2.0042)	(2.9396)	(7.1147)	–	(7.0495)	(1.0644)	(4.7063)	–
32. Rail	-0.0316	0.7860	0.2130	–	-0.0061	–	–	-0.5777
	(0.3099)	(7.0645)	(1.9647)	–	(1.5375)	–	–	(1.5957)
33. Road	-5.4178	0.6614	0.1667	2.8091	0.0298	–	–	-1.8803
	(3.6518)	(5.8968)	(0.9734)	(2.6695)	(4.7436)	–	–	(2.6517)
34. Oth Trans	-0.5128	0.3231	0.5741	–	0.0153	–	–	-2.2123
	(5.7236)	(4.5501)	(8.2549)	–	(4.9035)	–	–	(6.8472)
35. Comms	-0.2865	–	0.7004	–	–	–	0.3154	-0.9506
	(2.0453)	–	(7.0213)	–	–	–	(2.9855)	(1.8557)
36. Distn	-0.3484	0.6049	0.2253	0.6658	0.0091	-3.6247	–	-0.9256
	(0.5731)	(5.0966)	(1.9331)	(3.6890)	(3.0468)	(2.1782)	–	(2.4498)
37. Bus.Serv	-0.3342	–	0.8157	0.4508	–	–	–	–
	(3.1442)	–	(18.0544)	(2.8249)	–	–	–	–
38. Prof.Serv	-0.9300	0.4390	–	2.1496	–	–	–	–
	(4.0937)	(3.7744)	–	(3.7474)	–	–	–	–
39. Misc.Serv	-3.5482	0.5662	0.4199	2.0923	–	-2.7979	–	–
	(2.2968)	(4.3334)	(3.6561)	(2.5513)	–	(1.5021)	–	–

Table 7.4

Industrial demand equations 1957-1981

	cons	y(-1)	p/$\bar{p}$	pm/$\bar{p}$	σ	tim
1. Agric.	5.6211	0.3055	-0.1158	0.0610	–	0.0180
	(4.4774)	(1.9613)	(1.7655)	(2.9242)	–	(4.0518)
2. Coal	3.3691	0.5919	–	0.0095	–	-0.0158
	(2.5444)	(3.7429)	–	(1.0418)	–	(2.3487)
3. Mining	4.5977	0.2043	-0.8333	–	2.7618	0.0179
	(7.1126)	(1.8085)	(5.5957)	–	(5.6760)	(6.0850)
4. Petrol	–	–	–	–	–	–
	–	–	–	–	–	–
5. Food	8.7105	–	–	0.0921	0.3195	0.0233
	(275.9102)	–	–	(7.1419)	(1.7433)	(22.8725)
6. Drink	3.3872	0.4681	-0.0941	0.0993	1.0475	0.0294
	(3.2617)	(2.8705)	(1.3350)	(3.2074)	(3.1036)	(3.2926)
7. Tobacco	5.1872	0.1791	-0.2333	–	0.5416	0.0082
	(5.9931)	(1.3006)	(4.6320)	–	(2.1739)	(5.5646)
8. Coal Prds	1.3557	0.7490	–	0.0479	1.3616	–
	(1.3414)	(4.1511)	–	(1.7588)	(1.8501)	–
9. Petrol Prds	4.9698	0.1943	-0.7735	0.4036	0.6468	0.0757
	(9.3455)	(2.2339)	(10.3930)	(5.3313)	(1.4801)	(7.9154)
10. Chems	4.9471	0.3157	–	0.2254	1.2261	0.0520
	(5.0046)	(2.3387)	–	(4.6357)	(3.2318)	(5.0921)
11. Iron	7.6348	–	-0.5209	0.4234	3.7558	0.0308
	(33.6199)	–	(2.5777)	(4.4633)	(3.5665)	(3.8131)
12. Oth Metals	7.0116	–	-0.2659	0.2246	2.9738	0.0222
	(105.4692)	–	(3.1409)	(8.5108)	(7.5963)	(8.3534)
13. Mech Eng.	-0.1960	1.0197	-0.4501	0.0319	1.8029	–
	(0.5196)	(24.5718)	(2.1794)	(2.5266)	(4.8198)	–
14. Inst Eng.	1.5290	0.7016	–	0.0960	2.0550	0.0243
	(2.4317)	(5.7253)	–	(2.5035)	(4.7567)	(2.4580)
15. Elec Eng.	3.3982	0.5505	–	0.0694	1.0649	0.0234
	(4.0246)	(4.9016)	–	(2.9382)	(3.5530)	(3.7030)
16. Ships	1.3898	0.8330	-0.4982	–	–	-0.0112
	(1.6996)	(7.3146)	(5.8833)	–	–	(4.7300)
17. Motors	6.9788	–	–	0.5946	–	0.0582
	(78.0278)	–	–	(15.4316)	–	(18.2570)
18. Aerosp.	7.3167	–	–	–	–	0.0061
	(134.4495)	–	–	–	–	(1.7630)
19. Oth Veh.	0.5448	0.9090	–	0.0413	0.4095	–
	(1.3423)	(15.2982)	–	(2.5941)	(1.1316)	–
20. Metal Gds	5.0821	0.3543	–	0.1625	3.0283	0.0142
	(4.3264)	(2.4032)	–	(2.9655)	(4.5755)	(3.0450)
21. Textiles	1.6971	0.7898	-0.4245	0.1172	1.8238	–
	(1.9404)	(7.5796)	(3.4461)	(4.2816)	(3.6353)	–
22. Clothing	2.0710	0.7314	-0.4883	0.1001	1.4756	–
	(2.3263)	(6.4726)	(3.2380)	(3.0257)	(3.2800)	–
23. Bricks	6.7232	–	-0.7946	0.2055	1.9423	0.0429
	(75.4233)	–	(4.1044)	(5.0801)	(5.7784)	(12.5439)
24. Timber	6.7893	–	–	0.3394	–	0.0396
	(77.9578)	–	–	(9.2907)	–	(12.9869)
25. Paper	5.4292	0.2152	-0.8692	0.2746	2.4179	0.0324
	(7.2390)	(1.9537)	(5.3387)	(4.9445)	(5.7230)	(5.5273)
26. Printing	6.0912	0.1063	–	0.2214	1.6314	0.0446
	(9.2010)	(1.0907)	–	(7.2678)	(6.4393)	(8.2918)
27. Oth Manuf	5.6826	0.2538	-1.1917	–	1.0352	0.0174
	(7.7721)	(2.5459)	(8.2990)	–	(2.6099)	(4.6101)
28. Constr.	0.7980	0.8794	-0.6822	0.0841	1.3996	0.0119
	(1.0927)	(10.8882)	(7.5866)	(2.5124)	(4.8371)	(4.4201)
29. Gas	1.4944	0.7738	-0.2312	–	–	0.0097
	(5.2784)	(17.5788)	(3.4091)	–	–	(3.5515)
30. Elec.	0.3467	0.9610	–	0.0066	0.5926	–
	(1.1487)	(26.7093)	–	(0.9910)	(2.7997)	–
31. Water	1.8961	0.6531	-0.2062	0.0547	–	0.0167
	(2.6331)	(5.3681)	(2.8139)	(4.0324)	–	(3.8750)
32. Rail	0.9436	0.8668	–	–	0.5698	–
	(2.3766)	(15.6342)	–	–	(1.9809)	–
33. Road	2.2839	0.6525	-0.1082	0.1184	0.4456	0.0180
	(2.1744)	(4.2519)	(1.6894)	(3.1190)	(1.3273)	(2.4718)
34. Oth Trans	4.1025	0.4813	-0.6503	0.0863	1.5560	0.0210
	(5.4397)	(5.0695)	(4.5460)	(3.3479)	(5.4497)	(5.2739)
35. Comms	3.0030	0.5628	-0.2382	0.0657	–	0.0272
	(4.9644)	(6.5987)	(4.4879)	(5.6834)	–	(6.2794)
36. Distn	4.2074	0.5405	–	0.0182	0.8812	0.0104
	(8.1276)	(9.5117)	–	(3.2116)	(7.7978)	(7.2153)
37. Bus.Serv	3.1556	0.5834	–	0.0419	–	0.0215
	(2.7968)	(3.8751)	–	(2.1395)	–	(2.6964)
38. Prof.Serv	4.8916	0.2956	-1.1330	0.2536	–	0.0504
	(4.1763)	(1.9910)	(4.3665)	(4.1584)	–	(5.6840)
39. Misc.Serv	3.4338	0.6237	–	0.0365	0.7199	0.0089
	(2.4055)	(4.0187)	–	(1.7680)	(2.4517)	(2.5042)

(....cont)

(Table 7.4 cont.)

Table 7.5

Estimated equation summary statistics

Ind.	Value objective fn. (L)	ΔL	Employ. eqn Price eqn Wage eqn Output eqn	RSS	s. error regression	R^2
1. Agric.	115.5568	18.89 (7)		0.0110	0.0209	0.9950
				0.0202	0.0284	0.9969
				0.0277	0.0333	0.9985
				0.0096	0.0195	0.9841
2. Coal	101.6654	5.43 (4)		0.0191	0.0276	0.9949
				0.0642	0.0507	0.9959
				0.1068	0.0654	0.9937
				0.1215	0.0697	0.9525
3. Mining	89.2666	11.45 (10)		0.0454	0.0426	0.9501
				0.0140	0.0236	0.9985
				0.0964	0.0621	0.9937
				0.0367	0.0383	0.9659
5. Food	128.9850	48.60 (11)		0.0056	0.0149	0.9773
				0.0123	0.0222	0.9986
				0.0157	0.0250	0.9991
				0.0043	0.0131	0.9873
6. Drink	105.4111	16.93 (4)		0.0106	0.0206	0.8804
				0.0499	0.0447	0.9902
				0.1232	0.0702	0.9940
				0.0127	0.0225	0.9943
7. Tobacco	93.2040	4.25 (10)		0.0418	0.0409	0.8626
				0.0699	0.0529	0.9903
				0.2845	0.1067	0.9887
				0.0130	0.0228	0.9280
8. Coal prds	117.3634	30.07 (8)		0.0897	0.0599	0.9421
				0.1914	0.0875	0.9900
				0.3467	0.1177	0.9830
				0.0909	0.0603	0.9051
9. Petrol prds	92.0606	6.52 (9)		0.0857	0.0585	0.8987
				0.0950	0.0616	0.9940
				0.0964	0.0621	0.9951
				0.0475	0.0436	0.9873

(cont...)

(Table 7.5 cont.)

		ΔL	RSS	s. error	R^2
10. Chems	93.5239	4.66 (10)	0.0075	0.0174	0.8558
			0.0188	0.0274	0.9970
			0.0106	0.0206	0.9994
			0.0254	0.0318	0.9908
11. Iron	93.5837	11.79 (8)	0.0302	0.0347	0.9739
			0.0398	0.0399	0.9962
			0.0298	0.0345	0.9982
			0.1546	0.0786	0.7684
12. Oth Metals	120.8037	14.45 (6)	0.0071	0.0168	0.9849
			0.0861	0.0587	0.9920
			0.0378	0.0389	0.9976
			0.0240	0.0310	0.8890
13. Mech Eng	102.0063	2.58 (5)	0.0102	0.0202	0.9621
			0.0042	0.0130	0.9995
			0.0179	0.0267	0.9990
			0.0252	0.0318	0.9646
14. Inst Eng	90.0900	2.15 (3)	0.0098	0.0197	0.9141
			0.0053	0.0145	0.9991
			0.0297	0.0345	0.9982
			0.0411	0.0406	0.9905
15. Elec Eng	112.3206	14.38 (4)	0.0099	0.0199	0.9155
			0.0074	0.0171	0.9988
			0.0176	0.0265	0.9988
			0.0211	0.0291	0.9891
16. Ships	94.2931	3.41 (6)	0.0123	0.0221	0.9904
			0.1463	0.0765	0.9761
			0.0107	0.0207	0.9994
			0.0832	0.0577	0.8102
17. Motors	103.0741	9.94 (8)	0.0084	0.0184	0.9699
			0.0160	0.0253	0.9983
			0.0354	0.0377	0.9979
			0.0795	0.0564	0.9298
18. Aerosp.	127.9204	48.73 (15)	0.0214	0.0292	0.9790
			0.0519	0.0456	0.9958
			0.0477	0.0437	0.9973
			0.2065	0.0909	0.1809
19. Oth Vehs	161.1501	82.59 (9)	0.0270	0.0329	0.9903
			0.0321	0.0358	0.9974
			0.0751	0.0548	0.9941
			0.0986	0.0628	0.9284
20. Metal Gds	90.3598	2.81 (8)	0.0077	0.0175	0.9529
			0.0171	0.0261	0.9983
			0.0226	0.0300	0.9985
			0.0721	0.0537	0.7502

(cont...)

(Table 7.5 cont.)

		ΔL	RSS	s. error	R^2
21. Textiles	136.4933	20.77 (8)	0.0085	0.0184	0.9960
			0.0283	0.0336	0.9946
			0.0289	0.0340	0.9984
			0.0433	0.0416	0.8692
22. Clothing	92.4117	2.24 (6)	0.0091	0.0191	0.9925
			0.0080	0.0179	0.9984
			0.0151	0.0246	0.9990
			0.0341	0.0369	0.8343
23. Bricks	87.4104	1.17 (6)	0.0093	0.0192	0.9840
			0.0086	0.0186	0.9991
			0.0390	0.0395	0.9977
			0.0314	0.0355	0.9617
24. Timber	203.7885	77.40 (9)	0.0061	0.0155	0.9434
			0.0311	0.0353	0.9966
			0.0300	0.0346	0.9980
			0.1026	0.0641	0.8102
25. Paper	105.7651	20.40 (8)	0.0160	0.0253	0.9518
			0.0375	0.0387	0.9959
			0.0318	0.0357	0.9984
			0.0307	0.0350	0.9135
26. Printing	99.6441	11.27 (7)	0.0053	0.0145	0.9538
			0.0217	0.0294	0.9980
			0.0243	0.0312	0.9984
			0.0109	0.0208	0.9860
27. Oth Manuf	97.3199	6.51 (8)	0.0065	0.0161	0.9609
			0.0239	0.0309	0.9969
			0.0143	0.0239	0.9992
			0.0514	0.0454	0.9710
28. Constr.	94.0268	8.77 (4)	0.0076	0.0175	0.9444
			0.0259	0.0322	0.9977
			0.0222	0.0298	0.9983
			0.0180	0.0268	0.9503
29. Gas	114.5352	21.37 (11)	0.0268	0.0327	0.9604
			0.0234	0.0306	0.9944
			0.0607	0.0493	0.9965
			0.0287	0.0339	0.9945
30. Elec	117.0610	28.9 (8)	0.0118	0.0217	0.9828
			0.0278	0.0334	0.9960
			0.0339	0.0369	0.9985
			0.0139	0.0236	0.9947
31. Water	113.2109	14.54 (4)	0.0427	0.0413	0.9075
			0.0440	0.0420	0.9956
			0.0326	0.0361	0.9978
			0.0078	0.0176	0.9866

(cont...)

(Table 7.5 cont.)

		ΔL	RSS	s. error	R^2
32. Rail	121.0427	36.3 (11)	0.0147	0.0243	0.9945
			0.0125	0.0224	0.9983
			0.0348	0.0373	0.9982
			0.0179	0.0268	0.9062
33. Road	102.2944	42.17 (5)	0.0052	0.0144	0.9598
			0.0793	0.0563	0.9918
			0.0448	0.0424	0.9975
			0.0188	0.0274	0.9776
34. Oth Trans	134.2575	38.31 (6)	0.0066	0.0163	0.9131
			0.0318	0.0357	0.9957
			0.0482	0.0439	0.9973
			0.0194	0.0279	0.9851
35. Comms	111.0461	22.44 (9)	0.0045	0.0135	0.9644
			0.0185	0.0272	0.9982
			0.0531	0.0461	0.9968
			0.0058	0.0152	0.9979
36. Distn	141.2515	54.89 (3)	0.0048	0.0138	0.9728
			0.0125	0.0224	0.9983
			0.0123	0.0222	0.9992
			0.0045	0.0134	0.9912
37. Bus.Serv	96.4547	22.87 (11)	0.0048	0.0138	0.9946
			0.0425	0.0412	0.9944
			0.0174	0.0264	0.9988
			0.0097	0.0197	0.9963
38. Prof.Serv	102.0084	5.18 (12)	0.0091	0.0191	0.9749
			0.0165	0.0257	0.9982
			0.0505	0.0450	0.9970
			0.1030	0.0642	0.9293
39. Misc.Serv	82.0936	1.23 (7)	0.0054	0.0146	0.9240
			0.0085	0.0184	0.9991
			0.0611	0.0494	0.9958
			0.0111	0.0210	0.9709

is to find precise estimates of the individual coefficients. The omission of one of two highly collinear variables in an equation will alter the interpretation of the estimated coefficient on the remaining variable, since this coefficient will now provide an estimate which is more closely related to the sum of the true coefficients on these variables in the model. In running simulations, the estimated restricted model will no longer be able to discriminate between the impact of movements in the individual variables, of course, and this reduces its usefulness in representing responses in the face of hypothetical shocks. However, simulations run on an unrestricted model in which errors in the estimated coefficients on collinear variables offset each other, is equally questionable, since error-based movements in variables may compound over time. On these grounds, then, it appears reasonable to leave in collinear variables where, as is true of the majority of cases, errors are not thought to be large. Where these errors are sufficiently large to cause a coefficient to take an economically unreasonable sign, however, the variable is dropped.

Table 7.5 shows, in the column headed ΔR, the change in the value of the objective function resulting from the imposition of the restrictions involved in moving from the estimates of Tables 5.3-5.6 to those of Tables 7.1-7.4. A test of the validity of the restrictions is given by comparison of this figure with the χ^2 distribution, with degrees of freedom as indicated in brackets. In all, there are 17 industries in which the overall fit of the estimated model is significantly reduced.(2) It is clear therefore that, while these equations provide in most cases a good fit of the data in terms of standard errors, the imposition of the restrictions of Tables 7.1-7.4 involves the omission of important explanatory variables from (at least) one equation of the system in a fairly large number of cases. For the reasons given above, this may be a reasonable set of equations for simulation purposes, but the accuracy of the estimated coefficients may be questioned in these industries. It is for this reason that the original estimated coefficients for the equations, as presented in Tables 5.3-5.6, were employed in the analysis of section 6.1.

The simulations themselves are generated through a Fortran programme which picks up the estimated coefficients of tables 7.1-7.4, along with those for the expected aggregate wage and price equations and the expected material input price equations as described in chapter 5. Simulated time paths start two years into the sample period, in 1956, providing initial values for the variables dated 1954 and 1955. Fully dynamic time paths are obtained as the model is solved period by period in an order that corresponds to the sequence of events which was described in the earlier discussion of the model estimation (section 5.2). Hence, at the beginning of each period, expectations are formed on aggregate wages and prices, and on the price of material inputs that will hold for that period. These expected values are obtained in the simulation by solving the relevant estimated equations using current values of exogenous variables, including lagged dependent variables taken at their base 1954-55 levels, or formed through the previous period model loop. These expected values are then used in the individual industrial equations which solve to give industrial employment, price, wage and output levels. This set of four equations is solved employing the Gauss-Seidel iterative technique, using convergence criteria of the order of 0.05% for the employment and output equations, and 0.5% for the price and wage equations. Errors obtained in estimation are treated here as exogenous shocks, and are added back into the simulated values to ensure that the model-simulated values of all variables exactly track their actual time paths over the sample period when true values of the exogenous variables are employed. Finally, the industrial values are aggregated to obtain simulated aggregate (un)employment, wages, and prices, and industrial material input price indices. These variables are then taken as data in the model solution of subsequent periods. A copy of the Fortran programme used to generate such a simulation is presented in figure 7.1 of the Appendix.

7.2 Identifying sources of inertia in interactions between industries

As the description above indicates, there are a variety of feedbacks between wage and price-setting decisions made at different times and in different sectors, and it is of interest to try to identify which of these are most significant in explaining the speed of adjustment in the labour market. One means of doing this is to shock the system with a single once-and-for-all innovation in a particular exogenous variable and to trace through the consequences of this over the following years by means of a series of simulations. This is precisely the approach taken here where the consequences of a successful incomes policy, hypothetically imposed in 1971, are considered. This specific year was chosen because it represents a time during the sample when there was relatively little government pressure on wage-setting, and because it preceded a period of rapid inflation.

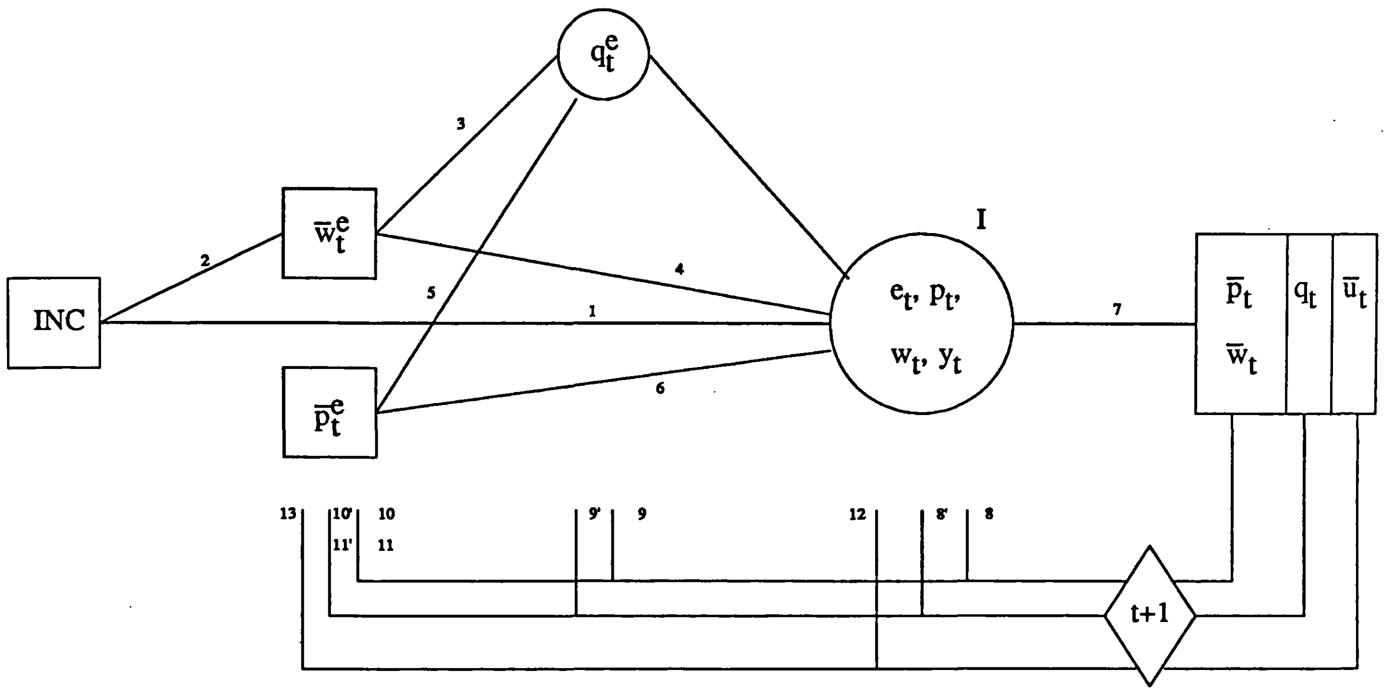
Such a scenario is incorporated into the model by assuming that the exogenous variable "inc_t", measuring the strength of incomes policy in time t, takes a negative value in that year. Specifically, it is noted that inc_{1971} takes the value 0.5, demonstrating the fact that there was little effort made to restrain wage claims during the first 18 months of Heath's Conservative administration (indeed, the "n-1 strategy" adopted in Public Sector negotiations provided for some degree of wage growth). To assume that this variable takes a value of -4.5 in this year, for example, would therefore represent the imposition of a very restrictive and well-supported policy; one might have in mind a policy of the sort employed during Labour's "Social Contract", during which Whitley's (1976) incomes policy variable, used in the study, was calculated to take values in the range of -3.0 to -7.0. While this degree of restraint would probably not have been achievable at that time, given the political climate, such a figure remains within the limits of credibility, and will provide quite a substantial shock to the development of wages and prices, the effects of which can then be broken down into their component parts.

Figure 7.1 provides an illustration of the feedbacks that might be analysed through this simulation exercise. In the particular example described in the paragraphs above, there are two effects, labelled 1 and 2, initiated by a change in the exogenous variable "inc": first, and most directly, a change in incomes policy will influence industrial wage setting, and hence industrial prices, output, and employment (represented in the figure as set I); secondly, the announcement of a policy also influences expected aggregate wage levels (path 2), and this in turn influences the industrial variables of set I, directly (path 4) and indirectly via expected material input prices (path 3). Alternative exogenous shocks might also influence expected material input prices, and/or expected aggregate prices (with subsequent influences along paths 5 and 6). Path 7 indicates the aggregation process in which industrial prices and wages are summed to obtain aggregate price and wage levels, along with the actual price indices of material inputs into each industry. Industrial employment levels are also summed here to obtain aggregate (un)employment levels in the current period.

Finally, paths 8-13 demonstrate the variety of ways in which these aggregated figures feed back into the earlier stages of the diagram in the following year. Lagged aggregate wages and prices effect the industrial variables of set I directly (path 8), and indirectly through expected input prices (9) and through expectations of aggregate wages and prices (10,11). Lagged material input prices of course influence current expected input prices (9'), and lagged unemployment levels feed back, directly and via wage and price expectations, to the variables of set I (paths 12 and 13). It is precisely these different paths of influence, then, that the simulation results aim to rank according to importance. Further, it is of interest to note the length of time taken for the once-and-for-all shock to work its way through the system, given the complexity of these interactions.

In what follows, seven artificial scenarios will be considered to illustrate the importance of the various paths of influence detailed in figure 7.1; these are summarised beneath the figure itself. Scenario 1 represents the simulation run in the absence of any shocks, and allowing all possible feedbacks; this records the actual time paths of all variables, therefore, and provides an important base against which to compare the other simulated results. Simulations 2-7 demonstrate the time paths of the variables following a shock, with successively more of the potentially important feedbacks initiated by the policy imposition included in the response. Among these, scenario 2 is the most restrictive, showing only the direct influence of the shock on the industrial parameters (through path 1 in figure 7.1), and allowing this to be passed on to the next time period through the paths labelled 7, 8, 9, 10, 11. Scenario 3 has the same restrictions on

Figure 6.3: Feedbacks initiated by an imposed incomes policy



Alternative scenarios

Scenario 1: history

Scenario 2: history + paths(1,7,8,9,10,11,6)

Scenario 3: history + paths(1,7,8,9,10,11,6) + paths(2,4)

Scenario 4: history + paths(1,7,8,9,10,11,6,2,4) + paths(3,5)

Scenario 5: history + paths(1,7,8,9,10,11,6,2,4,3,5) + paths(8',9',10',11')

Scenario 6: history + paths(1,7,8,9,10,11,6,2,4,3,5,8',9',10',11') + path(13)

Scenario 7: history + (all paths) = full effects

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influences over time, but also allows the indirect effect of the shock on $\overline{w}^e$ (through paths 2 and 4). Scenarios 4 and 5 include for the first time the feedbacks observed through material input prices, the former including paths 3 and 5 of figure 7.1 (so that it incorporates the impact of changes in expected aggregate wage and price movements on material input prices), and the latter further including paths 8', 9', 10' and 11', so that the accumulation of these effects over time is also admitted. Finally, scenarios 6 and 7 incorporate the feedbacks associated with changes in unemployment generated by the shock. Scenario 6 adds in path 13 of figure 7.1, which demonstrates the indirect pressures exerted by the unemployed on industry decisions as higher unemployment rates are expected to depress aggregate wage inflation. Scenario 7 further includes path 12, so that the direct effects of changes in unemployment on industrial wage setting (and the other industrial variables of set I) are included. Scenario 7 therefore incorporates all of the possible feedbacks identified in figure 7.1, and represents the model's prediction on the time paths that would have been observed in the face of the shock (labelled "Full effects" in what follows).

As a summary of the full effects of the proposed incomes policy shock, figures 7.2-7.5 illustrate the simulated time paths relating to scenario 1 (the actual time path) and scenario 7 (full effects following the shock) for nominal wages, prices, real wages and unemployment rates at the economy-wide level. Figure 7.2 documents the very dramatic fall in nominal wage growth that would have been obtained on impact (a 4% fall in wage inflation in 1971). This is followed by two years in which wage growth converges to the original time path, and a very close correspondence between the new and the original wage growth paths from around 1974. Aggregate price responses, as shown in figure 7.3, are rather slower, generating a 1.5-2% reduction in price inflation in the year of impact, a further reduction in 1972, and a convergence by 1975. Interestingly, there are also more long term effects in aggregate price inflation, with a noticeably higher level of inflation under scenario 7 through from 1976 to the end of the sample period. Together, these shifts generate some fairly substantial shifts in real wage inflation, as illustrated in figure 7.4. The movements in figure 7.4(a) again highlight the strong impact effect of the incomes policy shock as real wage growth falls by around 2-2.5% in 1971. This is followed in 1972 by a growth rate that is roughly equal to that obtained in reality, but is followed in 1973 by a rise in real wage inflation of around 6.5%, some 2.5% higher than the actual observed rate. A higher real wage growth is maintained in 1974, reflecting the relative persistence of the price inflation slowdown, until similar rates of real wage growth are established in 1974 and thereafter. The overall impact on real wages in the long run, as illustrated in figure 7.4(b), is to leave real wage levels relatively unchanged from 1973 onwards, stabilising at a level approximately 1% higher than was achieved in

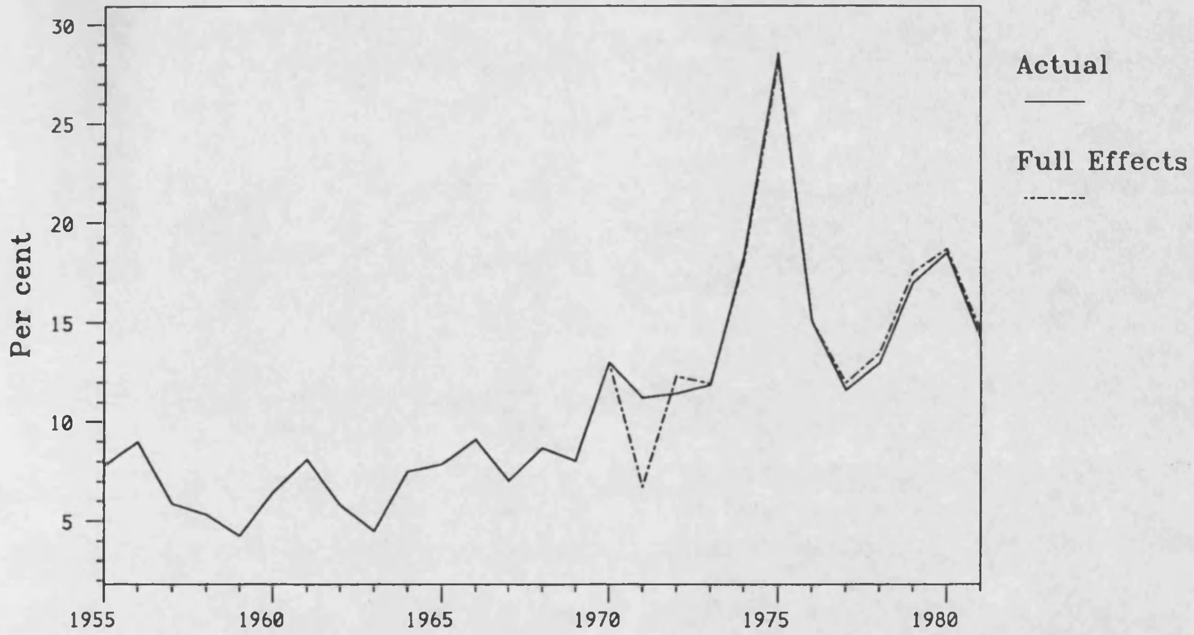


Figure 7.2: Aggregate nominal wage inflation

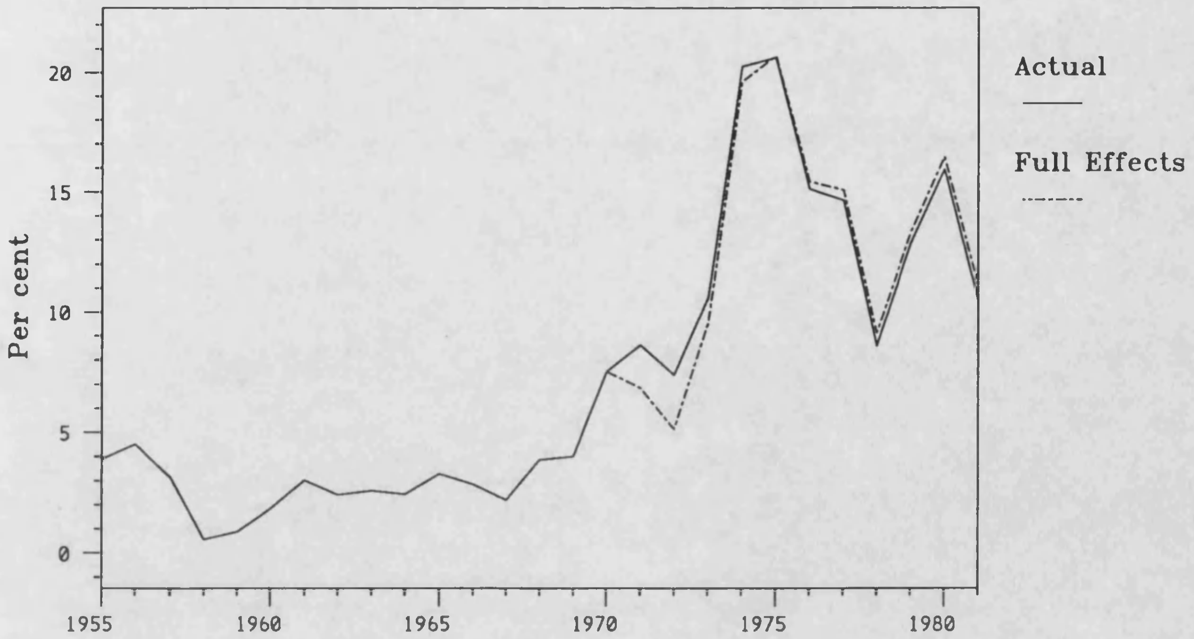


Figure 7.3: Aggregate price inflation

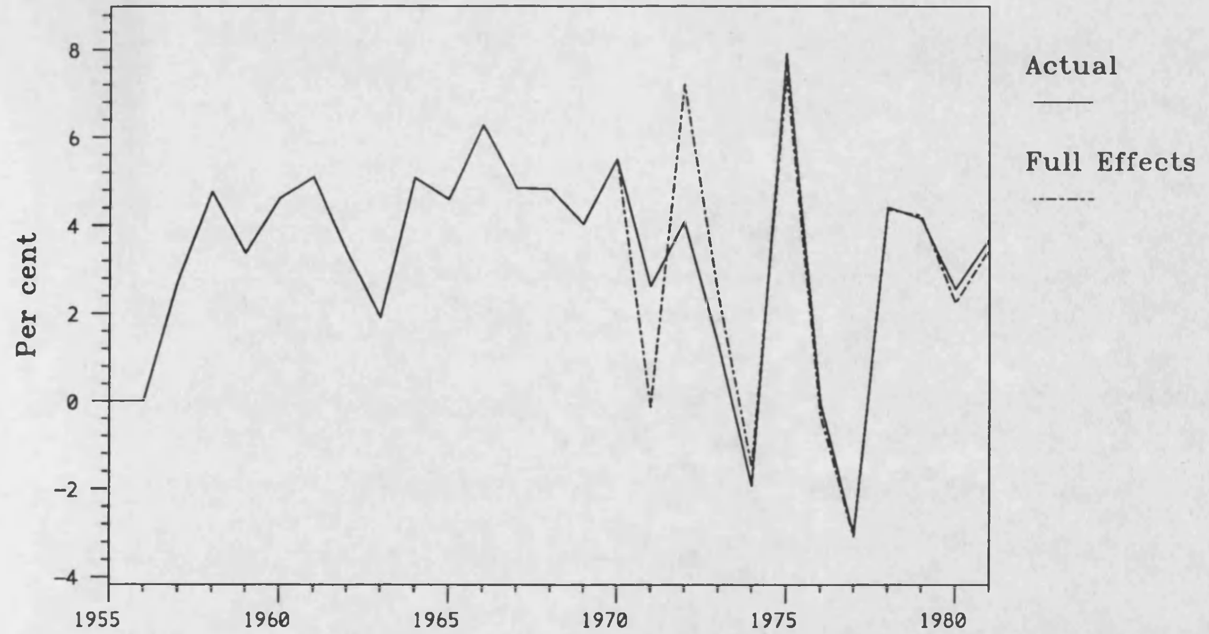


Figure 7.4(a): Aggregate real wage inflation

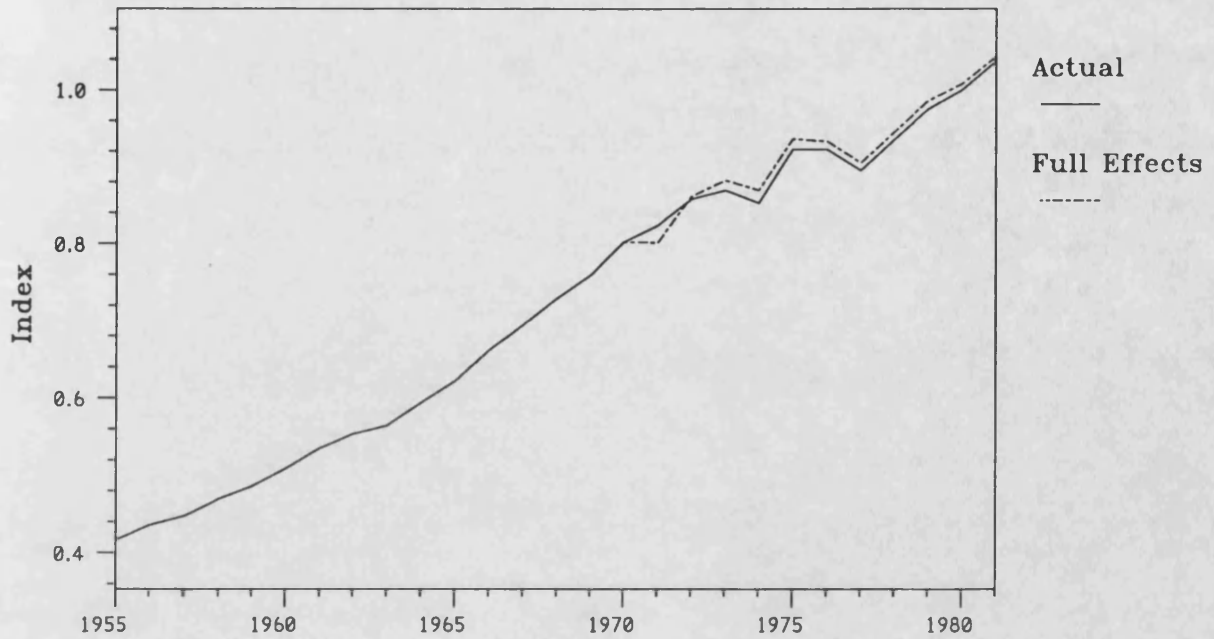


Figure 7.4(b): Aggregate real wage index

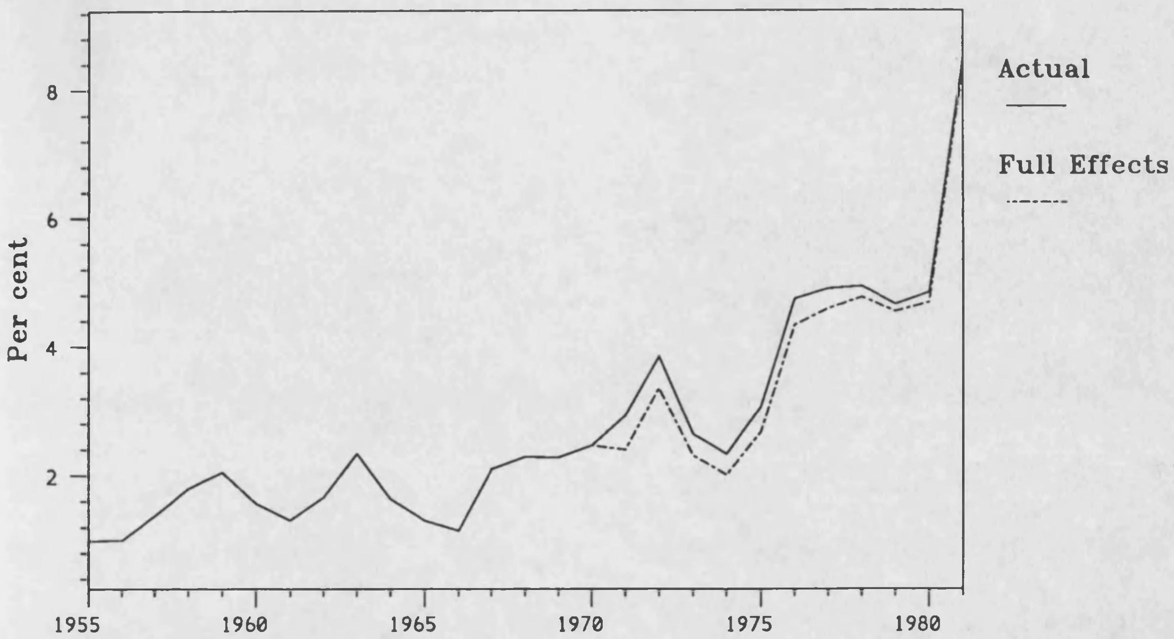


Figure 7.5(a): Aggregate unemployment rate

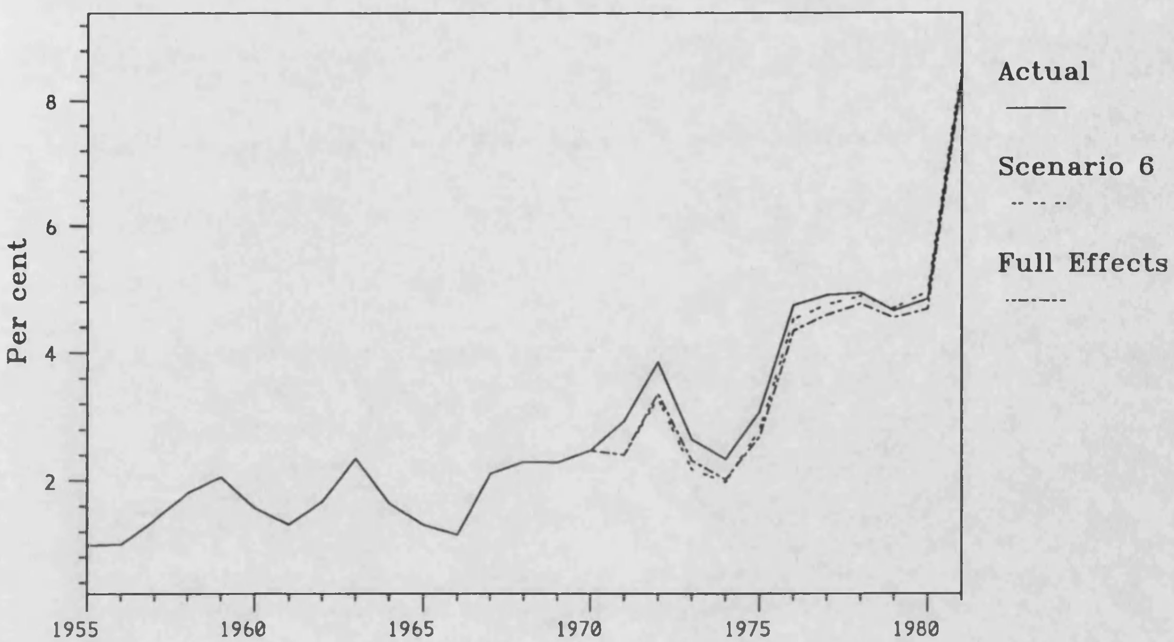


Figure 7.5(b): Aggregate unemployment rate (1,6,7)

the absence of the policy shock. However, the time paths of the variables underlying these changes are important, as demonstrated in figure 7.5. In this, the time path of the unemployment rate generated by the simulated run including the incomes policy shock shows a reduction in the rate of unemployment of approximately 0.5% in the year of the shock and, moreover, this unemployment reduction is maintained throughout most of the remaining period. Such a simulation illustrates very clearly the impact effects of the reduction in the real wage obtained through the policy innovation. Further, given the fact that real wage levels are gradually reestablished, the simulation also demonstrates the "hysteresis" effects by which policies which succeed in obtaining a once-off reduction in unemployment levels might also expect to achieve longer-term benefits.

While these overall effects are of interest, the main point of this exercise is to identify the separate components of the overall changes. These issues are considered in diagrams 7.2.1-7.2.4, 7.3.1-7.3.4, and 7.4.1-7.4.4, where the time paths of aggregate nominal wages, prices, and real wages are plotted under the seven alternative scenarios described above. Differences between the scenarios that are captured in these plots are small in some cases, indicating that the extra feedbacks incorporated in the successive scenarios are relatively unimportant in these instances. On the other hand, it is also clear from these that the overall effects identified in the previous figures are in many cases built up from a variety of offsetting influences, and that there is some considerable change underlying the relatively stable patterns observed overall.

Perhaps least dramatic of the scenario sequences is that relating to aggregate nominal wages, illustrated in figures 7.2.1-7.2.4. The first of these figures, 7.2.1, illustrates the time path of aggregate nominal wages under scenarios 1 (the actual time path), 2, and 3. Between these there are no alterations in the way in which the incomes policy effects are passed on over time, but they do illustrate well the joint influence of an exogenous shock to wages, which work directly and indirectly through $\overline{w}^e_t$. Scenario 2 incorporates the effects of the hypothetical incomes policy in 1971, and nominal wages drop substantially below the actual path of wages, as expected. However, this scenario abstracts from the indirect effects of the policy, which cause further wage restraint at the industrial level, as captured in scenario 3, since aggregate wages are also expected to fall in the light of the policy. These simulations indicate that, although the difference in time paths are eliminated relatively quickly, as much as a third of the impact effect of the imposition of the policy takes place through the indirect route, confirming the importance of wage-wage comparisons in wage setting, and stressing the importance of credibility in the design of incomes policy. A similar, although less extreme, breakdown shows in the equivalent figure for price inflation, 7.3.1. It is noted here that, since lagged aggregate wages were not found to be influential in either the aggregate wage or the aggregate price

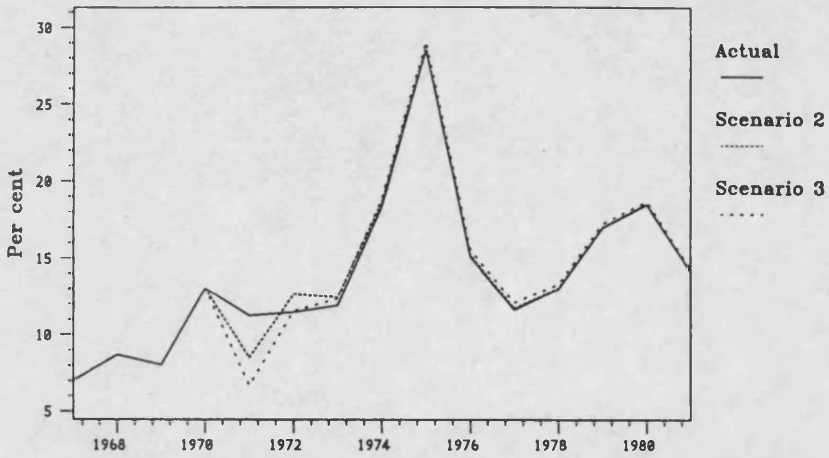


Figure 7.2.1: Agg. nominal wage inflation (1-3)

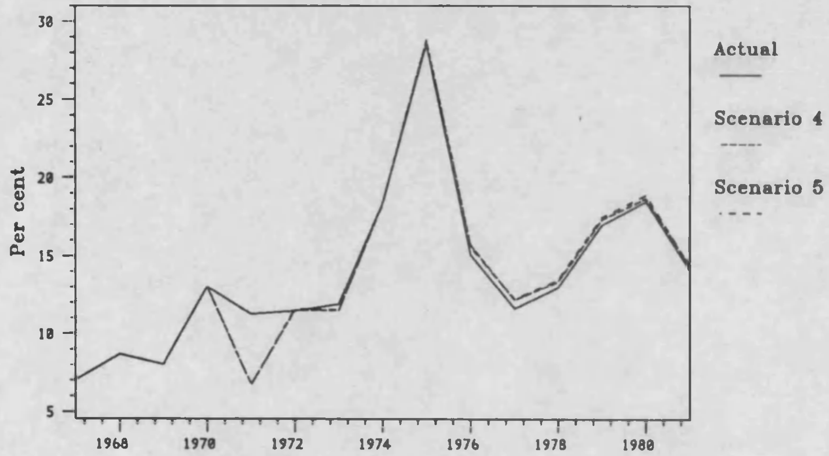


Figure 7.2.3: Agg. nominal wage inflation (1,4,5)

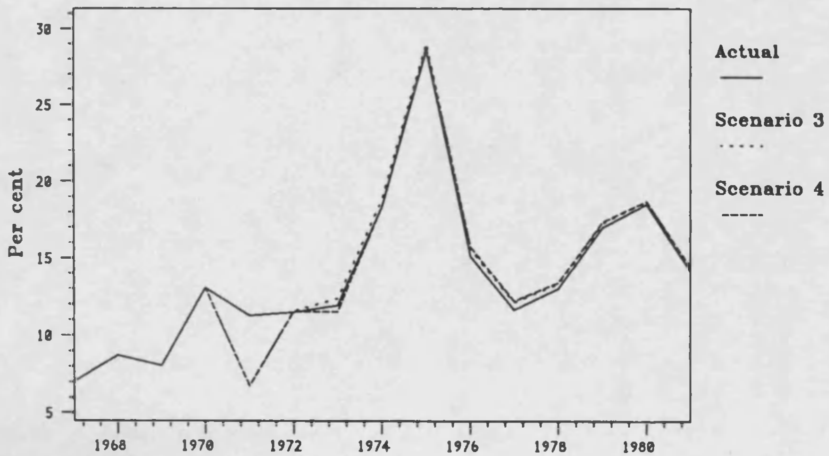


Figure 7.2.2: Agg. nominal wage inflation (1,3,4)

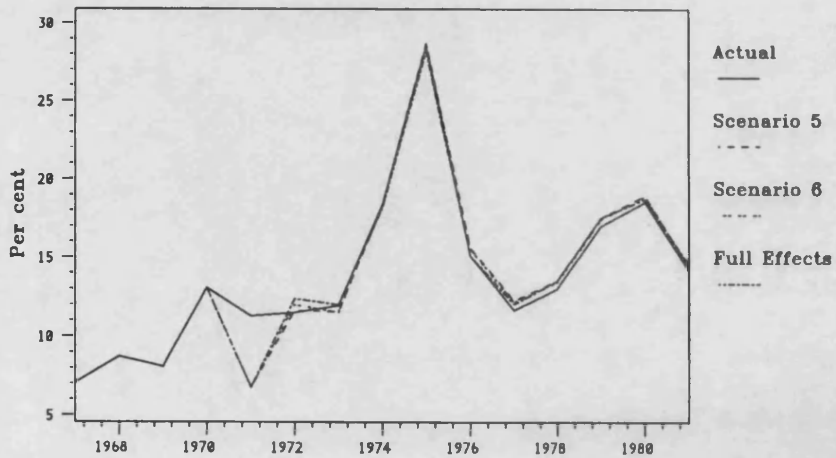


Figure 7.2.4: Agg. nominal wage inflation (1,5-7)

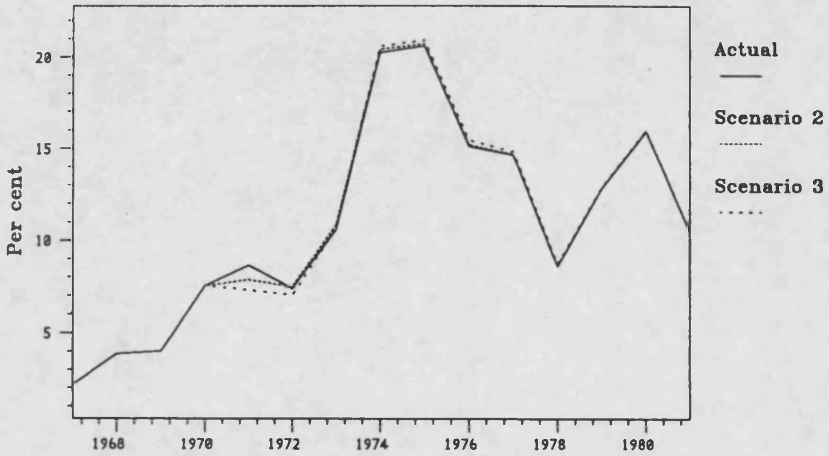


Figure 7.3.1: Agg. price inflation (1-3)

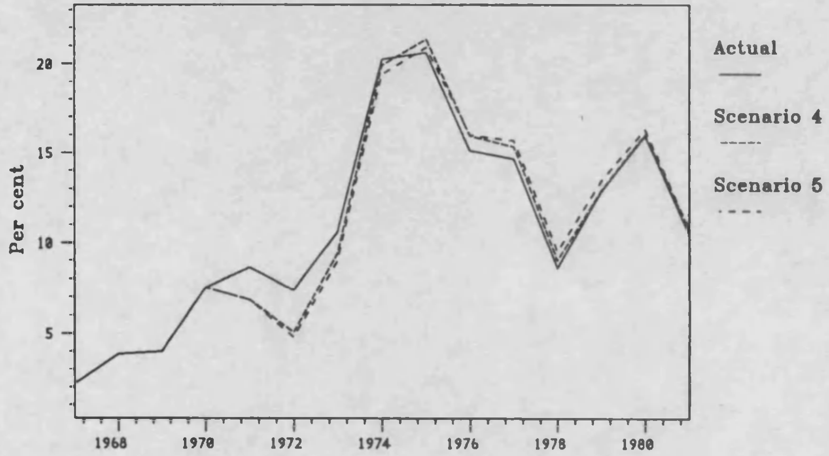


Figure 7.3.3: Agg. price inflation (1,4,5)

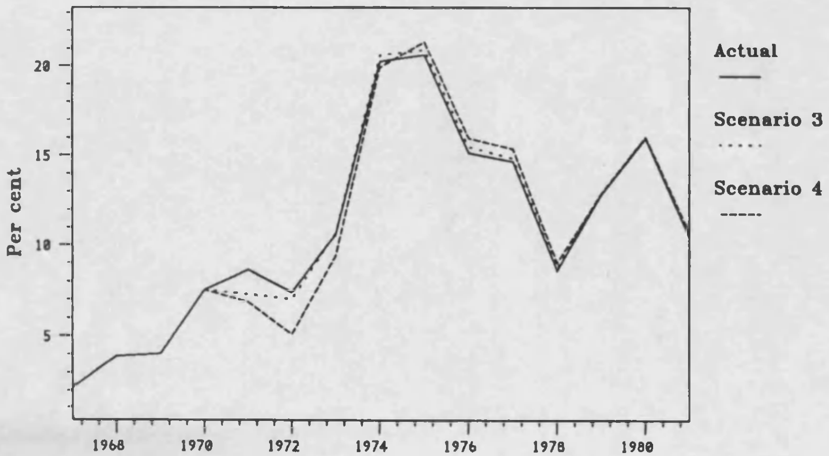


Figure 7.3.2: Agg. price inflation (1,3,4)

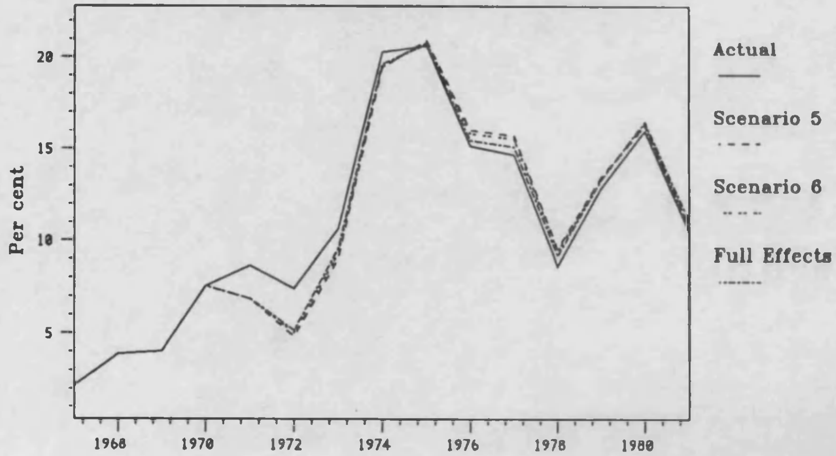


Figure 7.3.4: Agg. price inflation (1,5-7)

Figure 7.4.1: Agg. real wage inflation (1-3)

Figure 7.4.3: Agg. real wage inflation (1,4,5)

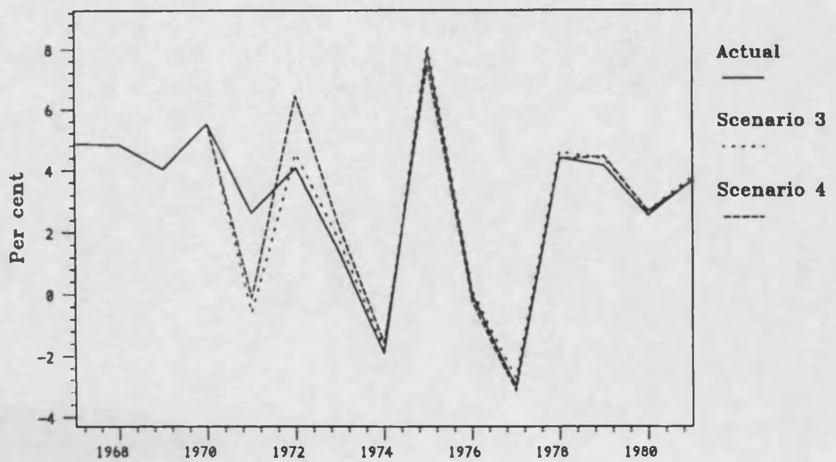


Figure 7.4.2: Agg. real wage inflation (1,3,4)

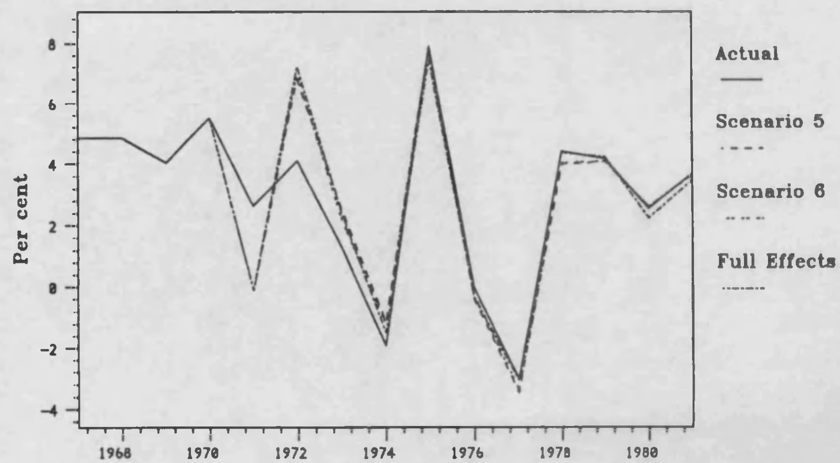


Figure 7.4.4: Agg. real wage inflation (1,5-7)

equations, the influence of the policy change on prices comes about through the industrial price equations alone, as prices are jointly determined with industrial wages, employment and output. Taken together, these movements are reflected in figure 7.4.1 where, on impact, the policy results in around a 2% reduction in real wage inflation generated through the direct effects alone, and around a further 1% reduction obtained with the additional indirect effects captured in scenario 3.

Figures 7.2.2, 7.3.2, and 7.4.2 show once more the time paths associated with scenarios 1 and 3, but include in addition those generated in scenario 4, where the expected value of the cost of material inputs to industries are allowed to be influenced by the changes instigated by the policy innovation. This extra effect has a relatively small influence on nominal wages, as shown in 7.2.2, and the new time path is almost indistinguishable from that of scenario 3 except in 1973, where the downward pressure on prices shows in a slight reduction in wage inflation. Far more clear, however, is the effect on aggregate price inflation, in figure 7.3.2, in which significant reductions in price inflation are observed between 1971-1974. This simulation highlights two extremely important points. First, the interdependancies between industries that are established through the purchase and sale of intermediate goods are extremely important in understanding the dynamics of prices. In their absence, the effects of the innovation are limited to the year of policy change, as shown in figure 7.3.1. Incorporating these feedbacks increases the magnitude of the impact effects, and significantly extends the period of time over which the policy has influence. In figure 7.3.2 price inflation is clearly effected upto 1974, but there are further marked influences in this simulation upto 1978. The second important point to note here is the significance of expectations of price movements; simulation 4 allows the expected value of material costs to respond to changes in $\bar{p}^e_t$, $\bar{w}^e_t$, and past values of (industry-specific and aggregate) prices and wages, opening up paths 3 and 5 in the diagram of figure 7.1. Feedbacks involving actual material input prices, labelled 8',9',10', and 11' in figure 7.1, are included in simulation 5 (illustrated in figures 7.2.3, 7.3.3, and 7.4.3) but are not incorporated in simulation 4. As figure 7.3.3 illustrates, the inclusion of these additional path of influence has some effect, stretching the strong policy effects to 1975, but these are small in comparison to the expectational effects captured in simulation 4. It appears that, just as the anticipation of a fall in aggregate wages was sufficient to generate wage restraint at the industrial level, so the anticipation of reductions in material costs will encourage restraint in industrial pricing decisions.

Finally in this section, we consider the feedback effects of the changes in (un)employment, as captured for the first time in simulations 6 and 7 and illustrated in figures 7.2.4, 7.3.4, and 7.4.4. Simulations 2-5 are each run taking as given the unemployment rates which were actually observed. In contrast, simulations 6 and 7 use unemployment rates derived through the estimation and aggregation of industrial employment. As the description of the model estimation of chapter 5 made clear, the model makes use of both economy-wide and industrial unemployment rates, and in simulations it is important to be clear on which industry newly-employed workers come from when extra jobs are created, and where workers go to if they become unemployed. In simulations 6 and 7, a simple strategy was employed. Where an industry contracts and sheds labour, then the number of jobs lost are translated one-for-one into an increase in that industry's unemployment figures. This corresponds precisely to the definition used in the published unemployment figures by industry, where the unemployed are classified according to the industry in which they were last employed.(3) When an industry expands, however, it is less clear where the extra workers come from, and in these simulations it was assumed that 30% of the new jobs would be filled by that industry's unemployed workers, while 70% would be filled from the unemployed in the rest of the economy.

Of course, although workers previously employed in an industry may have some advantage over others in regaining employment in that industry, because of their previous training and work experience, these figures may well overstate the size of the advantage. Indeed, it is clear that work skills are not generally specific to the industry within which an employee works, and that an analysis of labour supply disaggregated by occupational status would be likely to provide more insights here. Hence, a more elaborate model might allocate the reduction in unemployment resulting from an expansion in a particular industry across industries according to the similarities that exist between the occupational characteristics of these industries and those of the the growing industry. Further, it is well known that the labour force expands as jobs are created, as many extra jobs are taken by workers who had not previously been registered as unemployed. Once more, these new entrants are generally of a particular occupational status, so that this phenomenon is more likely to occur during the expansion of some industries than others (for example, a growth in the distribution industry might be associated with growth in the employment of women who were not previously searching for work). It is recognised therefore that the procedure employed in these simulations is rather ad hoc. In the absence of adequate data on these issues, however, the procedures used here provide reasonable and workable figures.(4)

These two final simulations demonstrate the relative insensitivity of wages and prices to unemployment rates, and it is clear that the reduction in the numbers of unemployed documented in figure 7.5 does not exert either a strong or a persistent downward pull on wages. Differences between scenarios 5, 6 and 7 are slight in most of the figures; a rise in nominal wage inflation of around 0.5% is discernible in 1972 in figure 7.2.4, and a further effect is noted in figure 7.3.4 where price inflation rates under scenario 7 falls by around 0.5% compared to scenario 6 in 1976. The first of these shows the effect of the fall in the unemployment rate in 1971 of around 0.5% as described earlier, so that there is evidence that changes in unemployment rates influence wage inflation, but the absence of any further deflationary pressure provides a clear illustration of the hysteresis effects that have been discussed previously. It is interesting to note that in both of these cases, the indirect effects of changes in unemployment, operating through agents expectations of $\bar{w}_t$ (and captured for the first time in scenario 6), are again at least as important as the direct effects of the unemployed on industrial wage setting picked up in scenario 7.

There are a number of conclusions to be drawn from these simulation experiments. First, it is clear that the imposition of a once-and-for-all policy shock has implications for nominal wages and prices which continue for many years; the feedbacks incorporated into the model here are sufficiently complex for repercussions to be noted five and six years after the imposition of the hypothesised incomes policy shock. This of course raises doubt on the precision of much of the work carried out, using aggregate wage equations, to investigate the effects of incomes policies in the past. This typically considered the impact (and possibly some catch up) effects of policy, but rarely allowed for the long term effects found here, and was simply unable to capture the important inter-industry effects in its framework of analysis.

A second conclusion to be drawn from the simulations is that indirect, expectation-based feedbacks are in many cases at least as important as actual demand and cost changes. In the simulations, expectations on future aggregate wage change, on aggregate price inflation, and on cost changes were all shown to be influential in the wage and price setting decisions made at the industrial level. This relates back to the ideas of sections 2.1 and 2.4, and associated with Taylor (1983a,b), which suggest that governments might undertake to make the process of expectation formation more "rational", possibly through the provision of a credible and widely-available forecasting service. Certainly the simulations suggest that there is scope for influential government activity in this area, since, if agents believe other agents will take the policy seriously, it appears that inflation might be "talked down" through a credible incomes policy.

Thirdly, the simulations illustrate the difficulties in capturing empirically the dynamics of labour market adjustment without employing some degree of disaggregation. Important inter-industry feedbacks were confirmed to exist both in wage setting, through wage-wage comparisons and the desire to maintain real purchasing power (relative to aggregate prices), and in price setting, through the aggregation of industrial prices into the cost of material inputs. Feedbacks from (un)employment levels, on the other hand, did not show strongly, as real wage inflation remained relatively unperturbed by movements in unemployment levels. This final point is of particular interest in view of the hysteresis debate and the continued scepticism over the usefulness of the concept of a "natural" rate of unemployment in labour economics. These issues are considered in some detail in the following subsection where the "natural" rate is investigated through simulation exercises.

7.3 Feedbacks between unemployment rates and wages and prices

In section 2.4, it was noted that the recent interest in models of wage determination based on explicit analysis of trade union behaviour had given rise to a number of explanations of why real wages might be unresponsive to labour market conditions. In particular, following the Phillips curve literature, the question was addressed of how the unemployed exert influence on wage setting in these circumstances, and some of the possible explanations of the current lack of responsiveness of real wages to high unemployment in the U.K. were noted. This discussion raised the issue of "unemployment hysteresis", in which the equilibrium level of unemployment is determined at least in part by the development of actual unemployment levels over the past. In these circumstances, it becomes less clear how one defines disequilibrium in the labour market, since equilibrating pressures on wages will be initiated at different levels of unemployment at different times (depending on recent unemployment experiences). In this section, then, attention is concentrated on the "natural rate" of unemployment, and how this concept relates to the disaggregated model that has been discussed in the last chapters. In particular, we ask how one recognises the presence of disequilibrium in the labour market, and attempt to eliminate this in a simulation exercise in an attempt to identify the "natural" rate of unemployment.

The ideas to be investigated are best explained with reference to a simplified version of the model described earlier, in which the industrial labour demand, price, and wage equations are rewritten as follows:

(i) $n = \alpha_0 + \alpha_1(w-p) + \alpha_2\sigma$

(ii) $p = \beta_0 + \beta_1 w + \beta_2\sigma$

(iii) $w = \gamma_0 + \gamma_1\overline{w}^e + \gamma_2\overline{p}^e + \gamma_3\overline{u} + \gamma_4 z$

Assuming for simplification that all industries are identical, so that parameters are the same across industries, $w = \overline{w}$ and $p = \overline{p}$, and assuming that price and wage equations are homogeneous in prices (so that $\beta_1 = 1$, and $\gamma_1 + \gamma_2 = 1$), (i), (ii), and (iii) can be rearranged with a fixed labour supply, $\overline{l}$, to obtain

(iv) $\bar{u} = \bar{l} - \bar{n} = \bar{l} - \alpha_0 - \alpha_1(\bar{w} - \bar{p}) - \alpha_2\sigma$

(v) $\bar{w} - \bar{p} = -\beta_0 - \beta_2\sigma$

(vi) $\bar{w} - \bar{p} = \gamma_0 + \gamma_1(\bar{w}^e - \bar{p}^e) + \gamma_3\bar{u} + \gamma_4 z + (\bar{p}^e - \bar{p})$

or alternatively,

(vi)' $\bar{w} - \bar{p} = \gamma_0' - \gamma_1'(\bar{w} - \bar{w}^e) - (\bar{p} - \bar{p}^e) + \gamma_3'\bar{u} + \gamma_4'z$

where $\gamma_0' = \gamma_0/(1-\gamma_1)$, $\gamma_1' = \gamma_1/(1-\gamma_1)$, $\gamma_3' = \gamma_3/(1-\gamma_1)$, and $\gamma_4' = \gamma_4/(1-\gamma_1)$. From these it is clear that there are three equations in three unknowns, $\bar{w}$, $\bar{p}$, and $\bar{u}$, explained by the exogenous variable list (σ, z, $\bar{p}^e$, $\bar{w}^e$, $\bar{l}$). Note that while $\bar{p}^e$ and $\bar{w}^e$ can be treated as exogenous to the industrial systems, they can be endogenised also, and will themselves depend on (σ, z, $\bar{l}$).

Together, (iv) and (v) provide a relationship between $\bar{u}$ and ($\bar{w}$- $\bar{p}$) based on firms' employment and pricing decisions:

$$\text{(vii)} \quad \bar{w} - \bar{p} = [-\beta_2(\bar{l} - \alpha_0) - \alpha_2\beta_0]/[\alpha_2 - \alpha_1\beta_2] + \beta_2/[\alpha_2 - \alpha_1\beta_2]\,\bar{u} = \varepsilon_0 + \varepsilon_1\bar{u}$$

This relationship complements that between $\bar{u}$ and ($\bar{w}$ - $\bar{p}$) provided by (vi) which, in the tradition of the Phillips curve literature since Friedman (1968), emphasises wage and price surprises. Taken together, (vi) and (vii) provide a solution for the unemployment level which depends on the push factors z, the expected real wage level, and price surprises

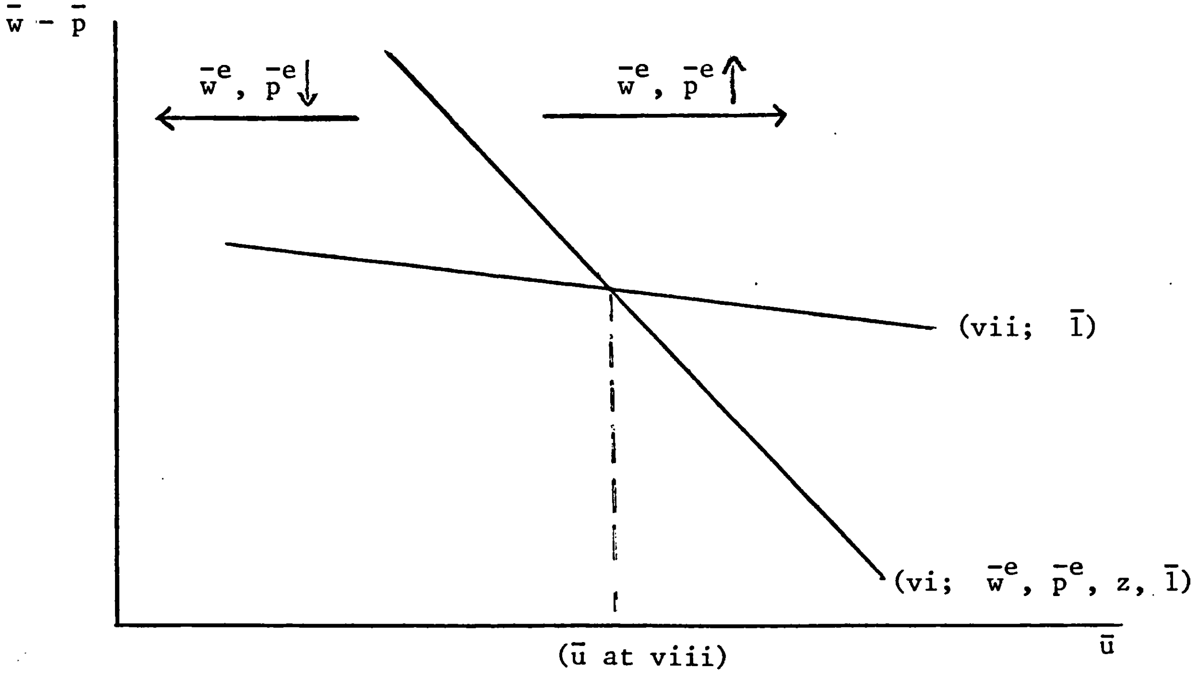
$$\text{(viii)} \quad \bar{u} = [1/(\varepsilon_1 - \gamma_3)]\ \{ (\gamma_0 - \varepsilon_0) + \gamma_1(\bar{w}^e - \bar{p}^e) + \gamma_4 z + (\bar{p}^e - \bar{p}) \}$$

This can be illustrated diagrammatically as in figure 7.6, which corresponds closely to the figure in, for example, Nickell (1986, p.102) showing equilibrium unemployment in the Layard-Nickell wage-price model. As there, the slope of the locus relating to (vii) is fairly shallow, since this is determined primarily by β_2 (the responsiveness of the markup to demand change) which is ambiguously signed. The locus for (vi) is unambiguously negatively sloped.

The "natural rate" of unemployment is identified as that level of unemployment which is consistent with no wage or price level surprises. The presence of wage or price surprises therefore indicates that the observed level of unemployment is not the "natural" one, and indeed it can be interpreted as part of the adjustment process instigated to reestablish unemployment and wages at their equilibrium levels. There is a locus in ($\bar{w}$- $\bar{p}$), $\bar{u}$ space which corresponds to (vi) in which $\bar{w} = \bar{w}^e$ and $\bar{p} = \bar{p}^e$. Here, the real wage/ unemployment trade-off generated by wage setters is given by

Figure 7.6

Equilibrium in a disaggregated wage/price model



$$(vi)^* \quad \bar{w} - \bar{p} = \gamma_0' + \gamma_3'\bar{u} + \gamma_4'z$$

and the unemployment rate at which wage setters' decisions are brought into line with firms' price and employment decisions is given by

$$(viii)^* \quad \bar{u}^* = [(1-\gamma_1)\varepsilon_0]/[\gamma_3 - (1-\gamma_1)\varepsilon_1] - [\gamma_4/[\gamma_3 - (1-\gamma_1)\varepsilon_1]\ z$$
$$= \delta_0 + \delta_1\ z$$

The intuition behind these results is straightforward. At any level of activity, and hence (un)employment, firms operate with a particular markup of prices over wages. This translates into the real wage relationship expressed at (vii). The real wage demanded by wage setters is also influenced by unemployment levels, as those with work realise that, should they become unemployed, the probability of reemployment is reduced by higher numbers of unemployed, for example. For given aggregate wage and price expectations and push factors, there is a single level of unemployment at which both firms' pricing decisions and wage setters' aspirations are brought into line, as expressed at (viii). Since the markup is unresponsive to changes in expectations or in the push variables, the achievable real wage is dominated by firms' pricing decisions and the exogenous activity variable σ. If there is an exogenous increase in wage or price expectations, then unemployment must rise to provide an offsetting downward pressure on the real wage in wage bargaining. Conversely if there is an exogenous fall in wage or price expectations, the unemployment rate must fall to bring wage setters decisions into line with the firms' chosen markup.

In this model, there is a unique level of unemployment at which firms' and wage setters' decisions correspond and at which wage and price expectations are accurate. This provides the "natural rate" of unemployment and, as shown in expression $(viii)^*$, this rate is determined by $\bar{I}$ (through δ_0), and by the push factors z. Note that, as pointed out in Layard and Nickell (1985), the elimination of wage and price surprises here requires that one of the "free" variables among the forcing variables ceases to be free. Given the monotonic transformation between $\bar{u}$ and σ provided by (iv) and (v), the expression at $(viii)^*$ provides a relationship between the variables $(\sigma, z, \bar{I})$ which has to be satisfied in order for wage and price expectations to be fulfilled. So, for example, for given levels of $\bar{I}$ and z, there is a unique, "natural" level of demand which will eliminate wage and price surprises. The expression at $(viii)^*$ provides the unique level of unemployment associated with this $(\sigma, z, \bar{I})$ combination.

The main difference between this description of equilibrium on the supply side and that presented in Nickell (1986), for example, is in its treatment of aggregate wage and price expectations. Since the aggregate wage relationship at (vi) is derived from many industrial relationships like that at (iii), in which $\overline{w}^e$ and $\overline{p}^e$ are reasonably assumed exogenous, it is unsurprising that wage and price expectations play the key role in determining the level at which actual wages and prices locate in the disaggregated model. This is illustrated most clearly by the solution of the system (iv)-(vi) presented below:

$$\text{(ix)} \quad \overline{u} = A + B\sigma$$

$$\text{(x)} \quad \overline{w} = C + \gamma_1\overline{w}^e + (1-\gamma_1)\overline{p}^e + \gamma_4 z + D\sigma$$

$$\text{(xi)} \quad \overline{p} = C + \gamma_1\overline{w}^e + (1-\gamma_1)\overline{p}^e + \gamma_4 z + (D+\beta_2)\sigma + \beta_0$$

where $A = \overline{I} - \alpha_0 + \alpha_1\beta_0$, $B = -(\alpha_2 + \alpha_1\beta_2)$,
$C = \gamma_3 A + \gamma_0$, and $D = -\gamma_3 B$

Here unemployment levels are determined solely by $\overline{I}$ (through A) and σ. Increases in the push variables z, and in $\overline{I}$, generate equiproportionate increases in both $\overline{w}$ and $\overline{p}$, while increases in σ raise $\overline{p}$ by $\beta_2\sigma$ over the increase in $\overline{w}$. Thus the real wage ((x) minus (xi)) is determined solely by σ, set at the level given by the industrial price-setting equation (v).

Nominal magnitudes $\overline{w}$ and $\overline{p}$ are driven primarily by $\overline{w}^e$ and $\overline{p}^e$, the relative importance of these two influences depending on γ_1, which determines the weights given to the expected aggregate wage and price deflators in the industrial wage equations. It is of course extremely important to know how expectations of $\overline{w}$ and $\overline{p}$ are formed if the model's properties are to be fully understood. As an illustration, consider the assumption of Perfect Foresight, imposed by taking expectations on both sides of (x) and (xi) for example. Here the model is indeterminate for $\overline{p}$ and $\overline{w}$ individually since, as it stands, the model has no element of inertia built into the movements of nominal wages or prices, and both are able to move, in tandem, to <u>any</u> level as they take the values that they are expected to take (subject to the markup determined by σ). More realistically, there are a variety of reasons, involving informational inadequacies, which might invalidate the Perfect Foresight assumption and introduce elements of inertia into the formation of expectations on $\overline{w}$ and $\overline{p}$.(5) In these circumstances, $\overline{w}^e$ and $\overline{p}^e$ may be formed independently of the industrial systems, and the process by which expectations are formed then plays a central role in the determination of levels (and rates of change) in prices and wages. It is for this reason that wage and price expectation terms are kept explicit in the model description presented above.

The estimated model of this chapter differs substantially from the stylised model presented above in a number of important respects. First, in the estimated model, price-setters also form expectations on material costs, so that (diagrammatically) we might locate off the (vi; $\overline{p}=\overline{p}^e$) locus also. Second, in the absence of identical parameter estimates across all industries, it is clear that there will be structural effects incorporated in the economy's response to unemployment which are not adequately captured in the stylised model; these effects will be compounded by the differing degrees of price homogeneity found to exist in the different industrial wage equations. Third, as the previous section illustrated, the interactions between industries are significant and complicated, introducing strong inter-dependencies and long delays in responding to shocks which are simply not considered in the stylised model. And finally, it is clear that the elimination of wage and price surprises is substantially more complicated in the estimated model than is implied by the stylised model. In the stylised model, $\overline{w}^e$ and $\overline{p}^e$ can be assumed exogenous, and the combinations of (σ, z, $\overline{l}$) which are consistent with $\overline{w}=\overline{w}^e$ and $\overline{p}=\overline{p}^e$ can be identified. However, while wage and price expectations are treated as exogenous to the industrial systems in the estimated model, they are not exogenous to the model itself. For the purpose of estimation and simulation it was essential that subsidiary equations be estimated to provide measures of $\overline{w}^e$ and $\overline{p}^e$. This was done through the estimated aggregate wage and price inflation equations. However, these equations clearly provide a further path of influence on wages and prices for (σ, z, $\overline{l}$), so that in this case it may no longer be possible to obtain simple combinations of (σ, z, $\overline{l}$) for which $\overline{p}=\overline{p}^e$ and $\overline{w}=\overline{w}^e$.(6)

Of course, it remains of considerable interest to consider the time path of the "natural" rate of unemployment over the recent past, and the generation of simulations based on the estimated model provides one means of attempting this. The simulation method will clearly accommodate the feedbacks over time and the inter-industry dependencies that are mentioned above. However, the problem of finding a simple combination of (σ, z, $\overline{l}$) which will eliminate both wage and price surprises simultaneously is difficult to overcome. Consider a situation in which price and wage levels have been higher than anticipated. An artificial increase in $\overline{l}$, for example, leaving the other two forcing variables z and σ unchanged, would raise unemployment (local and aggregate), and have a depressing effect on actual and expected wages and prices. In the stylised model presented above, the deflation on actual prices and wages will be more severe than that on expected wages and prices so long as the impact of higher unemployment on $\overline{w}^e$ and $\overline{p}^e$ are of similar magnitudes. This follows from the following expressions based on (x) and (xi):

$$(\delta\overline{w}/\delta l) = (\delta\overline{w}^e/\delta l) + \{ \gamma_3 + (\gamma_1-1)[(\delta\overline{w}^e/\delta l)-(\delta\overline{p}^e/\delta l)] \}$$

and

$$(\delta\overline{p}/\delta l) = (\delta\overline{p}^e/\delta l) + \{ \gamma_3 + (\gamma_1)[(\delta\overline{w}^e/\delta l)-(\delta\overline{p}^e/\delta l)] \}$$

These show that the impact of higher unemployment on $\overline{w}^e$ and $\overline{p}^e$ is compounded by any direct effect on wage setting, captured by the (negative) term γ_3. In these circumstances, there will be a level to which $\overline{l}$ can be raised which is sufficiently high to ensure that $\overline{p}=\overline{p}^e$. This increase in $\overline{l}$ will also serve to reduce $(\overline{w}-\overline{w}^e)$ and, if aggregate wage and price expectations are formed in a way that is consistent with the industrial systems, then a coincidence of $\overline{p}=\overline{p}^e$ and $\overline{w}=\overline{w}^e$ will be forced to emerge. However, if expectations on $\overline{w}$ and $\overline{p}$ are formed without such consistency, as is the case in the estimated model presented in this chapter, then it is recognised that these equalities will not coincide, so that there will be no $(\sigma, z, \overline{l})$ combination which gives zero wage and price surprises simultaneously. In this situation, and in what follows, the forcing variables will be manipulated to attempt to achieve $\overline{p}=\overline{p}^e$ (allowing $\overline{w} \gtrless \overline{w}^e$), and the level of unemployment corresponding to the derived $(\sigma, z, \overline{l})$ combination will be identified. While this is not the standard interpretation of the "natural" rate of unemployment, it is obviously closely related and it will provide some idea of the development of the "natural" rate over the recent past.

In the following paragraphs, this scenario, in which $\overline{l}$ is manipulated to eliminate price surprises, is investigated over the period 1954-1981 through a model simulation. The decision to manipulate $\overline{l}$ is not an obvious one to make since in practice governments might aim to stabilise inflation through monetary and fiscal policy, or through an incomes policy, so that σ or elements of z would be the control variables used. However, as the discussion above explains, there is a symmetry about altering any of the forcing variables $(\sigma, z, \overline{l})$, and in the simulations, it is rather easier to achieve no price surprises through $\overline{l}$ manipulation than through either of the other variables, and the interpretation of results is clearer.

The extent to which the chosen forcing variable should be altered to eliminate price surprises is by no means obvious because of the complicated feedbacks between industries and across time which are incorporated in the model. Manipulation of the forcing variable in one period will have repercussions on the economy for many years after, and subsequent manipulation has to take this into account. As an illustration, assume that $\overline{l}$ is controllable and is used to raise and lower unemployment rates directly. It is noted that because the growth in the unemployment rate is important in the formation of price and wage expectations, the elimination of a sequence of positive price surprises will involve successively larger increases in $\overline{l}$. An increase in $\overline{l}$ in the first year will raise unemployment over its former level and exert downward pressure on $(\overline{p}-\overline{p}^e)$ and on $(\overline{w}$-

$\overline{w}^e$). However, with no further manipulation of $\overline{I}$, this will reduce unemployment growth below its former level in the second year, and the simulated values of ($\overline{p}$-$\overline{p}^e$) and ($\overline{w}$-$\overline{w}^e$) will rise. Where there is a sequence of positive price surprises then, $\overline{I}$ must be raised not only to eliminate the price surprise, but also to offset the effects of the previous changes imposed on $\overline{I}$.

These dynamic problems complicate the issue of choosing appropriate levels of adjustment in $\overline{I}$, but the task would be still more complex if σ or z was the chosen control variable. While $\overline{I}$ affects only unemployment rates directly (and through these wage and price expectations plus industrial wage setting), σ has a direct, and often conflicting, influence on wage and price expectations, and on the equations explaining industrial wages, prices, and employment. Because such complicated feedbacks are involved, the main point of the exercise, which is to identify the "natural" rate of unemployment, would be obscured. It is for this reason that only $\overline{I}$ manipulations are considered here, answering the question "What levels of unemployment would have been required to eliminate price surprises over the period 1954-81 given the developments of σ and z during that time?".

Figure 7.7 provides the specific answer to this question obtained through model simulation, illustrating the actual time path of the unemployment rate over the sample period and that achieved after manipulation of $\overline{I}$ (termed the "natural" simulation on the diagram). In fact, $\overline{I}$ was altered to attempt to obtain values of ($\overline{p}$-$\overline{p}^e$) which lie in the interval (-0.05,0.05) since any further degree of fine-tuning was not possible. As it is, the figure demonstrates once more the lack of responsiveness of nominal values to unemployment rate movements, since relatively large swings in the unemployment rate are necessary to achieve the targets set. Indeed, as demonstrated in figure 7.10, it was simply not possible to achieve price surprises in the target band in 1964, 1966 and 1969 because aggregate unemployment rates had already been reduced to just 0.05%, and further reduction seemed simply unreasonable.

While the simulated paths of figure 7.7 appear rather volatile, the underlying trends observed are quite consistent with previous studies in this area. Figure 7.8 smooths out the unemployment rate paths in figure 7.7, plotting a five year moving average of the actual and "natural" simulated unemployment rates.(7) Over the period 1956-66, the "natural" rate of unemployment was on average just 0.34% above the actual rate, according to this simulation, and this discrepancy rose to 0.84% through the period 1967-74 (during which, the natural rate was in the region 3.46%). The largest gap between the two rates occurred during the period 1975-79 when the natural rate rose to around 5.66%, which was some 1.20% higher than the actual rate. This trend was sharply reversed in the last two periods of the sample, 1980-81, however, where the gap had reduced to its

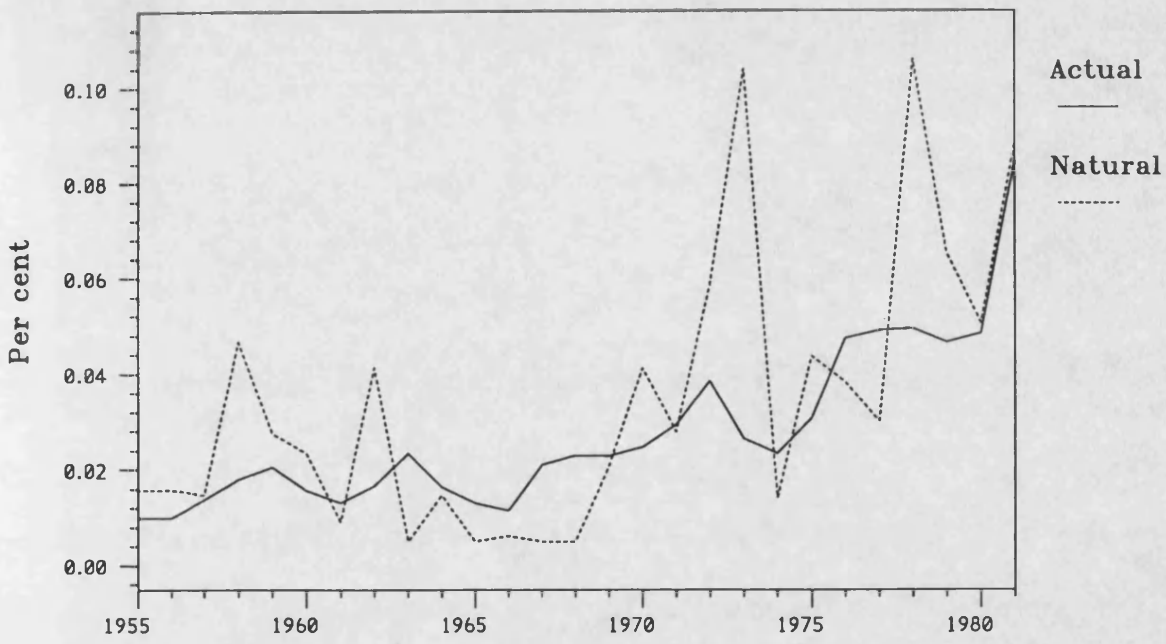


Figure 7.7: Unemployment rate

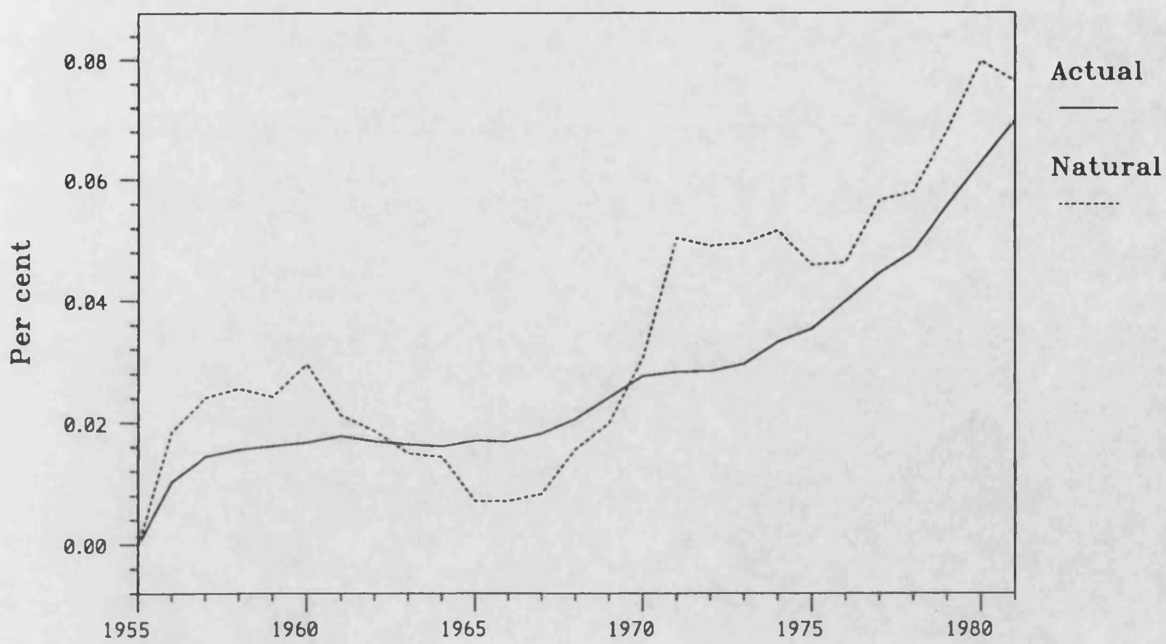


Figure 7.8: Unemployment rate (moving average)

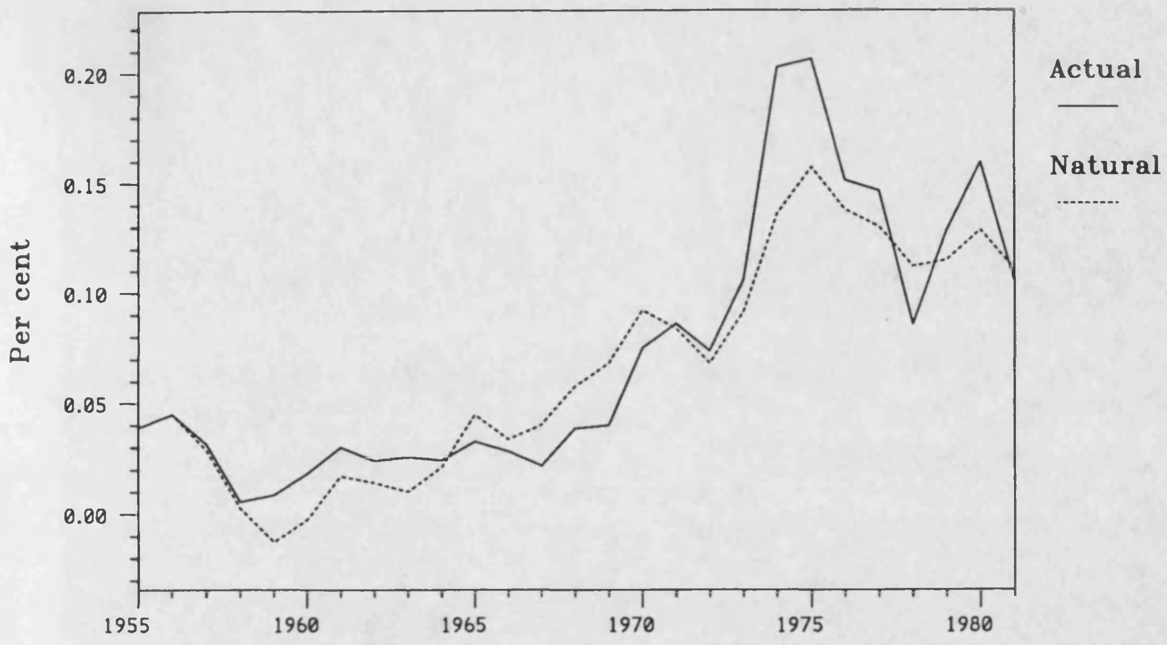


Figure 7.9: Price inflation

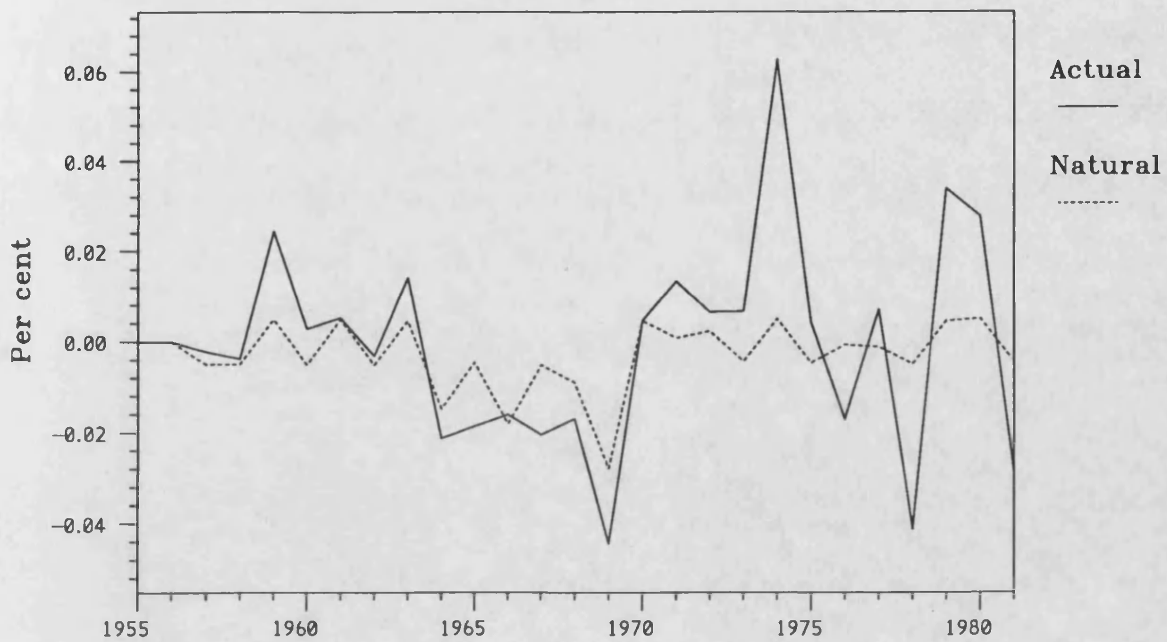


Figure 7.10: Price surprises

lowest level of 0.30%, with the natural rate rising to 6.96%. These figures correspond closely to those in Layard and Nickell (1985), although they are not directly comparable since the measurement of unemployment employed differs from that used here. Moreover, their analysis was able to extend the sample period upto 1983, and it is estimated that actual unemployment rates rose above the natural rate, on average, during this (extended) final period, 1980-83. Of course, given the sample period used in the current study, this can neither be confirmed nor rejected, but the very sharp reversal in trend that is already noted is of course perfectly consistent with these calculations.

Perhaps the most interesting result obtained through this simulation is the close association that is found between the time paths of the actual rates of unemployment and the "natural" rates that have been calculated. In a simple regression, some 71% of the variability in the (moving average) representation of the "natural" rate can be explained in terms of the actual unemployment rate lagged one period. This indicates that the rate of unemployment below which downward pressure on wages is initiated is determined to a large extent simply by the rate of unemployment experienced last period. Obviously, the tendency for the labour market to adjust freely to eliminate unemployment is, at best, only very weak; in these circumstances, there is clearly an incentive for active government intervention in the labour market to stimulate employment and reestablish equilibrium unemployment rates at a new lower level.

7.4 The structure of industrial feedbacks

In both of the sections above, we have emphasised the significance of inter-industry interactions in understanding the process of adjustment in the labour market. The simulations make clear the importance of both direct industry-to-industry links, and indirect links through expectations formed on aggregate developments. However, although the disaggregated nature of the analysis is central to the results obtained, the discussion so far has focussed on their impact on aggregate variables only. Of course, underlying the changes documented above are important **structural** developments which we could also consider, and we comment on these in this section.

Figure 7.11 illustrates this point. Here, the 38 industries are classed into one of four groups according to the Manufacturing/Non-Manufacturing split, and according to the level at which wage bargaining takes place. Among the manufacturing sector, industries 11-20 (which might be termed 'heavy manufacturing industries') are assigned to group A, as wage settlements in these industries have tended to be more affected by industry wide agreements than elsewhere in the manufacturing sector. Among the Non-Manufacturing

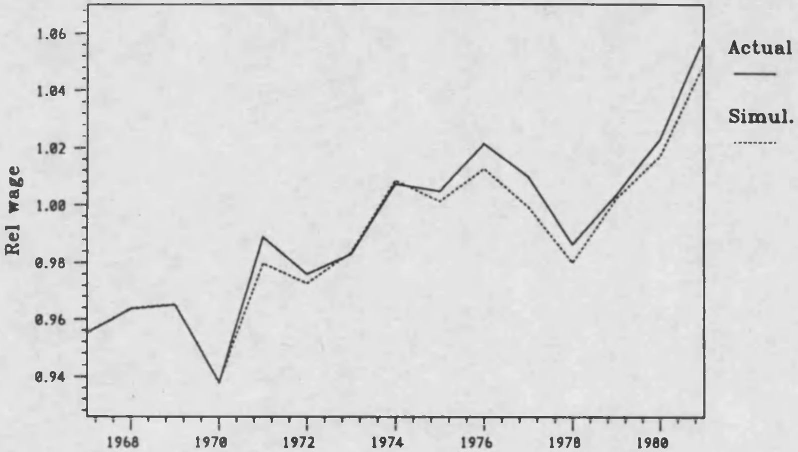


Figure 7.11.1: Wages in Manuf. grp A relative to aggregate wages

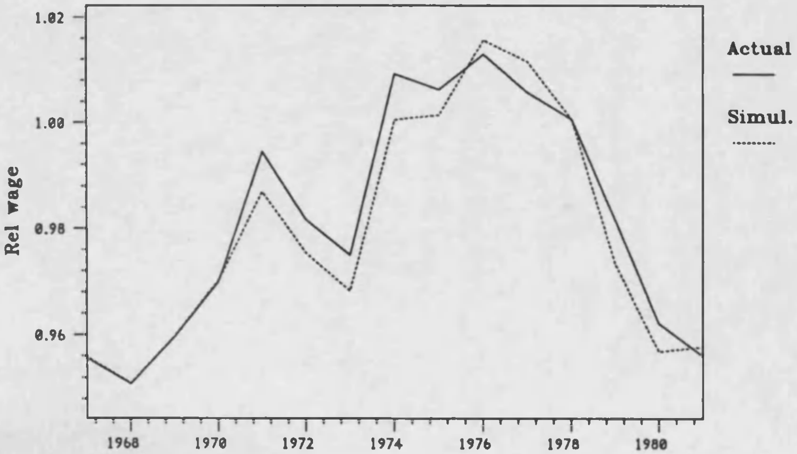


Figure 7.11.2: Wages in Manuf. grp B relative to aggregate wages

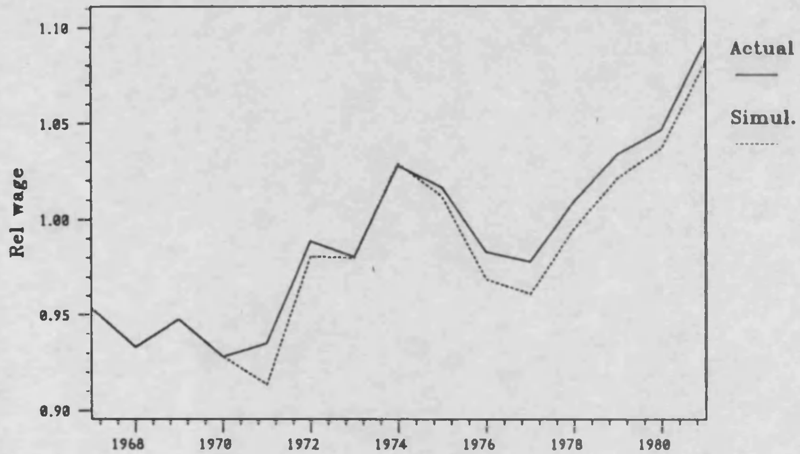


Figure 7.11.3: Wages in Non-Manuf. grp A relative to aggregate wages

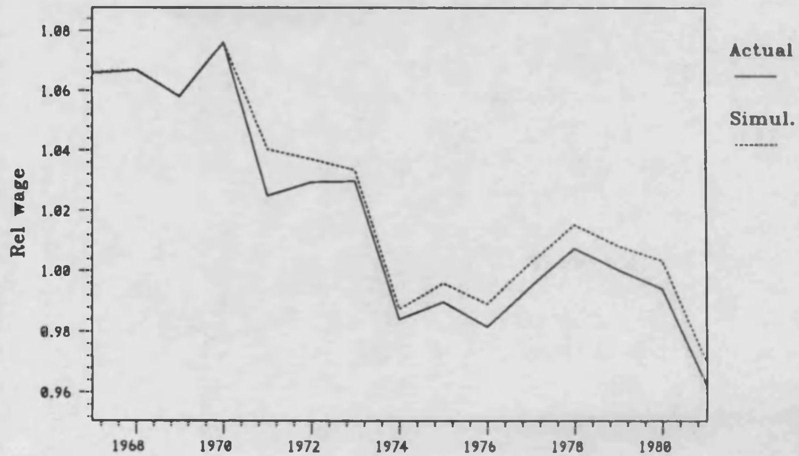


Figure 7.11.4: Wages in Non-Manuf. grp B relative to aggregate wages

sector, the agriculture, energy, and transport industries (i.e. industries 1-3, and 29-32) were assigned to the corresponding 'centralised bargaining' group, A. While this assignment of industries is a little arbitrary, some justification for the choice is provided by figures given in Brown (1981) on the proportion of establishments in an industry in which industry wide agreements were the most important level of wage negotiation. Moreover, this four sector classification allows us to consider in a more tractable way the structural changes that underlie the adjustment of the supply side to shocks. Specifically here, for example, the division enables us to examine the hypothesis that wages set in industries where wage bargaining takes place at a high level of centralisation may be more responsive to incomes policy than those set in industries using highly decentralised bargaining procedures (where enforcement may be more difficult to implement). If this is the case, then one would expect relative wages to fall in the former industries (groups A) in the face of an incomes policy shock.

Figure 7.11 shows that this is indeed the case, plotting both the actual evolution of wages in these sectors relative to the aggregate wage and that obtained in the simulation above in which an incomes policy effect is imposed in 1971. So, for example, the simulated paths of relative wages are substantially lower than those actually observed over most of the period following the shock in both Figures 7.11.1 and 7.11.3, which show relative wages in Manufacturing group A and Non-Manufacturing group A respectively. Relative wages remain comparatively unchanged in Manufacturing sector B, but there are considerable increases in relative wages in Non-Manufacturing group B, as shown on Figure 7.11.4. Of course, this is only a very simple look at the role of bargaining arrangements in the implementation of incomes policy, but it provides a good illustration of the sort of structural changes that underlie the simulations described above.

This simple example illustrates the fact that different sectors exhibit different characteristics, and respond differently to policy measures. It is in recognition of this fact that a case can be made for an **industrial strategy** in which policy is designed taking explicit account of these structural considerations. This case is a strong one, since policy measures can be directed at areas where they will be most beneficial and will therefore be most cost-effective. On the other hand, the simulations above illustrate also the complexity of the interactions between sectors that are observed in response to policy action. These interactions mean that the impact of policy on any sector is more difficult to assess, and must take into account the feedbacks initiated by adjustments made by sectors elsewhere in the economy in response to policy innovations. This of course includes those adjustments which move in the opposite direction to that which the policy aims to push the economy. For example, imagine that a policy is designed to achieve employment growth in a particular sector of the economy. Imagine also that this is achieved with little cost in terms of inflationary pressure in the sector. It is possible that the reduction in unemployment that is achieved causes an increase in inflationary pressure, through its impact on expected aggregate wage movements, throughout the economy. The ultimate effect of the increase in wage costs may offset the direct effect of the policy in the initial sector, while unemployment may also rise elsewhere in the economy. Of course, this example does not negate the case for structural policies, but it does demonstrate the need for well devised plans which involve **coordinated** structural policies for employment growth and wage control.

Figures 7.12 and 7.13 provide a good illustration of the usefulness of structural policies and the need for some sophistication in the specification of these policies in the face of complicated sectoral adjustments. In these figures, we aim to demonstrate the structural effects on employment and wages of a change in the levels of industrial capital that might be achieved through a policy to increase capital investment. Specifically, we use the model described earlier in the chapter to simulate the effects of a 0.5% increase in the level of capital in all industries in 1971, obtained through the introduction of a capital grant scheme, say. We then examine the employment consequences in the four sectors described above, distinguished according to the Manufacturing/ Non-Manufacturing split and the level of centralisation at which wages are generally set. Two simulations are considered. In the first, while prices, wages and employment in the various industries are allowed to change, unemployment levels are assumed to remain unaltered from their actual levels (as though any new jobs created are filled by people previously not in the labour force, and as though any people losing a job simply leave the labour force). In this first scenario, therefore, changes in the level of capital in a particular sector affect employment in that sector directly through capital labour substitution, and indirectly through it's impact on prices and, hence, output levels. The price effects also have repurcussions that go beyond the initial sector, and these feedbacks are also captured in the first scenario. Of course, in general, a second path of influence from one sector to another is that generated through the unemployment rate, as changes in the level of employment in a particular sector alters the tightness of the labour market both locally and across all industries. By assuming that employment changes are reflected entirely by changes in the labour force in the first scenario, this path of inter-industry interaction is eliminated. It is reintroduced in the second scenario, however; here, the employment change is accomodated in the model as described earlier in the chapter, and employment growth will now affect wages through the influence of local labour market slack on industrial wage setting and through its effects on aggregate wage expectations.

Concentrating initially on the first scenario, we note first that there are substantial structural differences in the effects of the introduction of the capital grants, and secondly that the full implications of the introduction of the grants are seen only over a

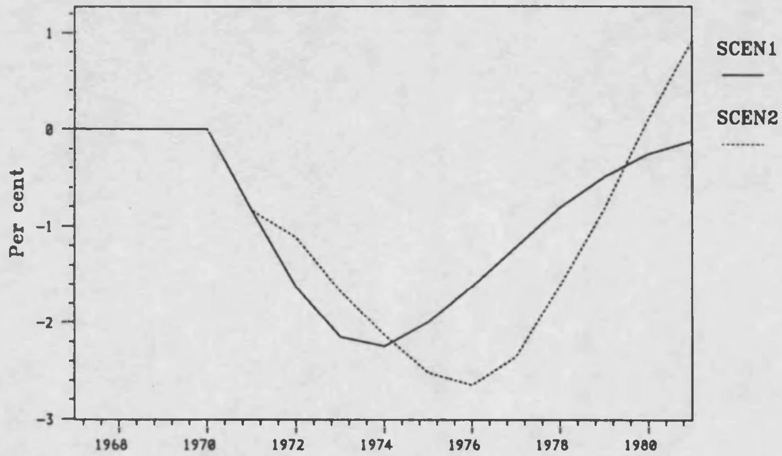


Figure 7.12.1: Prop. change in employment (Manuf. grp A)

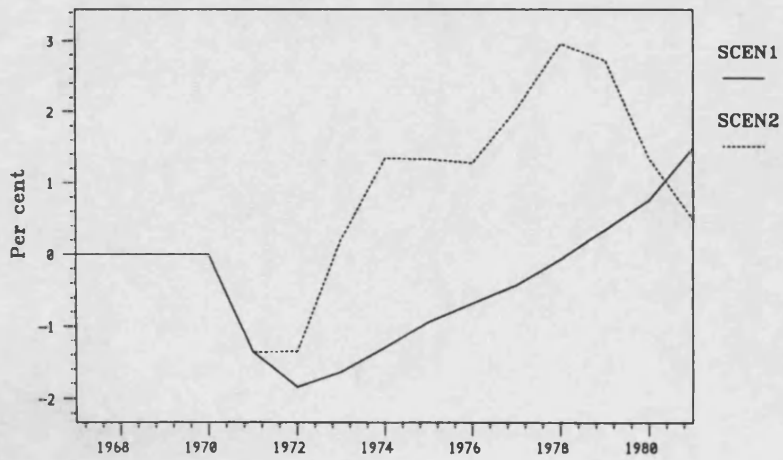


Figure 7.12.2: Prop. change in employment (Manuf. grp B)

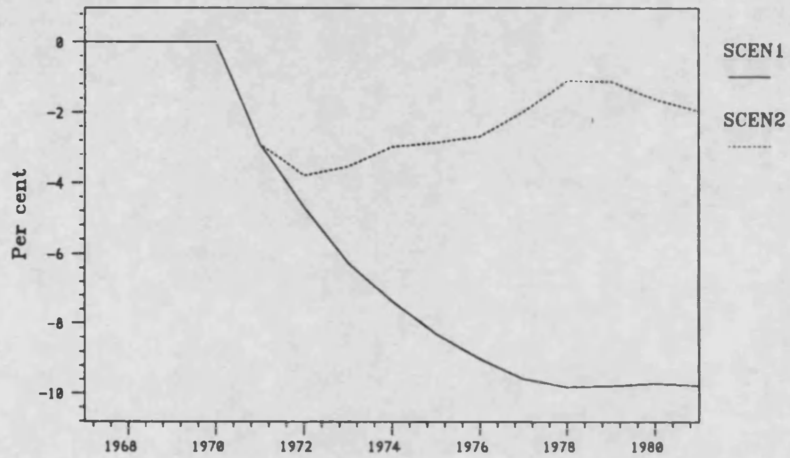


Figure 7.12.3: Prop. change in employment (Non-Manuf. grp A)

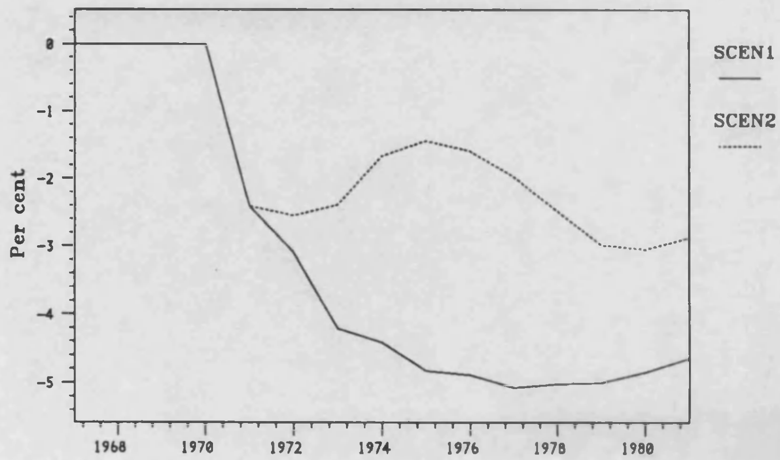


Figure 7.12.4: Prop. change in employment (Non-Manuf. grp B)

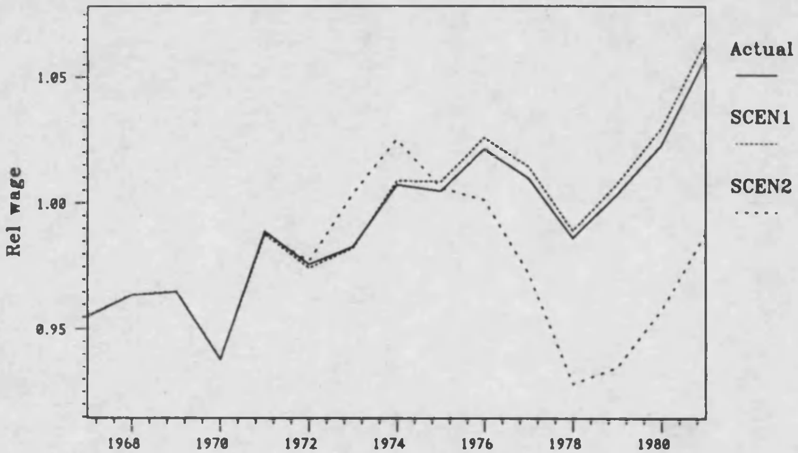


Figure 7.13.1: Wages in Manuf. grp A relative to aggregate wages

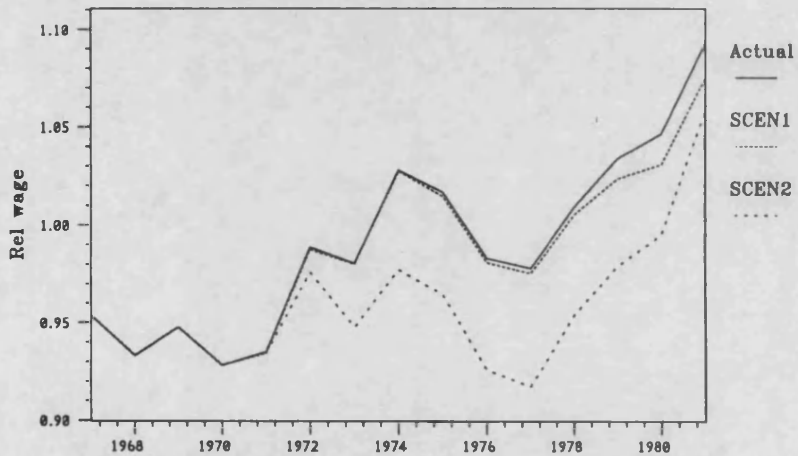


Figure 7.13.3: Wages in Non-Manuf. grp A relative to aggregate wages

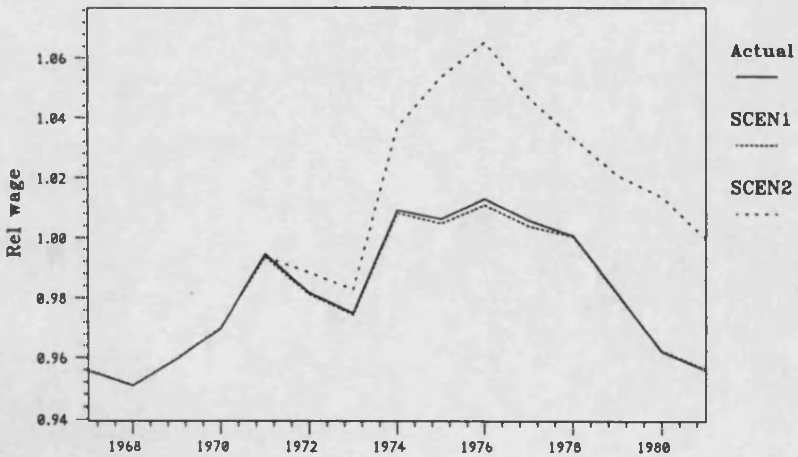


Figure 7.13.2: Wages in Manuf. grp B relative to aggregate wages

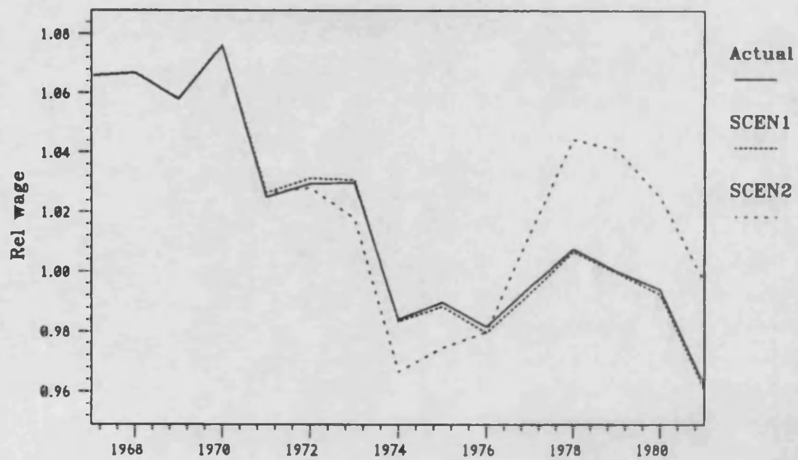


Figure 7.13.4: Wages in Non-Manuf. grp B relative to aggregate wages

considerable length of time, with adjustment to the policy changes still apparent after ten years in some cases. In Figures 7.12.1- 7.12.4, for example, we plot the changes in the level of employment relative to the actual level of employment observed in each of the four sectors of the economy described above. Scenario 1 is shown in each case by the solid line, and indicates that employment falls initially in every case in response to the imposed increase in capital in 1971. While employment recovers in the Manufacturing sectors (both A and B) over the following ten years, however, it remains low relative to that which was actually observed in both of the Non-Manufacturing groups. These developments can be explained in terms of the characteristics of the groups themselves, and indicate clearly the usefulness of selective capital grant aid in policy design. Specifically, inspection of the coefficients of tables 7.1-7.5 indicates that the scope for capital-labour substitution is greater in the Non-Manufacturing sector industries than in the Manufacturing industries, as implied by larger estimates of the elasticity of demand for labour with respect to capital in the former industries. Increased capital investment results in an initial fall in employment in all sectors, therefore (as less labour input is required for a given level of output), but this shake-out of labour is most pronounced in the service sectors. Of course, the effects of capital-labour substitution are offset to some extent since these developments are associated with a reduction in prices, and consequently, with growth in output demand. In the simulation of scenario 1, aggregate price inflation in 1971 is 6.6%, compared to the 8.6% which was actually observed. In 1972, inflation is again around 2% lower in the simulated run than was actually observed. It is 1% lower in 1973, and it is of a comparable order thereafter. The associated price reductions are spread fairly evenly over all industries, but the responsiveness of output to the price changes differ considerably. Specifically, it is the manufacturing sectors which benefit most in terms of increased output demand as prices fall, as industries in these sectors show the largest (domestic and imported) price elasticities in their output demand equations. As a consequence, output grows more quickly in these sectors (so that the proportion of total output produced rises from 45.7% to 46.8% by the end of the sample period), and employment grows also. Although the output elasticity of demand for labour is relatively high in the Non-Manufacturing sector, the responsiveness of output to price reductions is low, so that there is less employment growth obtained through this source in these sectors, and employment levels in the simulated run remain low relative to their actual levels.

The first scenario indicates very clearly the usefulness of selective capital grants as the long run effects are far more satisfactory in the Manufacturing sector than in the Non-Manufacturing sector. (Indeed, the overall effects of the increase in capital levels in scenario 1 is, because of the large reductions in employment in the Non-Manufacturing sectors, to reduce total employment levels. Of course, such an extreme outcome may be moderated if the installation of the new capital results in productivity gains and further improvements in competitiveness which are not accomodated in the simulations. Nevertheless, the significance of the structural effects remains clear). Moreover, even within the manufacturing sector, there are gains from selectivity. Specifically, the scope for capital-labour substitution appears lower in Manufacturing group B than in Manufacturing group A, while the price responsiveness of output demand in the former is larger, so that the expansionary effects described above are more pronounced in group B than in group A, even within the manufacturing sector. Moreover, although the impact of the 'internal' effects on wages are relatively small throughout the economy, these are slightly greater among the industries in Manufacturing group A than Manufacturing group B. Hence, as the internal pressures for employment growth are felt, there is more upward pressure on wages in this group than elsewhere. This is reflected in Figure 7.13.1, where wages in the sector, measured relative to the aggregate wage level, are shown to rise slightly during the period. This effect is small, and indeed one can see that relative wages are little affected in all of the groups in this first scenario, but it will contribute to the observed slowdown in employment growth in Manufacturing group A which is not observed in Manufacturing group B.

Turning now to the second scenario, we note that at the aggregate level, the changes in prices observed in scenario 1 are less pronounced than those found in scenario 2, in which the impact of employment changes are reflected in changes in unemployment levels. Hence, aggregate price inflation in scenario 2 falls by 2% (compared to its actual level) in 1971, as in scenario 1, but this is followed by a fall of 3.3% in 1972, growing to 4.4% in 1974 and 1975, before falling back to a 2% reduction by the end of the period. Clearly, the effects on price inflation are far more pronounced, and extend over many more years than in the first scenario. These developments are explained if we recognise the feedbacks from unemployment to nominal wages, and then to prices. In scenario 2, the fall in employment documented above raises the aggregate unemployment rate in 1971 by 1.9%, as the simulated unemployment rate of scenario 2 is 4.8%, and this is compared to the actually observed rate of 2.9%. This simulated increase falls to 1.2% by 1974, but this additional level of unemployment in maintained until the end of the period. Of course, higher rates of unemployment exert downward pressure on nominal wages (directly at the level of industrial wage settlements, and indirectly through expectations of future aggregate wage inflation), and this in turn reduces prices, so that the reduction in price levels noted in scenario 1 are exacerbated. As we shall note below, there are some differences in the extent to which these price reduction were distributed across the sectors of the economy (as relative price movements partially reflect differential movements in wages). However, the price reductions are fairly evenly spread across the industrial sectors, improving international price competitiveness throughout the economy. Moreover, as noted above, this will improve the demand for manufacturing output, reflecting the heavy reliance of these sectors on trade, and hence employment prospects in these sectors (particularly in Manufacturing group B). Certainly the fall in prices will help explain the improvement in employment levels observed in scenario 2 in all sectors over that observed in scenario 1, as documented in Figures 7.12.1-7.12.4.

Even more significantly, however, Figures 7.13.1-7.13.4 show that while there are only moderate movements in relative wage in scenario 1, there are more noticable effects on relative wages found in scenario 2. Underlying these relative changes is the tendency for rather more wage moderation in those industries in Manufacturing and Non-Manufacturing groups A (i.e. those with a more centralised wage bargaining structure) than in those industries in the corresponding group B classes. Hence, by 1975, simulated nominal wage levels in scenario 2 are some 11.8% lower than their 'true' levels in Manufacturing group A, compared to 7.8% in Manufacturing group B, while in the Non-Manufacturing group (where the local unemployment rates grow most quickly for the reasons described above) nominal wages are 16.5% and 13.3% lower in groups A and B respectively. These disparities become even more marked by the end of the period: nominal wages in Manufacturing group A and B are 26.5% and 17.7% lower than their 'true' levels, while those in Non-Manufacturing sectors A and B are 23.8% and 18.4% lower respectively. These changes are clearly reflected in the relative wage movements documented in Figures 7.13.1-7.13.4. Moreover, although relative price movements show a similar pattern across the sectors (and this in turn is reflected also in material input price changes), the price of labour inputs relative to material inputs, which is of importance in the labour demand decision, also falls in the group A industries compared to the group B industries. Obviously, some part of the extra wage moderation observed in the group A sectors reflects the severity of the changes experienced in the local labour markets following the policy implementation; we have already noted that the group B industries in the Manufacturing sector will benefit more in terms of employment than the corresponding group A industries, and Figures 7.12.3 and 7.12.4 show that the employment shake-out in Non-Manufacturing group A is more severe than that in group A in scenario 1. However, the ultimate employment effects of the policy change, when the relative wage movements are included, indicate that the group A industries fare well relative to the group B industries, so that the relative wage movements more than offset the direct effects of the policy captured in scenario 1. Hence, we note that falling wages in Manufacturing goup A in the period 1975-1978 results in employment growth which substantially outpaces that observed in scenario 1. Equally, in Non-Manufacturing group A, continually falling wages throughout the period 1972-1977 results in employment growth which almost offsets the capital effects documented in scenario 1. In contrast, the large increases in relative wages observed to occur in 1974-1976 in Manufacturing group B are reflected in a lower rate of growth in scenario 2 than observed in scenario 1, and ultimately the employment gains achieved in scenario 1 are by and large lost. Finally, we note the initial fall in relative wages in Non-Manufacturing group B observed over the period 1973-74 which is associated with rising employment in the sector (relative to scenario 1). This is followed by a progressive rise in relative wages over the period 1975-1978, however, and this is reflected in a falloff of employment from 1976 onwards, so that this sector ultimately loses more jobs than any other sector in the economy.

Of course, the four-sector division used above is too coarse a classification for use in actual policy prescription. However, the simulations do illustrate the difficulties involved in constructing an industrial strategy when there are inter-industry interactions initiated by industries' adjustment to the policy. This does not mean that an industrial strategy is not workable, but means that there needs to be a coordinated industrial strategy on pay and employment. In the above example, directing investment grants to the Manufacturing sectors is clearly preferable to a blanket coverage of the economy in terms of the jobs that can be created. On the other hand, such a policy will not be as successful as might be hoped if there is not also a policy on wages which can hold in check the wage inflation that will ensue if the investment programme is successful, especially in those sectors in which higher levels of unemployment had been exerting reasonable downward pressure on wages prior to the policy (i.e. group A industries in the example above). Innovative policies are needed which could tie these two aspects of adjustment together. For example, in order to generate more jobs, a scheme can be envisaged in which investment grants are awarded only to those industries in which there is likely to be a substantial employment benefit. In the light of the above discussion, it might also be reasonable to insist that the award is offered only if the industry also adopts a training scheme which will offset the sort of labour market shortages which could subsequently generate upward wage pressure in the industry. Alternatively, the awarding of a grant might be tied to changes in the wage bargaining institutions of the industry. Such policy prescriptions require further consideration, and go beyond the scope of this work. Nevertheless, the simulations above demonstrate clearly the need for more sophisticated industrial policies in order to reduce the level of unemployment without incurring higher inflation.

7.5 Concluding comments

The results of sections 7.2-7.4 provide a reminder of the usefulness of disaggregation in investigating the processes of adjustment involved in the labour market and illustrate the importance of various paths of influence which are often overlooked in more aggregate empirical studies. These insights often arises not because of any new developments obtained at the theoretical level, nor because of the availability of more information, but simply because emphasis is placed on rather different issues in disaggregate work, both in discussion and in analysis, than in aggregate work. So, for example, in emphasising disaggregation in the discussion of wage setting behaviour, it became clear that individuals may use an aggregate wage rather than an aggregate price deflator in assessing the real worth of their negotiated nominal wage, and indeed, the whole notion of wage-wage comparisons in wage bargaining was raised in importance and highlighted. Equally, given the time and effort involved in the estimation of the 160+ equations of the model presented here, the problem of informational inadequacies in the formation of expectations was clearly illustrated in the disaggregate work. The assumption that expectations may be formed on the basis of readily available, aggregate information only is made far more acceptable with these difficulties in mind. Of course, both of these issues can be accommodated into aggregate empirical work, and they have been in the past. However, such issues have a much clearer intuition at the disaggregate level and this results in this shift in emphasis.

Perhaps still more significant in the results of this chapter, however, are the gains in information and the possibility of examining extra mechanisms of adjustment that are achievable in this disaggregated work. So, for example, the transmission of price change along the chain of production examined in our disaggregate model simply could not have been accommodated into an aggregate analysis of price movements by construction of the model. Equally, while the importance of structural change can be investigated through the use of an aggregate index measuring such change, this approach is unlikely to be sufficiently flexible to be able to capture the effects of both the different rates of change of variables across industries and of the different degrees of responsiveness of industries to these changes (as captured by different parameter estimates in the disaggregated model).

The practical significance of many of these issues has been demonstrated in the empirical work of this chapter. For example, on the basis of the results of section 7.2, it was argued that nominal wages would be a reasonable target for manipulation through government policy. Here, expectations of aggregate wages were seen to be the single most influential factor in the determination of industrial wages and, it was argued, the provision by the government of a high-profile, credible wage target could provide it with a useful policy tool through which to influence wage expectations and hence wage setting in general. Further, it was argued that policies which rely on free adjustment of the labour market to eliminate unemployment were unlikely to succeed, as strong hysteresis effects were observed, as demonstrated graphically in section 7.3. Moreover, the disaggregate structure of the model suggested a rather novel source for these hysteresis effects, emphasising the importance of expectation formation. The simulation experiments illustrated that the deflationary effects of unemployment growth, influencing the formation of aggregate wage expectations, were at least as important as the direct effects of local unemployment rates damping down industrial wage settlements, and it is the former effect which has been identified with the hysteresis phenomenon.

As has been stressed throughout the last two chapters, the process by which expectations are formed is not the central issue of this work, and the subsidiary equations used to generate $\overline{w}^e$ and $\overline{p}^e$ in the simulations were simply the best statistical representations to be obtained if only aggregate information was to be used. However, it would be most interesting to investigate more thoroughly the process of expectation formation, perhaps through the use of direct, survey-based measures of expectational variables, and in particular it would be of interest to investigate more formally the responsiveness of the direct measures of wage expectations to levels and changes in the unemployment rate. It is instructive to recall the tone of the press coverage of the unemployment figures in the late 1970's/early 1980's and compare this to the relatively tolerant attitude taken to high, but falling, unemployment experienced over the recent past. On this informal basis, there appears to be a good case for the argument that changes in unemployment have more impact on people's perceptions of the state of the labour market than actual unemployment levels. Certainly, in the light of the findings of the simulation experiments, a study of how individuals form their views on the "tightness" of the labour market would provide important information on the time paths of any targets to be established if active government intervention in wage setting was to be attempted.

Finally in this chapter, we noted the case for an **industrial** strategy in the construction of government policy. This acknowledges the wide variation in industrial characteristics that exists, and, consequently, the varied reactions which will ensue following the implementation of government measures. In this, however, we also emphasised the complexities of inter-industry interactions, highlighting in section 7.4 the effects that policy-induced changes in one sector have elsewhere in the economy. It is argued that these interactions should be explicitly accomodated in policy formulation, noting that measures designed to promote employment growth must be coordinated with those aiming to reduce inflationary pressures, with each directed at those industries which will be most responsive to policy.

CHAPTER 8

Conclusions

In this final chapter of the thesis, we provide an overview of the ideas and findings expressed in the previous chapters, reflecting first on the discussion and evidence presented on the causes of inertia, and then considering the consequences of inertia that have been identified in the course of the work. Finally, we focus on some of the policy implications that have been drawn out of these. In doing so, we note that the work has concentrated on two related themes, both of which are shown to be important through the empirical work in understanding the evolution of the UK supply side over the past, and in constructing policy measures to help reduce unemployment and to fight inflation.

The first of these themes emphasises the **institutional detail** involved in the workings of the supply side, since these provide reasonable explanations for the existence of wage and price rigidities. So, for example, in chapters 2 and 5 we noted the importance of the internal organisation of unions in affecting negotiation costs in wage bargaining, and hence nominal wage inertia. Similarly, we noted how the nature of the product being sold affects 'shopping costs', and hence price inertia, through the costs incurred by a producer in responding to changes in costs or demand conditions with price adjustments. Finally, as another example, in looking at real wage rigidities, the discussion of union based models of wage determination showed how the institutional arrangements of the players involved in wage bargaining, or indeed the bargaining framework itself, could affect the wage outcome, and the responsiveness of wages to local and aggregate labour market conditions. In each of these examples, it is real world institutions which provide the explanation for the cause of rigidities.

The second theme of the thesis stresses the issue of **disaggregation.** This issue is significant on a number of fronts: first, it is argued that many of the important institutional arrangements involved in wage and price setting reflect the difficulties faced by any individual unit in interacting with others and anticipating their actions (good examples of this are provided by the discussion of the influences of market structure on individual firms' price setting behaviour, or by the discussion of the significance of wage comparabilities in wage setting); second, it is argued that the inertia generated at the level of the individual unit is compounded for the economy as a whole as units interact and recognise the inflexibility shown elsewhere in the economy; and third, it is recognised that the presence of (differing degrees of) wage and price inertia across sectors means that there may be substantial structural changes implied by any real or nominal shock (including policy-induced shocks).

Both of these broad themes were encountered in our discussion of the causes of inertia. However, it is the role of supply side institutions which arises most regularly in the analyses of chapters 4, 5, and 6, which provide the most direct studies of the microeconomic causes of wage and price rigidities. In chapter 6, for example, price inertia was shown to be systematically related to various industrial characteristics. In particular among these, inertia was demonstrated to be primarily determined by the market structure of the industry, as prices respond more quickly in industries in which firms enjoy a high degree of domestic market power, and where there is a low degree of international competition. These findings confirm, and extend, those expressed previously in the literature, and fit well with the theoretic discussion of the possible causes of inertia presented in chapter 2.

Equally, chapter 4 provides evidence to support the view that wages are set in open-ended contracts which are renegotiated periodically as the negotiable wage reaches a critical level, as would be predicted by microeconomic theory. The frequency with which the critical bound is reached varies stochastically, as the determinants of the negotiable wage also vary stochastically, but will be systematically influenced by labour market conditions. (Indirect evidence in support of this view was of course also provided in chapter 3). In particular amongst these, evidence was found of a positive relationship between negotiation frequency and price inflation (once the pattern of past settlements is adequately taken into account in the empirical work), and successive periods of incomes policy were shown to have had a significant influence on the timing of wage settlements.

Finally, in chapter 5, evidence was presented on the (lack of) responsiveness of wages to changes in demand conditions. Industrial wage equations presented in that chapter showed that 'internal', industry-specific variables exert relatively little influence on wage setters, so that contracting demand for an industry's product is not reflected in rapidly falling wages. Equally, rising local unemployment rates were shown to exert little downward influence on wages in the industrial wage equations. The clearest indication of aggregate demand effects on wages was observed to take place through the impact on expectations, as falling demand caused expectations of aggregate wage and price inflation to be moderated. However, as these effects were shown to take place only slowly over time, this path of influence was also shown to be weak. Taken together, these findings provide some insights into the working of the labour market, emphasising the importance of those labour market institutions which close down the potential paths of influence from labour market conditions to wage setting decisions. As examples of these, we mentioned the possible importance of 'insiders' in wage setting, the 'discouraged worker' effect caused by prolonged periods of unemployment, and the importance of wage-wage comparabilities in wage setting. Whatever the precise cause of the unresponsiveness of wages to demand conditions, it is clear that much of the explanation lies in the

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institutional detail of the workings of the supply side.

While the discussions of chapters 4, 5 and 6 help to identify some of the causes of inertia in wages and prices, the consequences of inertia are best illustrated in chapters 2, 3 and 7. In chapter 2, for example, we provide a simple algebraic model which illustrates the macroeconomic consequences of nominal wage inertia in a two sector economy. In this illustration, nominal wage inertia is modelled through the use of negotiation probabilities. The use of this technique for modelling inertia is given some justification by the empirical work of chapter 4. The probability of negotiation reflects the probability that the negotiable wage reaches the (s,S) critical bound, and is endogenously determined. In particular, rising inflation is likely to be reflected by a rising probability of negotiation, although so long as the responsiveness of negotiation probabilities to inflation is not too high, these probabilities will remain below one for moderate inflation rates, so that instantaneous adjustment in any sector is unlikely. Since the two sectors' wage setting decisions are interrelated (through their respective influence on the aggregate price level), the inertia generated directly in each sector, as wages fail to adjust every period, is compounded at the economy-wide level. This follows from the fact that wages do not fully reflect the underlying change in exogenous variables even when they are reset because of the known inflexibity in wages in the other sector. Moreover, in the case of a monetary disinflation, for example, there will be a real output loss throughout the period during which prices remain high relative to the nominal money stock, due to the real balance effect. The fact that wage adjustment in the face of shocks may take substantially longer than the duration of any single settlement provides the government with the potential for relatively long-lasting effective intervention. Further, this conclusion holds despite the endogeneity of nominal inertia in this example.

In the simulation exercise of section 7.2, we considered the impact of an incomes policy shock on the disaggregated supply side model of the UK economy that had been developed in chapter 5. Two results were highlighted in this exercise which emphasise the relevence of the algebraic illustration described above to the UK economy. In the first, it was noted that because of the complexity of the interactions that take place between sectors, the repurcussions of the shock could still be identified in aggregate wages and prices six years after the imposition of the shock. This period would clearly straddle a number of wage settlements in any sector, and therefore mirrors the properties of the algebraic model described above. The conclusions for the scope for policy intervention based on the algebraic model of chapter 2 are equally relevent here therefore. The second result related to the paths through which the sectoral interactions were observed to take place. The algebraic exercise shows clearly that the existence of more than one sector and the recognition that, within any sector, negotiation will take place only periodically in the future, means that there is a forward-looking element in wage negotiations. In the absence of perfect foreseight, this ensures that expectation formation is important, and indicates that simple announcements of future policy by government could have an impact on current wage settlements if the announcements were believed. In the simulation exercise of section 7.2, expectations on aggregate wages, on aggregate prices, and on material costs were shown to be extremely important in the process of adjustment as captured by our model of the UK economy, with these expectation-based feedbacks being at least as important as those caused by the actual changes in these variables. The implication of this finding is that, if the government could exert influence on the process of expectation formation, then this would provide a useful policy instrument for government exactly as in the algebraic model.

The simple algebraic model of chapter 2 provides some insights into the consequences of inertia, but it is recognised that this is a relatively simple model, in which nominal shocks are eventually offset through wage and price adjustment, with the real economy experiencing no long term effects. Of course, in reality, the impact of shocks in an economy in which inertia is found may have *persistent* effects, if there are structural changes instigated by the shock which reduce the level of output to which the economy ultimately returns to one which is below that from which the economy originally started. Examples of such effects are provided by the explanations for 'unemployment hysteresis', as described in section 2. The simulation of section 7.3 provided a graphic illustration of this phenomenon, as the imposed incomes policy shock was seen to reduce unemployment throughout the remainder of the sample period. One source of this hysteresis was identified with the impact of unemployment on aggregate wage expectations, as these were found to be moderated only by changes in unemployment rates. These issues were further explored in section 7.4 in which a simulation exercise was carried out to identify the 'natural rate' of unemployment (identified as that rate associated with zero price surprises). In this experiment, we found that large changes in unemployment were required to eliminate price surprises, reflecting the low degree of responsiveness of wages to aggregate demand discussed above. In fact, the 'natural rate' that was identified changed over time, rising from a level of around 1.5% between 1956-1967 to 3.5% between 1968-74, to 5.7% over 1975-79, and upto around 7% by 1981. Moreover, some 71% of the variability in our (moving average) representation of the natural rate was explained by actual unemployment lagged one period, showing a very strong hysteresis effect. Clearly the presence of such an effect reinforces the arguements for active government intervention in offsetting the effects of adverse shocks to the economy.

Finally, we note here that the presence of inertia has been shown to have far-reaching consequences not only for the macroeconomy as a whole, but also for the structural composition of the economy. The empirical work of chapter 3, for example, demonstrated clearly the impact of changes in the inflation rate, and of successive periods of incomes policy on wage relativities across industries. Again, in chapter 6, it was noted that those industries which respond slowly to changes in costs will face a relatively severe profit squeeze in times of inflation compared to those who are able to pass on cost increases more rapidly. Changes in the structure of demand are brought about not only through changes in relative prices, therefore, but also through the more long term effects on investment behaviour across sectors caused by the squeeze on profits. More generally, we noted that the estimated employment, price, wage, and output equations of chapter 5 showed that there is considerable heterogeneity across industries in the responsiveness of these variables to changes in their determinants. This means that economy-wide shocks, including those that are policy-induced, can have very different repurcussions in the different sectors. Such effects were illustrated in the simulation exercises of section 7.5. Here we considered the structural consequences of an incomes policy shock and of a hypothesised scheme for increasing investment, and showed the wide disparities in reaction to the shocks across a simple four sector classification of the industries of our disaggregated model. Moreover, because of the dynamics of the model, and because of the complexity of the interactions between sectors, we noted that some evidence of structural change was still apparent some eight years after the imposition of the shock.

These results, I believe, provide some support for the interventionists case, and in particular, the work has demonstrated a useful role for some form of incomes policy. The empirical work of chapters 3 and 4 showed that the successive periods of incomes policy in the past had a significant impact on wage setting behaviour, especially on the timing of wage settlements. The algebraic model of chapter 2 was employed in chapter 4 to illustrate some of the possibilities for policy measures in this area. For example, if the government were able to reduce negotiation costs (through legislative change affecting bargaining institutions, for example, or through an incomes policy which reduced the bargaining zone, and hence the scope for disagreement), then this would clearly reduce the degree of inertia, and limit the pain involved for the macroeconomy in adjusting to shocks. Alternatively, the government could accept the degree of inertia faced by individual firms, but attempt to manipulate this inertia to the benefit of the economy. Hence, a simple illustration is provided in which adjustment costs are reduced because the government is assumed to be able to time its policy implementation to coincide better with the wage setting decisions of the private sector. Equally, a policy designed to take out the stagger from wage bargaining, possibly by increasing negotiation costs, would result in a reduced adjustment cost for the economy as a whole, as a more complete adjustment to any shock could be made by each unit when entering into wage negotiations (recognising that others are simultaneously renegotiating wages elsewhere in the economy). In both of these latter cases, the gains to be obtained come from the manipulation of the timing of wage setting, and, as the empirical work of the thesis has demonstrated, incomes policy provides a realistic means of achieving this aim.

On a related theme, we have noted on a number of occassions the potential gains to be achieved through the use of guidelines on pay and incomes, especially as they affect the process of expectation formation and wage-wage comparabilities. These could have an effect both on nominal rigidities (given the backward looking nature of the equations explaining expectation formation in the applied work) and, in the light of the discussion of unemployment changes on expectations, on real rigidities. Throughout the work, we have noted the possibility, following Taylor (1983a), of making expectations formation more 'rational' through the provision of a credible and widely-available forecasting service provided by government. This could complement the introduction of legislation designed to alter wage-fixing institutions to improve the performance of the macroeconomy. One example of such change that has been cited is Meade's suggestion of 'almost-compulsory arbitration'. Such a system would be likely to reduce the bargaining zone involved in wage negotiations, and hence reduce inertia. Further, by identifying the promotion of employment growth as an important criterion on which wage claims would be judged, this sytem would provide a means by which some of the wider implications of wage setting decisions could be 'internalised' by individual decision makers, improving the responsiveness of industrial wages to local demand conditions. And the provision of guidelines for wage increases, either stated explicitly or inferred from the decisions on disputes taken to the Arbitral body, would provide an important source of information on which to base expectations on current and future aggregate price developments.

Apart from these suggestions on the usefulness of policies directed at wage and prices setting, the work of this thesis indicates also that the presence of rigidities provides the scope for effective demand management policies, offsetting shocks which would otherwise involve protracted and painful adjustment, at the least, and which may result in persistently higher levels of unemployment and lower levels of output. It is suggested that such policy would be most effective if it was seen as part of an industrial strategy for pay and employment which explicitly takes into account the heterogeneity in supply side relationships shown across industries. This strategy would involve sophisticated linkages which tie expansionary policy measures, aimed at sectors most likely to generate extra jobs, with the implementation of the sort of policies on wages and prices which have been suggested for limiting the inflationary consequences of these measures. Only if the policies on pay and employment creation are coordinated in this way can policy makers ensure that the benefits of the policies are not offset by the complicated intersectoral interactions instigated by sectors' adjustment to policy.

Our understanding of the operation of the supply side of the economy has improved rapidly in recent years, as high unemployment has directed much academic attention to the issue. However, the reliance on theory based on abstract, stylised models, and on empirical work based at the aggregate level may have obscured some of the detail of the adjustment process. Explicit analysis of union behaviour, labour market institutions and the interactions of individuals across industries, occupations and regions seems essential in building a more sophisticated understanding of the workings of the labour market. More work at a lower level of disaggregation may provide the scope for the development of more imaginative and informed policies to defeat unemployment. This thesis should be viewed as an attempt to encourage work in this direction.

NOTES

Chapter 2

(1) Put briefly, the NRH argues that there is no money illusion and that agents base their decisions on relative price movements only. Assuming that prices and quantities are determined at each point in time in competitive equilibrium, this means that only one level of employment can be generated in the labour market if all agents are fully informed. In the short run it is feasible that employment might not be at this "natural" level since agents may form incorrect expectations of the relevant price level, and set nominal wages at an inappropriate level. This is not possible in the long run however, when expected prices are assumed to be equal to actual ones. Attempts by governments to raise employment beyond the natural level would therefore fail in the long run and show only in increased inflation.

(2) In the 1973 paper, Lucas sets out an algebraic interpretation of Friedman's analysis which illustrates that in this framework there will be a trade-off between the degree of price variability in an economy and the responsiveness of the level of activity to government policy. As an indirect test of this idea, he considers 18 countries, estimating for each the relationship between output (relative to trend levels) and growth in nominal income. From here, he is able to plot price variability against the responsiveness of output to policy (as given by the size of the coefficient on nominal income growth in his estimated equations) for each country. Lucas finds that there is indeed some evidence for the predicted trade-off, with output responsiveness in stable-price economies shown to be higher than in volatile-price countries, although the reliance of the results on two outlying volatile-price countries reduces the impact of these results.

Barro's empirical work on the US, and the equivalent studies of Attfield, Demery and Duck for the UK, provided more direct evidence in support of the "policy-is-ineffective" arguments by employing a two-stage method which attempts to quantify explicitly the unanticipated component of government policy. So, for example, in Barro (1977) the growth in US money is explained in terms of the level of government expenditure relative to normal, lagged unemployment, and recent money growth rates. The residuals from this first stage regression are then used as a measure of unanticipated monetary policy in a subsequent regression analysis of unemployment. The finding that this unanticipated policy helped to explain unemployment levels, while the anticipated element of money growth did not, was seen as good evidence in support of the theoretical models of Lucas, and Sargent and Wallace (LSW).

(3) For example, debate on the validity of the assumption of the neutrality and super-neutrality of money, see Buiter (1980), questioned the underlying base of the Natural Rate Hypothesis. Equally, there have been numerous criticisms of the assumption that agents form expectations rationally (see, for example, Pesaran (1988)). Others chose to present their arguments working within the LSW framework, however, modifying some of the less realistic assumptions made in their stylised models. Examples of this approach are given by Weiss (1980), or Begg (1982), in which the importance of the assumptions on information sets in the LSW models are highlighted. In the first of these, an active feedback rule for money growth is shown to be superior to a constant x% growth rate rule when "capitalists" are assumed to know the profitability of investment one period in advance, while "workers" learn of it only in the current period. In the second, the informational advantage that the government may hold over workers, who have less access to up-to-date information, is used to demonstrate another situation in which active government policy can be used to influence real magnitudes.

(4) Substituting (3) into (1) and (2) gives

$$p = \lambda[\ \mu p(-1) + (1-\mu)w\ ] + (1-\lambda)m$$

$$w = \tau[\ \eta w(-1) + (1-\eta)p\ ] + (1-\tau)m$$

where $\lambda = (1+\alpha)^{-1}$, and $\tau = (1+\beta)^{-1}$. High values of μ and λ emphasise the backward-looking nature of wages and prices within the square brackets. Further, as $\alpha,\beta \rightarrow 0$, then $\lambda,\tau \rightarrow 1$, and the influence of the square bracket is increased relative to the current money supply.

(5) While I will make some reference to the determinants of the responsiveness of the price markup (i.e. the value of α) later in section 2.3 and in chapter 5, the focus of my attention will be on real rigidities generated in the labour market.

(6) This is given some empirical credence by Cecchetti (1985) who finds that the frequency of price change in the US (derived from observations on the dispersion of inflation over sectors of the economy) rises during periods of high inflation.

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(7) Such a smoothing may be justified in an *ad hoc* way on the grounds of aggregation over many small discrete movements.

(8) While these models provide a useful insight into the effects of lump sum costs for individual firms, it is important to recognise that the results obtained do not necessarily provide simple conclusions for the aggregate economy. Rotemberg (1987) points out that if the aggregate price level is growing at a constant rate, there may be an equilibrium in which the "average" firm's price rises at the given aggregate rate even though there exist some firms whose price is unaltered. This has serious implications for the policy interventionist since the presence of fixed prices is in this case quite consistent with policy neutrality. Such possibilities are shown to be very sensitive to the assumption of monotonic growth in aggregate prices, however, and would be eliminated either if this growth rate altered, or if there was a once-and-for-all shift in the aggregate price level (since this would effect the distribution of firms at different stages of the adjustment process). Hence, while the BSW model provides a useful indication of the consequences of adjustment costs for the frequency of individual price movements, care must be taken in extrapolating individual firms' strategies to those of the economy as a whole.

(9) For a more detailed consideration of influence of these variables on strike behaviour, see Shorey (1976), or Blanchflower and Cubbin (1984).

(10) This methodology is explained in Heckman (1979).

(11) See, for example Azariades (1975), Baily (1974) or Hart (1983) for discussion of the implicit contracts literature. Also see Pissarides (1985), and Solow (1979) for reviews on search and efficiency wage models.

(12) See, for example Oswald's (1982) consideration of the 'utilitarian' union or Booth's (1984) analysis of the influence of the organisational structure of the trade union.

(13) A similar approach is taken in Grubb, Jackman and Layard (1983) and in Carruth and Oswald (1986).

(14) See, for example, Brenner's (1979) paper in which Keynes' view is explained in terms of workers' concept of justice.

(15) Wage rigidity in this context does not refer just to the inflexibility of real wages in

the face of shifts in demand for the firm's output as discussed above. Indeed, the extreme case of insider power might be characterised through an indifference curve mapping for the union in which indifference curves are vertical at the the level of employment achieved in the previous period. In this case, an increase in the demand for labour shows entirely in a rise in real wages and employment levels are completely unresponsive. Here, however, we refer to the lack of responsiveness of real wages to the presence of external pressures, as well as to internal pressures of the type more generally considered. For example, we noted above the possibility that aggregate demand expansion may create upward (external) pressure on real wages as reduced unemployment levels raise unions' fallback wages. If wages are set independently of local labour market circumstances, then this path of influence from aggregate demand to real wage levels is closed down, and the policy implications of real wage rigidities described earlier will apply exactly as they would in the case of inflexibilities in the face of internal pressures.

(16) It should be noted that, in the context of the hysteresis debate, the persistence of high unemployment levels follows from the fact that higher levels will have correspondingly higher numbers of long-term unemployed, who effectively raise the natural rate of unemployment.

(17) An additional requirement for such an assumption to be justified is that the decision to negotiate is 'memory-less' in the sense that past decisions do not impinge on the current decision. If this were not the case, then the timing of past settlements would effect the current decision, and the assumption would be justified only if negotiations were synchronised.

(18) By setting $\pi_{at+j} = \pi_{bt+j}$, we abstract from the disaggregated nature of wage/price setting to some extent, although the accumulation of inertia across sectors is accomodated in the coefficients E, F, and G in (2.9).

(19) If $1 > b(2 - e^a(1 + e^a)^{-1})(g_2 - g_1)$, then λ_1 lies in [0,1], and the solution in the text is appropriate. If b is large, however, then $\lambda_1 < -1$, and $\lambda_2 > 1$, and no convergent solution to (2.9) exists.

(20) Similar conclusions are noted in Buiter and Miller (1985) in the context of continuous time models. Again, it is recognised that if expectations are formed rationally, a disinflation package can be successfully implemented with no output costs, even in the presence of price-level inertia. Output costs will arise only in the

presence of inertia in the inflation process, as generated by the existence of fixed-length, staggered contracts, but these can be minimised by the announcement of (credible) future disinflation programmes.

(21) Benefits will also be gained from this change if, as a result, real wage aspirations are also formed on more relevant and more complete information.

(22) Brown (1988) makes a strong case for a policy involving more centralised bargaining achieved not through a more coordinated union movement, but through a more powerful employer confederation. His argument is that an equality of strength is a prerequisite for any sort of "negotiated incomes policy" since this would make restraint on the union side more feasible, and would make the arrangement less dependent on the presence of a government which is sympathetic to the union movement.

Chapter 3

(1) Hamermesh's ideas on informal indexing would also be captured explicitly in the model by allowing the coefficients γ and α to adjust with the level of inflation uncertainty.

(2) Some recent attempts have been made to address the issue of what determines π empirically, as noted in chapter 2; see for example, Pencavel (1982) and Christofides (1985). From these, it is clear that industries do face different negotiation costs, so that in reality $\pi_{it} \neq \pi_{jt}$, $i \neq j$. Further, it is likely that π_{it} is itself dependent on y_{it}.

(3) Of course, the convergence of industry-specific γ_i's to unity as informal indexation occurs remains an alternative possible explanation.

(4) Wage rates rather than earnings series would be more appropriate to the analysis here, but such series are not available in the detail required. Information on actual and normal hours worked are available by industrial sector, however, so that the figures could be adjusted to obtain a reasonable approximation to the wage rate series. (the adjustment is described in Layard and Nickell (1985)). Results obtained with the adjusted data were very similar to those presented, however, and are

therefore not reported.

(5) Of course, 'proportional' policies may effect wage growth variability if the stated maximum becomes influential in the calculations of a target rate of wage growth for many sectors.

(6) See for some recent discussion on these issues Jackman and Roper (1987), Wood (1988), and Jackman and Kan (1988).

(7) The insignificance of unanticipated price change indicates that γ is close to zero, and that wages are set in accordance with anticipated price change only.

(8) It has been noted that there are two extreme values in the wage growth series in 1974(2) and 1975(1). Calculation of the "leverage" and the D-statistics (see Cook (1979)) for these observations shows them to be close to the 'rule-of-thumb' borderline for acceptability in terms of their (disproportionate) influence on the estimated relations. On the other hand, these periods were ones in which record levels of inflation occurred so that one would expect them to provide more information than observations in other periods, and certainly a priori there are no legitimate reasons for their exclusion from the sample.

Chapter 4

(1) Note that α and 'costs' could be assumed to be constant over the period between negotiations, while changes in w might be adequately proxied by changes in $\overline{p}$; changes in these terms will disappear in the explanation of negotiation frequency in this chapter therefore.

(2) The analysis presented in Danziger, as in the Sheshinski and Weiss papers, assumes monotonic growth in aggregate inflation, as more sophisticated assumptions on the time path of aggregate prices greatly complicates the optimal strategy (specifically, more than two parameters are required with more sophisticated time paths for the aggregate deflator, as the s,S bounds themselves vary over time in this case). Clearly unless the unanticipated shocks are small relative to the expected average growth rate, this assumption may be violated, and the clear cut results of Danziger and Sheshinski and Weiss will no longer hold. Even here, however, one can assert

that a related strategy, in which negotiations occur only when real wages fall to a critical limit, is likely to hold. Hence in the real world, it is likely that only those shocks which reduce the real wage below that which was bargained for will cause wage negotiations to occur.

(3) In this, and the next section, we will restrict our attention to simple movements in labour market influences between the current period and some previous period, even though, as noted in the illustration of section 2.5 of chapter 2, the negotiable wage in any period, z_t, is not determined just by current values of these variables, but by the entire set of past, present, and expected future values of these variables weighted according to their relevance to the period over which z_t would hold. Obviously, on this basis, changes in the negotiable wage would be correctly measured by the change in the whole profile of past, present, and expected future values of labour market variables from one negotiation to the next. However, it is clear that correctly modelling the expected future movements of all relevant influences will be difficult and time-consuming, even ignoring the difficulties of finding the appropriate (and possibly changing) weights, so that this 'correct' measure will not be used. In fact, so long as the weightings do not alter too greatly over time and there are few jumps in X^e_{t+i}, then $(X_t - X_{t-s})$ will serve as an adequate proxy, although we stress the limitations of this measure, particularly in this section where we are working in a linear setting with $(X_t - X_{t-s})$ further proxied by $(X_t - X_{t-4})$ and T_t.

(4) F-tests of the joint significance of changes in real GDP (Δgdp), in direct and indirect taxes (Δdt, Δit), and in the replacement ratio (Δreprat), along with profit levels, strike activity, and trade union membership are given below for each of the uncertainty measures used:

UNCERT1: $F = 0.706$, UNCERT2: $F = 0.766$, UNCERT3: $F = 0.642$

all of which are to be compared with $F_{7,19}$.

Where aggregate demand change is alternatively measured by changes in world trade (Δwdtd), in competitiveness (Δcomp), and in government spending (Δg), the F-statistics are

UNCERT1: $F = 0.684$, UNCERT2: $F = 0.649$, UNCERT3: $F = 0.574$

each of which is compared to $F_{9,17}$.

(5) This table replicates some of the information given in Table 3.2 of the previous chapter, but provides the quarterly timings of the policies, and pays more attention to the policies involving proportional guidelines.

(6) F-tests of the significance of UNCERT1, UNCERT2, and UNCERT3 are given by F = 0.268, F = 0.772, and F = 1.495 respectively, e ach compared to $F_{1,26}$. F-tests on the joint significance of the five variables excluded from column (1) of Table 4.3 to achieve column (3) are F = 1.563, F = 1.991, and F = 3.007, to be compared with $F_{5,26}$.

(7) Equivalent tests to those shown in note 4 on the extended data set are

UNCERT1: F = 1.604, UNCERT2: F = 0.711, UNCERT3: F = 1.001

to be compared with $F_{7,818}$, and

UNCERT1: F = 1.267, UNCERT2: F = 0.416, UNCERT3: F = 0.678

to be compared with $F_{9,816}$.

(8) F-tests of the restrictions implied in the move from column (1) to (2) in Table 4.5 are F = 8.727, F = 3.273, and F = 0.133 for UNCERT1, UNCERT2, and UNCERT3 respectively (each compared to $F_{1,825}$). F-tests of the restrictions implied in the move from column (1) to (3) in the table are F = 2.579, F = 3.122, and F = 8.263, to be compared with $F_{5,825}$.

(9) Tests of the joint significance of the cost variables and the exogenous aggregate demand measures (Δcomp and Δg) are given below for uncertainty measure UNCERT1:

$$L = 3216.84 - 3207.07 = 9.77, \text{ cf. } \chi^2(7).$$

(10) A likelihood test of the restriction $\alpha_i = \alpha_d$, where α_i and α_d are the coefficients on the change in indirect and direct tax rates respectively, is given by

$$L = 2(\text{log likelihood with } \Delta dt \text{ and } \Delta it \text{ entered separately}) - 2(\text{log likelihood with } (\Delta dt + \Delta it) \text{ entered})$$

$$= 0.85, \text{ cf. } \chi^2(1).$$

(11) The use of incomes policy dummies C1,C2,..C5 in place of C1INC,C2INC,..C5INC leaves the results of the regression analysis qualitatively unchanged.

(12) An equivalent test to that in note (9) for the model including drepi is

$$L = 3185.75 - 3191.08 = 6.67, \text{ cf. } \chi^2(7).$$

Chapter 5

(1) So, for example, we have noted that the unresponsiveness of real wages to demand shifts (i.e. real wage rigidity) is most important in determining the speed of supply side adjustment. We have seen how demand shifts may influence labour demand and, hence, wage bargaining through its effects on the labour demand constraint. Equally, there are indirect effects experienced as *unemployment* consequences (fail to) feed through to wage decisions. A sophisticated model is necessary to capture all of these important paths through which influences might be exerted.

(2) The "normal cost" pricing hypothesis is one such theory.

(3) Oswald (1982), or Booth (1984), provide examples of the former approach.

(4) Moreover, in recognising the wide variety of paths of influence that can exist in the disaggregated model, this description casts some doubt on the power of some of the tests that have been used to discriminate between the 'efficient bargain' models and those in which firms locate on their labour demand schedules. This follows because these tests rely on the (in)significance of the external factors in applied work, working within a much more tightly defined labour market framework than that described here, with fewer potentially important paths of influence. (A similar point is made in Burgess and Delado (1989), who introduce further paths of influence to those envisaged by the standard models through variable adjustment costs incurred as employment levels are altered).

(5) On a related issue, we note here that the price of material inputs to an industry, q, is calculated in this work using prices of domestic product to the home market by industry and the 1979 input- output tables (again see the Data Appendix for further details). It is acknowledged here that the use of a single set of input-output tables to obtain the weights for the use of the material input price measure will introduce some inaccuracies since this assumes that material inputs are used in the same proportions throughout the sample period. This eliminates by assumption the possibility of substituting one material input for another as their relative price alters. To the extent that such changes occur continuously over time, these effects may be picked up by the time trend.

Finally, we should note also the inclusion of a time trend in the output demand equation, (5.15). This is again included to provide the model with additional flexibility, this time picking up the possible effects of changes in tastes and nonquantifiable changes in product quality which occur continuously over time.

(6) There has been some interest shown in the literature on the appropriate procedures to apply in the estimation of models involving expectations (see, for example, Pagan (1984)). In particular, there has been some criticism of the "two-stage" procedures employed in the early applied work, and indeed subsequently, in this area. In this, the first stage (OLS) regression is used to explain the variable on which expectations are formed, and the expectation of the variable is then identified as the fitted value of this regression. The fitted values are used in a subsequent (OLS) regression of the relationship of interest involving the expected variable. This procedure has been criticised on the grounds that its coefficient estimates are inefficient if some of the second stage regressors are excluded from the first stage information set, although consistency is achieved. Moreover, since the error term in the second stage consists of two elements (one of the usual form plus an "error-in-measurement" term introduced through the use of the generated regressor rather than the true expected value), the estimated variance-covariance matrix of the second stage regression coefficients obtained through OLS will generally be inconsistent, and inferences based on these therefore invalid. The use of 2SLS or IV estimation techniques can eliminate this problem, however, although again it is assumed that the second stage regressors form part of the first stage information set.

Despite these difficulties, a two-stage estimation procedure *is* appropriate here. One of the primary means of interaction between sectors may be, as we saw in Chapter 2, through individuals' expectations of what others are about to do. These expectations may be based on incomplete information, based on simple aggregates of the disaggregated data, for example, and this may have important implications for supply side adjustment. Both of these elements are incorporated into this model through the use of expected aggregate wages and prices in the industrial relationships. It is of course important that we constrain all individuals to have the same view of the expected variables (since to allow industry-specific expectations would make the model unwieldy). Moreover, in order to identify, and simulate, the important feedbacks that affect supply-side adjustment, we need to be able to consider and model the way in which expectation formation itself is influenced by supply-side developments. It is for this reason that we generate series for expected aggregate wages and prices.

As we shall see, IV techniques are employed in the subsequent analysis of the industrial systems, but in these the generated regressors are used, and not the actual values for aggregate wages and prices (as suggested in the literature). This is justified if one assumes that the true expected variables are equal to the generated regressors apart from random errors (with zero mean). This assumption does not have the support of the theoretical argument that the actual value of the variable must deviate unsystemmatically from the expected value (if these are formed rationally), but is made so that the expectation formation process can be identified explicitly. Having made this assumption, the use of IV techniques ensures the consistency of the estimated parameters.

(7) The results in Table 5.2 are not homogenous in price inflation, and indeed the imposition of homogeneity was not accepted by the data. While this is perhaps surprising, we felt that homogeneity should not be imposed on this equation for this reason. Of course, these equations reflect the process by which expectations are formed and not the determination of actual wage and price levels. As we shall see, price homogeneity is imposed in the industrial price and wage equations in which the actual levels are determined.

(8) Price homogeneity is rejected in industries 7 (Tobacco), 8 (Coal prds), 11 (Iron), 12 (Mon-ferrous mets), 13 (Mech. eng), 18 (Aerospace), 22 (Leather, etc), 23 (Bricks), at the 5% level, and rejected at the 1% level in industries 1 (Agric.), 2 (Coal), 24 (Timber).

(9) On this theme, and perhaps raising doubts about this explanation, it is interesting to note that those industries for which price homogeneity was rejected appear to be ones which would be placed at the beginning of the chain of production, producing goods for intermediate rather than final demand.

(10) The exclusion restrictions are rejected at the 5% level in industries 1 (Agric.), 2 (Coal), 14 (Inst. eng.), 15 (Elec. eng.), 16 (Ships), 17 (Motor vehs), and rejected at the 1% level in industries 12 (Non-ferr. mets), 18 (Aerospace), 19 (Other vehs.), 20 (Metal gds nes), 21 (Textiles), 22 (Leather, etc), 23 (Bricks), 35 (Communications).

(11) Before coming to a discussion of the estimates themselves, I should note that there were some industries for which convergence in estimation was more problematic than others; this is of interest since later we will wish to use these estimated systems for (dynamic) simulation purposes, and so we should be aware, before starting this exercise, of those industries which might cause problems. Specifically, while the great majority of industries achieved convergence in the minimisation of the objective function within ten to fifteen iterations (using a convergence criterion of 0.001 in their estimation), industries 7 (Tobacco), 18 (Aerospace), 34 (Oth.

transport), and 37 (Bus. serv.) took considerably longer. Industries 7 and 37 achieved the convergence criterion in 27 and 37 iterations respectively, but industries 18 and 34 had still failed to converge after 40 iterations (their respective movements in their final iteration equalled 0.06 and 0.006). Industry 18 (Aerospace) is clearly most problematic, and inspection of the statistics in Table 5.8 for this industry show the estimated demand equation to be the source of the problems, with a zero R^2 for this equation. Of course, this industry is in its relative infancy, so that there may have been some justification for its exclusion from the sample as with industry 4, Petroleum and Natural Gas. However, the employment, price and wage equations appear to perform adequately for this industry, so I have included their estimates in the reported results. Care must obviously be taken in their interpretation and subsequent use however.

(12) It should be noted that the aggregate studies have usually considered the estimation of "reduced-form" employment equations, where the output term has been substituted out (so that we would expect the wage elasticity to be higher). Nevertheless, the discrepancy between the wage elasticities obtained in aggregate and disaggregate studies seems large, and certainly warrants further attention.

(13) Johnson (1972, pp160-62) explains the circumstances in which potentially large and opposite errors might arise in the estimation of coefficients on collinear explanatory variables.

(14) The point was made in chapter two that incomes policy, aimed at reducing wage pressure on prices, can have only a gradual influence since relatively large reductions in the rate of growth of wages are necessary to obtain significant effects on the overall rate of inflation at any one stage, given the low proportion of value added from labour inputs.

(15) These results are in contrast with those reported in Nickell and Kong (1987) who estimated industrial wage equations in a related, though different, framework to that developed in this chapter. In their paper, an "internal productivity" term, of a similar form to INT, showed significantly in all equations. However, the influence of aggregate wages is constrained to enter the Nickell and Kong specification in a different way to that considered here, so that direct comparisons cannot be made. The disparity in results illustrates the sensitivity of the estimates to model specification, however, and emphasises the care that has to be taken in accommodating the influence of aggregate developments in disaggregate work.

(16) The presence of a slight positive influence of local unemployment on industrial wage determination is also reported in Nickell and Kong (1987) and in Beckerman and Jenkinson (1989). These note that this may in fact provide some support for the insider-outsider scenario, as rising unemployment may reduce the number of insiders and this may result in upward pressure on subsequent wage demands.

(17) This is beyond its influence on $\bar{w}^e$ of course. Note that t_1, the employer tax rate, was seen to influence $\bar{w}^e$, but does not add to the fit of the industrial equations, while t_3, the indirect tax rate, has not shown significantly in any of these equations.

Chapter 6

(1) Note that the discussion here considers the estimated coefficients of the equations irrespective of significance levels. The equations set out in the previous chapter represent our preferred representation of the price setting process and its dynamics. Different dynamics would be obtained if a monotonic adjustment was imposed by including just one ldv, although in the case where a second ldv is insignificant, the differences would not be large.

(2) It is recognised that because the π measures are derived from the price equations estimated in the first stage of the analysis, some prior information exists on the precision of the measures through the estimated standard errors of these equations. This information might be incorporated into a GLS regression analysis at this stage (see Winter's (1981) criticism of Domberger's (1979) work). It has been noted already, however, that the measures used here may only be sufficiently accurate to be used as indicators of an industry's characteristics, and in these circumstances, such sophistication seems misplaced. Moreover, the measure of inertia used here ($=\pi$ = weighted accumulation of the (square) deviation of actual prices from target in the face of a shock) is a complicated function of the estimated coefficients of the price equations, so that the implied variance-covariance matrix to be used in GLS is not at all clear. For these reasons, simple OLS regression analysis has been employed.

(3) Of course, these interactions between variables can also be investigated when working with categorical data through a log-linear transformation of the problem. However, given that information is already lost (through working with categorical data), and given the complexities of the sequence of tests that need to be considered

in log-linear models, a sample of size 22 is simply inadequate to carry out such an investigation.

Chapter 7

(1) The equations estimated here are used primarily to obtain a model of the U.K. supply side which will provide some quantitative information on the importance of inter-industry feedbacks. The equations of chapter 5 are preferred as statistical representations of the industrial relationships.

(2) Of the 17 industries in which the overall fit is significantly reduced, two are at the 5% level (industries 12 and 25), and twelve are at the 1% level (1, 5, 6, 8, 15, 18, 19, 24, 30-36).

(3) We have already discussed the difficulties involved in measuring and using sectoral unemployment data in Chapter 3.

(4) Experiments were carried out using alternative assumptions on the split between jobs taken up by those previously employed within the industry and the rest. These made little qualitative difference to the results.

(5) It is precisely this element of indeterminacy that it is suggested could be manipulated by a centralised, coordinating wage setting body in the conclusions to the analysis of section 7.2.

(6) Again it requires knowledge of the process by which expectations are formed to understand whether any combination of (σ, z, $\bar{I}$) is able to ensure no wage or price surprises. The assumption of perfect foresight once more provides a useful illustration, since under this assumption the industrial systems themselves provide the basis on which expectations are formed. From (x) it is noted that

$$\bar{w} - \bar{p} = C + \gamma_1(\bar{w}^e - \bar{p}^e) + (\bar{p}^e - \bar{p}) + \gamma_4 z + D\sigma$$

so that $$\bar{w}^e - \bar{p}^e = C + \gamma_1(\bar{w}^e - \bar{p}^e) + \gamma_4 z + D\sigma$$

and hence $$\bar{w}^e - \bar{p}^e = C/(1-\gamma_1) + [\gamma_4/(1-\gamma_1)]z + [D/(1-\gamma_1)]\sigma$$

Equally, taking expectations through (v) provides

$$\bar{w}^e - \bar{p}^e = -\beta_0 - \beta_2\sigma$$

These two equations provide a relationship linking the variables (σ, z, $\bar{l}$), and in this case there is a unique, "natural" level of demand for any (z, $\bar{l}$) combination. Clearly, where there is less than perfect foresight, the model is unlikely to have this property.

(7) By considering changes in the "natural" rate of unemployment between four selected intervals (1956-66, 1967-74, 1975-79, and 1980-83), Layard and Nickell (1985) employ a similar smoothing exercise.

APPENDIX

Appendix to Chapter 2

We can write $E(x_{at} - x_{ot})$ and $E(l_{at} - l_{ot})$ as follows:

$$E(x_{at} - x_{ot}) = (1 - \pi^e_{bt}) \quad [\tfrac{1}{2}(z_{at} - w_{bt-1}) - x_{ot}]$$

$$+ \pi^e_{bt} \quad [\tfrac{1}{2}(z_{at} - z^e_{bt}) - x_{ot}]$$

$$+ (1 - \pi^e_{at+1}) \quad \{ (1 - \pi^e_{bt})(1 - \pi^e_{bt+1}) [\tfrac{1}{2}(z_{at} - w_{bt-1}) - x_{ot}]$$

$$+\pi^e_{bt} (1 - \pi^e_{bt}) [\tfrac{1}{2}(z_{at} - z^e_{bt}) - x_{ot}]$$

$$+ \pi^e_{bt+1} [\tfrac{1}{2}(z_{at} - z^e_{t+1})] \}$$

$$+ \ldots\ldots\ldots$$

$$= (\tfrac{1}{2} z_{at} - x_{ot}) \quad \{ 1 + (1 - \pi^e_{at+1}) + (1 - \pi^e_{at+1})(1 - \pi^e_{at+2}) + \ldots\ldots \}$$

$$+ (-\tfrac{1}{2} w_{bt-1}) \quad \{ (1 - \pi^e_{bt}) + (1 - \pi^e_{bt})(1 - \pi^e_{at+1})(1 - \pi^e_{bt+1}) + \ldots\ldots \}$$

$$+ (-\tfrac{1}{2} z^e_{bt}) \quad \{ \pi^e_{bt} + \pi^e_{bt}(1 - \pi^e_{at+1})(1 - \pi^e_{bt+1}) + \ldots\ldots \}$$

$$+ \ldots\ldots\ldots$$

$$= (\tfrac{1}{2} z_{at} - x_{ot}) P(1) + (-\tfrac{1}{2} w_{bt-1}) P(2) + (-\tfrac{1}{2} z^e_{bt}) P(3) + \ldots\ldots$$

while

$$E(l_{at} - l_{ot}) = (m_t + u_t) + (1 - \pi^e_{at+1})(m^e_{t+1} + u^e_{t+1}) +$$

$$(1 - \pi^e_{at+1})(1 - \pi^e_{at+2})(m^e_{t+2} + u^e_{t+2}) + \ldots\ldots$$

$$+ [-\tfrac{1}{2}(1 - \gamma)(z_{at} - l_{ot})] P(1) + [-\tfrac{1}{2}(1 - \gamma) w_{bt-1}] P(2) +$$

$$[-\tfrac{1}{2}(1 - \gamma) z^e_{bt}] P(3) + \ldots$$

In deriving (2.9) in the text, we first note that the expected time path of aggregate wages is given by:

(i) $w_{t-1} = \frac{1}{2}(w_{at-1} + w_{bt-1})$

(ii) $$w_t^e = (1 - \pi_{at}^e)(1 - \pi_{bt}^e)\,\tfrac{1}{2}(w_{at-1} + w_{bt-1}) + \pi_{bt}^e(1 - \pi_{at}^e)\,\tfrac{1}{2}(w_{at-1} + z_{bt}^e)$$

$$+ \pi_{at}^e(1 - \pi_{bt}^e)\,\tfrac{1}{2}(w_{bt-1} + z_{at}^e) + \pi_{at}^e\,\pi_{bt}^e\,\tfrac{1}{2}(z_{at}^e + z_{bt}^e)$$

$$= \tfrac{1}{2}(1 - \pi_{at}^e)(w_{at-1} + w_{bt-1}) + \tfrac{1}{2}\pi_{at}^e(z_{at}^e + z_{bt}^e)$$

(iii) $$w_{t+1}^e = \tfrac{1}{2}(1 - \pi_{at}^e)(1 - \pi_{at+1}^e)(w_{at-1} + w_{bt-1}) + \tfrac{1}{2}\pi_{at}^e(1 - \pi_{at+1}^e)(z_{at}^e + z_{bt}^e)$$

$$+ \tfrac{1}{2}\pi_{at+1}^e(z_{at+1}^e + z_{bt+1}^e)$$

... etc.

where we recall that $\pi_{at+j}^e = \pi_{bt+j}^e$, and expectations are formed on the basis of the Government's (impoverished) data set, in which the outcome of neither union's decision on whether to negotiate in time t is known, as described in the text.

Next, expressions for z_{at}^e and z_{at+1}^e are derived simply from (2.8): z_{at}^e can be seen immediately as the RHS of (2.8), with the 'e' superscript denoting expectations formed on the basis of the Government's information set, while z_{at+1}^e is obtained by simply rewriting (2.8) in time t+1 and taking expectations. Exactly equivalent expressions can of course be obtained for z_{bt}^e and z_{bt+1}^e, and since these expectational terms are all based on the same information set, they will be directly comparable. Substitution of these expressions into (i), (ii), and (iii) above provides us with (2.9).

To obtain the linearised version of the wage equation discussed in the text, we first write $u_t = m_t + \sigma_t - [\, l_o - (1 - \theta)\theta^{-1}(1 + \gamma)\, x_o \,]$, and then use (2.9) to define the following

$$Z(w_{t+1}, w_t, w_{t-1}) = w_{t+1} - Fw_t - Ew_{t-1} - Gu_t = 0$$

The Taylor Series expansion of Z around the point $\bar{w}$ provides the following approximation for Z:

$$Z = Z(\bar{w}, \bar{w}, \bar{w}) + (\delta Z/\delta w_{t+1})|_{\bar{w}}(w_{t+1}-\bar{w}) + (\delta Z/\delta w_t)|_{\bar{w}}(w_t-\bar{w}) + (\delta Z/\delta w_{t-1})|_{\bar{w}}(w_{t-1}-\bar{w})$$

If probabilities are given by (2.10), then noting, for example, that

$$\frac{\delta F}{\delta w_t} = \frac{2\theta b\, \pi^2(2-\pi)}{(1+\gamma)(1-\pi),}$$

and that

$$\pi|_{\bar{w}} = \frac{\exp(\, a + b\{\bar{w}-\bar{w}\}\,)}{1 + \exp(\, a + b\{\bar{w}-\bar{w}\}\,)} = \frac{e^a}{1 + e^a}$$

this expansion provides the linear approximation given in the text.

If the dynamic time path of wages is described by the linearised version of (2.9) given in the text, then the derivation of the solution for wages in the face of a general form describing the evolution of money over the future is provided below. Here, noting that with expectations formed rationally we can write

$$w_t = w_t^e + \varepsilon_{1t} \qquad \text{where} \quad E(\varepsilon_{1t} \,/\, \text{Govt. info set}) = 0$$

$$_t w_{t+1} = w_{t+1}^e + \varepsilon_{2t} \qquad E(\varepsilon_{2t} \,/\, \text{Govt. info set}) = 0$$

and putting $\omega_t = w_{t-1}$, we can rewrite (2.9) in the text as

$$\begin{bmatrix} \omega_{t+1} \\ _t w_{t+1} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ E & F \end{bmatrix} \begin{bmatrix} \omega_t \\ w_t \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ G & -F & 1 \end{bmatrix} \begin{bmatrix} u_t \\ \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

$$= A \begin{bmatrix} \omega_t \\ w_t \end{bmatrix} + \Gamma Q_t$$

In this form, the Blanchard and Kahn (1980) methodology for the solution of linear difference models is applicable; ω_t is a pre-determined variable in the sense that its current value cannot respond to 'news' becoming available in time t, while w_t is non-predetermined. With F and E as given, there exist two real and distinct roots to the characteristic equation of (2.9), λ_1 and λ_2, one of which is greater then unity, and one of which lies between zero and one. This ensures the existence of the following unique solution:

$$\omega_t = \begin{cases} \omega_0 & , t = 0 \\ B_{11}\lambda_1 B_{11}^{-1}\omega_{t-1} + \Gamma_1 Q_{t-1} - \\ (B_{11}\lambda_1 C_{12} + B_{12}\lambda_2 C_{22})\, C_{22}^{-1}(\text{term in discounted future forcing variables}) & , t > 0 \end{cases} \quad \text{(A2.1)}$$

and

$$w_t = - C_{22}^{-1}C_{21}\omega_t - C_{22}^{-1}\,(\text{term in discounted future forcing variables}) \quad , t \geq 0 \quad \text{(A2.2)}$$

where the "term in discounted future forcing variables" is

$$\sum_{i=0}^{\infty} \lambda_2^{-i-1}(C_{21}\Gamma_1 + C_{22}\Gamma_2)Q^e_{t+i},$$

and

$$C = \begin{bmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{bmatrix}, C^{-1} = \begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix}, \text{ and } CAC^{-1} = \begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix}, \lambda_1>1, \lambda_2<1$$

While the specifics of this solution may not be important, the form of the solution demonstrates the complicated inter-relationship between variables over time, even when the probability of negotiation in each period is fixed. Specifically, the nominal wage holding last period, w_{t-1} will depend on some initial condition ω_0, on the actual values of the forcing variables Q_t between t_0 and t-1, and on the expectations, formed at each point in time s between t and t-1, of all values of Q_t beyond s. These influences from the past effect the current wage level w_t only through their effect on w_{t-1}, although w_t is also dependent on anticipations of all future values of the forcing variables, i.e. ε^e_{1t}, ε^e_{2t}, u^e_t, u^e_{t+1}, ...

The ability of government policy to influence real magnitudes is also clearly demonstrated by the solution (A2.1) and (A2.2) above. For example, any announcement over future money supply changes (or alternatively, over any future changes in the exogenous aggregate demand term, $\bar{\sigma}_{t+i}$) will generate an immediate response: unions recognise that there is a finite probability that they will not negotiate over wages again before the future change occurs, and so take into account the consequences of the changes in their current negotiations. In our example, an announcement of a future increase in the money supply which was previously unanticipated will cause wage rates to rise in the current period, and given that firms operate on their demand for labour schedules, (3), at each point in time, this will result in a fall in employment

The size of any changes in wages in response to announcements of future money supply adjustments will depend on the extent of the adjustment, and the length of time until the adjustment will occur. Figure A2.1 illustrates this point; the difference equation at (2.10) provides us with one locus of points in w_{t-1}, w_t space for which $w_{t-1}-w_t = 0$ ($\dot{w}_t=0$), while the 45^o line clearly provides us with another. The line aa is the saddle-path provided by our solution at (A2.1) and (A2.2) above; only when the wage lies on aa will it converge to the steady-state position at A. Given that w_{t-1} is a predetermined variable, there exists a unique choice of w_t which will situate the economy on the convergent path aa to ensure that an explosive path for wages is avoided. Now, in Figure A2.2, as an example, we consider an announcement at t_o that the money supply will rise in t_1. At t_1, the new saddle-path a'a' will be appropriate, and at time t_o, w_t will jump from the previous steady state A to a point B, off the existing saddle-path aa and directly above point A with w_{t-1} fixed. Over the period t_o to t_1 wages will follow the divergent path B to C, arriving at point C on the new saddle-path at the time of the money supply change. Convergence is ensured as wages now move along a'a' to the new steady state wages at A'. This time path for the wage is shown in Figure A2.3, involving an initial jump and then gradual adjustment, first at an increasing rate, then at a decreasing rate. Clearly, the presence of a forward-looking element in wage determination, resulting from the existence of negotiation probabilities which are less than one, generates complicated time paths for wages which will be difficult to recognise and to model econometrically.

FIGURE A2.1

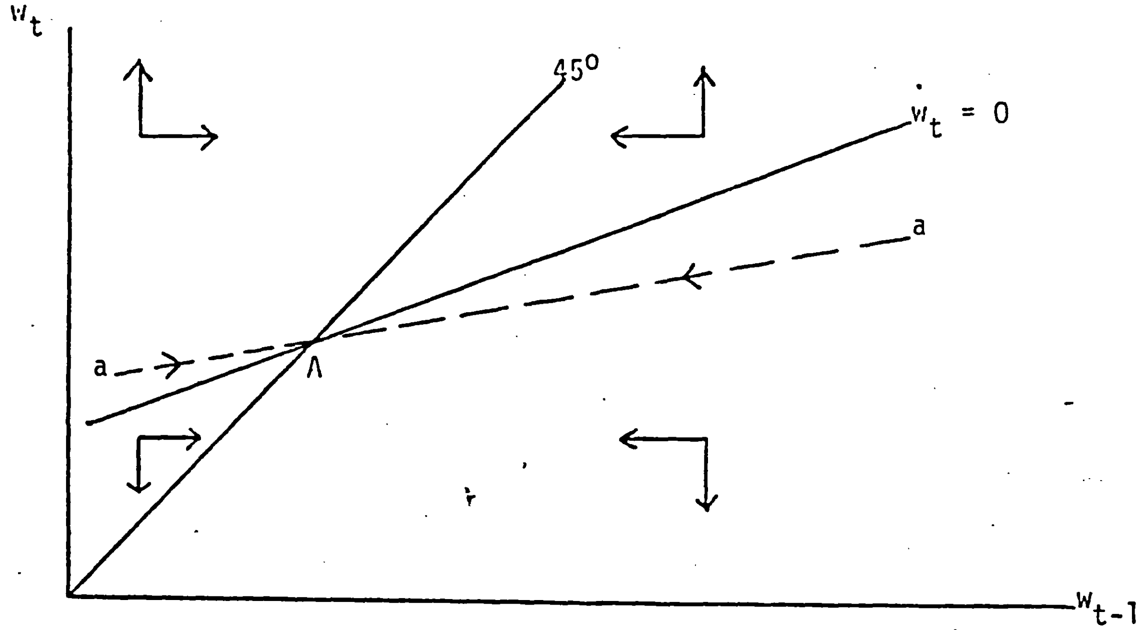


FIGURE A2.2

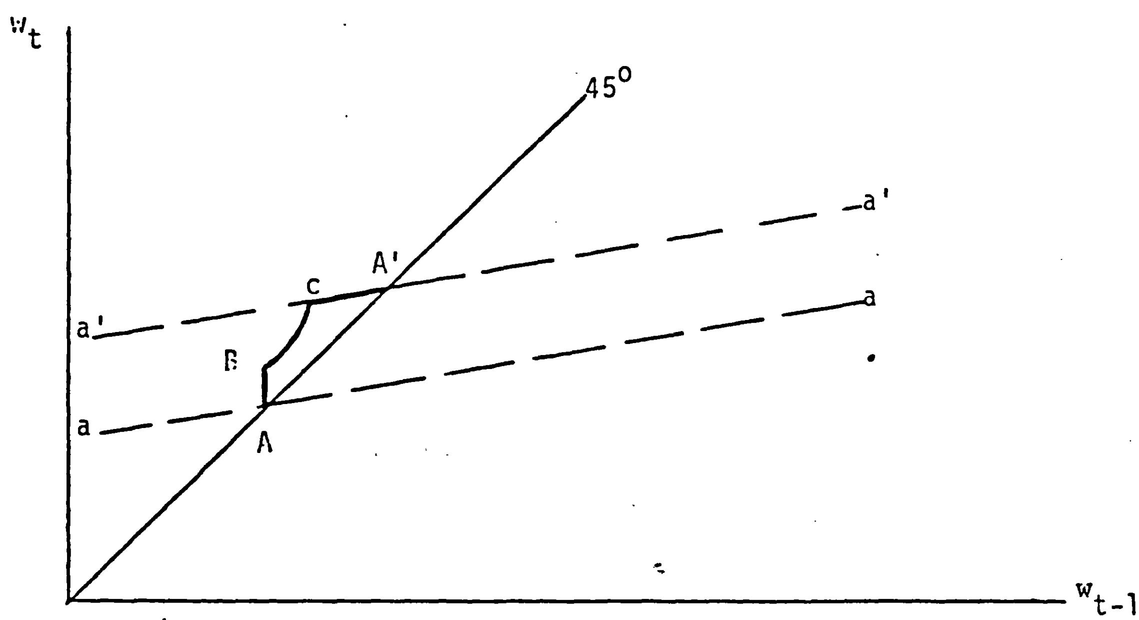
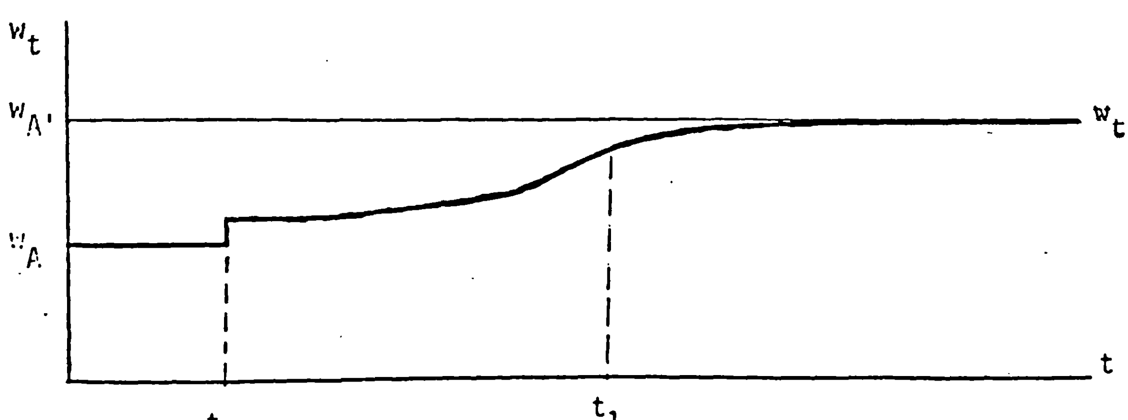


FIGURE A2.3



Appendix to Chapter 3

The following demonstrates the derivation of $var(w_{it})$ when wages are set according to (3.4) of chapter 3, to obtain the expression at (3.5). The derivation of (3.3), when wage setting is described by the expression at (3.1), follows simply by setting $\pi=1$.

$$(3.4) \Rightarrow E(w) = \pi \int_{y^*}^{\infty}(p+\alpha y)\, g(y)\, dy, \text{ where } p = p^e + \gamma p^u, \text{ and } y^* = -(p/\alpha).$$

Hence,

$$\begin{aligned}
var(w) &= \pi \int_{y^*}^{\infty}(p+\alpha y)^2 g(y)\, dy - \pi^2 \left[\int_{y^*}^{\infty}(p+\alpha y)\, g(y)\, dy\right]^2 \\
&= \pi p^2 \int_{y^*}^{\infty} g(y)\, dy + 2\pi p\alpha \int_{y^*}^{\infty} y\, g(y)\, dy + \pi\alpha^2 \int_{y^*}^{\infty} y^2 g(y)\, dy \\
&\quad - \pi^2\left[p \int_{y^*}^{\infty} g(y)\, dy + \alpha \int_{y^*}^{\infty} y\, g(y)\, dy \right]^2 \\
&= \pi(1-\pi)\left\{ p^2(1-G)^2 + 2p(1-G)\alpha \int_{y^*}^{\infty} y\, g(y)\, dy + \left[\alpha \int_{y^*}^{\infty} y\, g(y)\, dy\right]^2 \right\} \\
&\quad + \pi(1-G)\left\{ \alpha^2 \int_{y^*}^{\infty} y^2 \frac{g(y)}{1-G}\, dy - \left[\alpha \int_{y^*}^{\infty} y \frac{g(y)}{1-G}\, dy \right]^2 \right\} \\
&\quad + \pi p^2 G(1-G) + \pi 2p\alpha \int_{y^*}^{\infty} y \frac{g(y)}{1-G}\, dy\, G(1-G) + \pi G(1-G)\alpha^2\left[\int_{y^*}^{\infty} y \frac{g(y)}{1-G}\, dy \right]^2
\end{aligned}$$

where $1-G = 1-G(y^*) = \int_{y^*}^{\infty} g(y)\, dy$

$$\begin{aligned}
&= \pi(1-\pi)(1-G)^2\left[p + \alpha \int_{y^*}^{\infty} y \frac{g(y)}{1-G}\, dy \right]^2 + \pi(1-G)\alpha^2\, var(\tilde{y}) \\
&\quad + \pi(1-G)G\left[p + \alpha \int_{y^*}^{\infty} y \frac{g(y)}{1-G}\, dy \right]^2
\end{aligned}$$

$$= \pi(1-G)\alpha^2 var(\tilde{y}) + \pi(1-G)[\, 1- \pi(1-G)\,]\left\{ p + \alpha \int_{y^*}^{\infty} y \frac{g(y)}{1-G}\, dy \right\}^2$$

$$= \pi(1-G)\alpha^2 var(\tilde{y}) + \pi(1-G)[\, 1- \pi(1-G)\,]\{E(\tilde{w})\}^2$$

$$= (3.5)$$

Appendix to Chapter 4

Table A4.1

Dependent variables = P_{It}; I = (all production industries), 1964i-75iv (n = 48)

	(1)	(2)	(3)	(4)	(5)	(6)
β_0, T_t						
Const.	1.371	1.344	0.390	1.719	1.345	0.396
	(2.174)	(2.455)	(5.769)	(2.758)	(2.455)	(5.215)
P_{it-1}	-0.373	-0.373	-0.196	-0.444	-0.373	-0.117
	(2.502)	(2.547)	(1.478)	(2.841)	(2.547)	(0.917)
P_{it-2}	-0.139	-0.142	-0.153	-0.117	-0.142	-0.078
	(1.089)	(1.165)	(1.189)	(0.955)	(1.165)	(0.594)
D74iv	0.578	0.581	0.626	0.524	0.581	0.698
	(3.710)	(3.843)	(4.351)	(3.340)	(3.843)	(4.922)
CATFRl	0.065	0.063	0.097	-0.014	0.063	0.113
	(0.362)	(0.361)	(0.591)	(0.076)	(0.361)	(0.657)
CATFR2	0.209	0.213	0.285	0.267	0.213	0.230
	(1.266)	(1.353)	(1.867)	(1.648)	(1.353)	(1.390)
X_t-X_{t-4}						
Δwhpr	2.956	2.889	-	3.446	2.889	-
	(2.473)	(3.129)		(3.372)	(3.129)	
Δ fc	-1.228	-1.220	-	-1.149	-1.220	-
	(1.970)	(2.013)		(2.326)	(2.013)	
Δ prody	1.470	1.498	-	0.380	1.498	-
	(0.699)	(0.732)		(0.171)	(0.733)	
C_t						
stocks	-0.055	-0.053	-	-0.074	-0.053	-
	(1.368)	(1.543)		(1.945)	(1.543)	
un	-0.035	-0.036	-	-0.019	-0.036	-
	(0.727)	(0.794)		(0.402)	(0.794)	
ql	0.131	0.128	0.033	0.164	0.128	0.040
	(1.707)	(1.845)	(0.606))	2.190)	(1.845)	(0.695)
q2	0.054	0.053	0.013	0.064	0.053	0.003
	(0.738)	(0.750)	(0.233)	(0.911)	(0.750)	(0.048)
q3	-0.047	-0.045	-0.056	-0.047	-0.045	-0.083
	(0.804)	(0.834)	(0.971)	(0.881)	(0.834)	(1.413)
dfl	-0.137	-0.139	-0.165	-0.109	-0.139	-0.178
	(1.577)	(1.708)	(2.222)	(1.298)	(1.708)	(2.321)
df2	-0.162	-0.158	-0.172	-0.162	-0.159	-0.194
	(1.317)	(1.369)	(1.772)	(1.412)	(1.369)	(1.923)

(cont...)

Table A4.1 cont.

C1	0.124	0.124	0.127	0.158	0.124	0.077
	(1.512)	(1.540)	(1.778)	(1.870)	(1.540)	(1.162)
C2	0.173	0.172	0.072	0.247	0.172	0.045
	(1.387)	(1.412)	(0.732)	(1.822)	(1.412)	(0.442)
C3	-0.015	-0.016	-0.077	0.020	-0.016	-0.096
	(0.254)	(0.272)	(1.422)	(0.312)	(0.272)	(1.718)
C4	0.178	0.175	-0.103	0.215	0.175	-0.039
	(1.009)	(1.030)	(1.287)	(1.251)	(1.030)	(0.537)
C5	-0.042	-0.042	-0.077	0.147	-0.042	'0.042
	(0.338)	(0.346)	(0.710)	(0.752)	(0.346)	(0.210)
X_t^u						
UNCERT2	-0.171		1.998			
	(0.090)		(1.585)			
UNCERT3				-0.025		-0.004
				(1.222)		(0.201)
RSS	0.340405	0.340510	0.470712	0.321993	0.340510	0.508185
SE	0.1144	0.1123	0.1232	0.1113	0.1123	0.1280
R^2	0.758	0.758	0.666	0.771	0.758	0.639
DW	2.26	2.26	2.42	2.29	2.26	2.28

Notes

absolute t-values in parentheses.

Table A4.2

Values of SIC-specific dummies in equation reported in Table 4.5(1), in Table 4.6(1) and Table 4.6(2)

SIC Classification	Dummy coefficient Table 4.5(1)	Table 4.6(1)	Table 4.6(3)
Mining and quarrying	0.018		
	(0.300)		
Food drink and tobacco	0.021	0.208	0.259
	(0.344)	(1.49)	(2.25)
Coal, petroleum, chemicals	0.044	0.379	0.400
	(0.715)	(3.21)	(3.52)
Metal manufacture	0.031	-0.132	-0.085
	(0.503)	(0.35)	(0.14)
Engineering and elec. goods	-0.016	-0.474	-0.457
	(0.257)	(2.89)	(2.62)
Shipbuilding	0.020	0.331	0.370
	(0.332)	(0.67)	(0.84)
Vehicles	0.034	-0.025	0.145
	(0.552)	(0.01)	(0.30)
Metal goods nes	-0.137		
	(2.239)		
Textiles	-0.087	0.247	0.275
	(1.425)	(1.70)	(2.08)
Leather, leather goods and fur	-0.079	0.295	0.351
	(1.291)	(1.01)	(1.41)
Clothing and footwear	-0.066	-0.050	0.000
	(1.084)	(0.01)	(0.00)
Bricks, etc.	-0.028	0.231	0.263
	(0.453)	(1.55)	(1.99)
Timber, furniture, etc.	0.031	0.075	0.128
	(0.503)	(0.10)	(0.29)
Paper, printing and publishing	-0.008	0.067	0.089
	(0.137)	(0.14)	(0.24)
Other manufacturing industries	-0.059	0.082	0.189
	(0.972)	(0.08)	(0.40)
Construction	0.095	.	.
	(1.550)		
Gas, electricity and water	0.021		
	(0.348)		
Transport and communication	.		

Notes:
absolute t statistics reported in parentheses for coefficients related to Table 4.5 (cf t_∞). χ^2 statistics reported for those related to Table 4.6 (cf χ_1).
"." indicates baseline industry.

\

Table A4.3

Dependent variable = P_{It} = (0, 1)
I=(103 industries engaged in unconstrained negotiations
in the private sector): 1964ii-75iv (n=333)

	(1)	(2)	(3)	(4)
Constant	1.236 (0.36)	2.061 (0.98)	-0.487 (0.05)	-0.235 (0.01)
	Plus 13 SIC-specific dummies in each case			
X_{it}-X_{it-s}				
Δwhpr	5.608 (7.36)	10.760(21.83)	5.608 (7.36)	10.760(21.83)
Δfc	-7.495(24.80)	-8.297(30.18)	-7.495(24.80)	-8.297(30.18)
Δprody	11.301 (3.21)	8.062 (3.43)	11.301 (6.98)	8.062 (3.42)
Δtax	-11.647 (3.21)	-31.102(16.02)	-11.647 (3.21)	-31.102(16.02)
Δwdtd	3.443 (9.51)	2.228 (3.69)	3.443 (9.51)	2.228 (3.69)
C_{it}				
un	-0.871 (1.48)	-1.238 (2.96)	-0.175 (0.05)	-0.311 (0.15)
dt1	-1.955(79.42)	-1.932(77.14)	-1.955(79.42)	-1.932(77.14)
dt2	-2.582(62.03)	-2.471(57.39)	-2.584(62.03)	-2.471(57.39)
Δprofits	-	5.662(25.60)		5.662(25.60)
X_t^u				
UNCERT2	0.222 (0.36)	0.296 (0.63)		
UNCERT3			-0.132 (0.36)	-0.177 (0.63)
Time dummies:	Separate time dummies for each period in each case			
-2logL	3216.84	3191.08	3216.84	3191.08
FRAC	0.780	0.785	0.780	0.785
RANK	0.572	0.581	0.572	'0.581

Notes:
See footnotes to Table 4.6 in text. χ^2 in parentheses.

Table A4.4

Time-specific dummies relating to Table 4.6, Columns (1) and (2)

Period		Table 4.6(1)	Table 4.6(3)
1964	ii	-1.817 (1.236)	-2.341 (1.239)
	iii	-8.437 (12.978)	-9.198 (12.928)
	iv	-3.119 (1.156)	-3.839 (1.165)
1965	i	-1.875 (0.964)	-2.633 (0.978)
	ii	-1.405 (1.029)	-2.134 (1.041)
	iii	-0.535 (1.000)	-1.257 (1.013)
	iv	-1.403 (0.977)	-1.923 (0.988)
1966	i	-0.175 (1.007)	-0.487 (1.012)
	ii	-0.750 (1.561)	-0.670 (1.568)
	iii	-2.898 (1.560)	-2.692 (1.566)
	iv	-7.416 (7.575)	-6.717 (7.574)
1967	i	-1.807 (1.747)	-0.939 (1.759)
	ii	-1.235 (1.364)	-0.333 (1,381)
	iii	0.440 (0.969)	1.098 (0.978)
	iv	1.076 (1.209)	1.831 (1.216)
1968	i	1.342 (1.246)	1.695 (1.249)
	ii	-1.180 (0.747)	-1.304 (0.743)
	iii	-0.184 (0.736)	-0.470 (0.739)
	iv	0.366 (0.734)	0.018 (0.744)
1969	i	0.127 (0.650)	-0.423 (0.669)
	ii	-1.283 (0.872)	-1.881 (0.892)
	iii	-0.242 (0.639)	-0.889 (0.659)
	iv	0.634 (0.575)	0.211 (0.587)
1970	i	1.399 (0.520)	1.404 (0.527)
	ii	0.088 (0.662)	0.286 (0.667)
	iii	1.236 (0.591)	1.749 (0.602)
	iv	1.237 (0.540)	2.044 (0.561)
1971	i	-0.245 (0.522)	0.059 (0.525)
	ii	.	.
	iii	.	.
	iv	.	.

Cont...

Table A4.4 cont.

1972	i	0.517 (0.432)	0.533 (0.436)
	ii	0.064 (0.469)	0.022 (0.470)
	iii	0.731 (0.413)	0.646 (0.414)
	iv	-0.929 (1.084)	-0.810 (1.087)
1973	i	0.381 (0.618)	0.288 (0.619)
	ii	2.602 (0.733)	2.385 (0.736)
	iii	2.455 (0.785)	2.046 (0.787)
	iv	2.194 (1.087)	1.537 (1.093)
1974	i	2.685 (2.162)	2.226 (2.171)
	ii	0.871 (3.469)	0.472 (3.479)
	iii	-0.277 (3.537)	-0.652 (3.548)
	iv	2.657 (3.642)	2.357 (3.653)
1975	i	0.852 (4.025)	-0.137 (4.043)
	ii	0.252 (4.606)	-0.605 (4.626)
	iii	1.559 (4.784)	-2.114 (4.805)
	iv	-1.891 (6.663)	-2.611 (6.691)

Note: Standard errors in parentheses.
"." indicates baseline periods.

Appendix to Chapter 5

Tables A5.3-A5.7 provide industrial labour demand, price, wage, and output demand equations estimated without restriction. They correspond to Tables 5.3-5.7 in the text.

Appendix to Chapter 6

Tables A6.1 and A6.2 relate to the analysis of industrial price inertia of chapter 6.

Appendix to Chapter 7

Figure A7 provides a printout of the Fortran programme used to generate the simulations of sections 7.2-7.4.

Table A5.3

Industrial labour demand equations 1957-1981

	cons	n(-1)	n(-2)	w	q	k	y	tim
1. Agric.	-0.3625	0.4251	0.4547	-0.0743	0.2383	0.1453	0.0862	-0.0198
	(0.5205)	(52.0944)	(2.3118)	(0.7035)	(2.4114)	(1.0467)	(0.6681)	(2.7147)
2. Coal	3.9641	0.8475	-0.2729	-0.1821	0.3802	-0.1982	0.2843	-0.0186
	(3.6137)	(4.9900)	(1.5515)	(2.3946)	(4.1124)	(0.9864)	(2.6545)	(1.0834)
3. Mining	16.2309	0.2123	-0.2456	-0.8428	0.7069	-1.4526	0.1610	0.0435
	(4.5534)	(1.3305)	(1.1457)	(8.2535)	(5.5224)	(2.9911)	(1.0752)	(2.4520)
4. Petrol	8.8621	0.2975	-0.1978	-0.1507	2.6036	-0.0074	0.1125	-0.1434
	(3.6610)	(1.1851)	(0.9357)	(2.1242)	(3.6503)	(0.5603)	(1.2853)	(2.8770)
5. Food	-5.0558	0.9245	-0.5605	-0.0015	0.0520	0.5504	0.8921	-0.0510
	(0.9396)	(3.2228)	(2.4066)	(0.0126)	(0.6166)	(1.4517)	(2.9633)	(2.1843)
6. Drink	7.7324	0.5402	-0.2430	-0.1611	0.1920	-0.5912	0.2295	0.0327
	(4.0836)	(3.0929)	(1.4415)	(3.5789)	(3.1872)	(1.7667)	(1.7261)	(1.9776)
7. Tobacco	-9.9277	0.1734	0.1870	-0.0868	-0.1661	2.5129	0.0226	-0.1650
	(1.9474)	(0.7173)	(0.7749)	(1.4024)	(1.4033)	(3.0526)	(0.0804)	(3.0078)
8. Coal Prds	-5.9457	-0.2111	0.0626	-0.6613	0.8325	0.8762	1.1028	-0.0461
	(0.9571)	(0.7187)	(0.3007)	(5.5540)	(3.5837)	(0.8973)	(5.3714)	(0.6694)
9. Petrol Prds	5.4858	0.5020	0.0126	-0.4150	0.0720	-0.1462	-0.2500	0.0508
	(1.7371)	(3.9070)	(0.1043)	(2.6083)	(1.1505)	(0.3387)	(1.4723)	(1.2833)
10. Chems	5.7793	0.7342	-0.3060	-0.1819	0.1354	-0.2840	0.2212	0.0114
	(1.5167)	(3.8395)	(1.3862)	(1.3724)	(1.1197)	(1.1376)	(2.0206)	(0.6980)
11. Iron	0.7579	0.5763	-0.2530	0.0757	-0.0461	0.3468	0.4186	-0.0313
	(0.3694)	(3.9846)	(1.2491)	(0.5254)	(0.3373)	(2.4757)	(5.8381)	(3.2573)
12. Oth Metals	11.3650	0.4529	-0.6855	0.0478	-0.2772	-0.5705	0.2948	0.0244
	(5.1367)	(4.5768)	(5.4962)	(0.5365)	(2.4876)	(3.9525)	(3.6301)	(2.9186)
13. Mech Eng.	6.5561	0.9586	-0.6062	-0.5711	0.4021	-0.3166	0.2172	0.0313
	(0.7834)	(5.4485)	(2.5288)	(3.1820)	(2.6744)	(0.1998)	(1.4343)	(0.6581)
14. Inst Eng.	10.9960	0.3250	-0.4384	-0.2659	0.2029	-0.7753	0.3367	0.0344
	(4.7913)	(1.9780)	(2.6923)	(2.6709)	(1.8290)	(3.9319)	(3.5181)	(2.8401)
15. Elec Eng.	0.0819	0.8427	0.0667	-0.4160	0.4543	-0.7701	0.7031	0.0211
	(0.0382)	(6.9502)	(0.4721)	(4.0336)	(3.9804)	(2.5646)	(6.5538)	(1.0849)
16. Ships	6.3028	0.6776	-0.3300	-0.3390	0.4490	-0.3044	0.2338	-0.0147
	(2.4401)	(4.2154)	(2.1150)	(2.3615)	(3.5785)	(1.3522)	(3.1746)	(1.3527)
17. Motors	3.8568	0.5182	-0.0246	-0.2424	0.1649	-0.5041	0.5029	0.0262
	(3.2544)	(4.5160)	(0.2188)	(2.4841)	(2.1727)	(2.7679)	(7.4279)	(1.6363)
18. Aerosp.	8.7721	0.7345	-0.4220	-0.2392	0.1614	-0.4051	-0.0325	0.0076
	(4.9011)	(4.9485)	(2.7849)	(2.3224)	(1.8579)	(2.7488)	(1.1740)	(0.9897)

(....cont)

(Table A5.3 cont.)

	cons	n(-1)	n(-2)	w	q	k	y	tim
19. Oth Veh.	3.5740	0.3731	0.1246	-0.0958	0.1215	-0.4669	0.5004	0.0075
	(1.9788)	(2.2419)	(0.9071)	(1.3168)	(1.6063)	(1.7356)	(5.4545)	(0.5292)
20. Metal Gds	4.8537	0.6430	-0.3246	0.0413	-0.0838	-0.2042	0.3987	0.0028
	(2.1811)	(5.5240)	(2.4589)	(0.4176)	(0.9730)	(0.4767)	(7.2062)	(0.1936)
21. Textiles	1.9281	0.5602	0.1670	-0.7057	0.7274	-0.8602	0.7769	0.0435
	(0.7960)	(5.2586)	(1.2766)	(5.7695)	(7.4987)	(2.3285)	(10.3711)	(4.7590)
22. Clothing	3.4625	0.4020	0.0102	-0.0342	-0.0376	-0.2430	0.4920	-0.0118
	(1.6791)	(3.1268)	(0.0665)	(0.2521)	(0.2704)	(0.9797)	(5.8189)	(1.5006)
23. Bricks	6.1911	0.5606	-0.3100	-0.4291	0.2746	-0.3339	0.3273	0.0247
	(3.4385)	(4.4158)	(2.2366)	(4.5129)	(2.5801)	(0.9292)	(3.9954)	(1.0721)
24. Timber	7.0983	-0.0399	-0.3601	-0.1294	-0.0235	1.0481	0.1087	-0.0437
	(6.3289)	(0.3367)	(3.8885)	(1.5847)	(0.3459)	(6.0244)	(2.9072)	(6.7500)
25. Paper	-5.9363	0.2821	-0.0363	-0.5922	0.5018	1.4515	0.2658	-0.0300
	(1.0327)	(2.7786)	(0.3438)	(5.1635)	(4.9851)	(1.8665)	(2.0856)	(0.9095)
26. Printing	4.3332	1.1222	-0.4272	-0.1716	0.1852	-0.5743	0.3299	0.0153
	(0.9385)	(7.6410)	(2.5249)	(2.0280)	(2.4322)	(1.2715)	(2.8023)	(0.6276)
27. Oth Manuf	-0.2045	0.6198	0.0155	-0.2444	0.1830	-0.1521	0.5695	0.0023
	(0.1478)	(5.3725)	(0.1111)	(1.4474)	(1.2594)	(1.5361)	(8.2776)	(0.1856)
28. Constr.	1.8895	0.9815	-0.3506	-0.0272	0.1170	-0.3457	0.5252	0.0071
	(1.4041)	(9.1061)	(2.7781)	(0.1906)	(1.3192)	(2.5809)	(4.8375)	(0.6275)
29. Gas	5.8471	0.8963	-0.7205	-0.0096	-0.0338	0.2013	-0.0442	-0.0192
	(4.1025)	(3.4361)	(2.4267)	(0.0945)	(0.5407)	(1.6862)	(0.5769)	(1.8612)
30. Elec.	0.8616	0.9195	-0.2065	-0.1449	0.1994	-0.3447	0.6797	-0.0276
	(0.7182)	(5.4020)	(1.3251)	(1.8613)	(3.7221)	(2.8441)	(4.0053)	(1.3348)
31. Water	33.2689	0.1802	-0.3005	-0.6370	0.4068	-3.7997	1.1480	0.0822
	(3.4157)	(1.0302)	(2.0219)	(5.0268)	(4.5122)	(3.5542)	(3.2078)	(3.3301)
32. Rail	-38.6526	1.1319	-0.3415	-0.4894	0.3153	3.5142	0.7143	0.0338
	(1.9774)	(6.2801)	(1.9387)	(2.5813)	(2.9654)	(1.8476)	(3.5210)	(1.8913)
33. Road	2.6221	0.4670	-0.3106	-0.1210	0.0322	0.4910	0.2940	-0.0239
	(1.1450)	(2.0330)	(1.6146)	(2.2080)	(0.6650)	(2.8702)	(2.3623)	(1.6083)
34. Oth Trans	13.8191	0.8114	-0.2946	0.0241	0.0121	-1.0449	0.0630	-0.0004
	(2.9754)	(4.8696)	(1.6740)	(0.3146)	(0.3015)	(2.5356)	(0.6800)	(0.0766)
35. Comms	3.0712	0.7663	-0.2196	-0.0475	-0.0054	-0.1380	0.3184	0.0014
	(2.3731)	(5.4030)	(1.3732)	(0.8377)	(0.0769)	(1.5140)	(2.4698)	(0.2385)
36. Distn	-0.8074	0.2553	0.7023	-0.3432	0.3656	-0.9931	1.0351	0.0341
	(0.4265)	(1.5162)	(4.1804)	(3.3044)	(4.8356)	(3.4611)	(7.0750)	(1.9071)
37. Bus.Serv	7.4918	0.6309	-0.5099	0.0935	-0.0778	0.1533	0.0126	0.0090
	(4.5741)	(3.8217)	(3.0825)	(1.0506)	(1.2695)	(2.6626)	(0.2478)	(2.0385)
38. Prof.Serv	8.2709	0.3902	-0.1958	-0.1664	0.1615	-0.0103	-0.0805	0.0225
	(3.7075)	(2.0819)	(1.1261)	(2.2570)	(2.4682)	(0.1241)	(1.2616)	(2.2255)
39. Misc.Serv	0.9229	0.5134	0.0132	0.0802	0.0661	0.0358	0.4847	-0.0198
	(0.3893)	(2.7285)	(0.0589)	(1.1270)	(0.9184)	(0.1412)	(4.1476)	(1.2411)

Table A5.4

Industrial price equations 1957-1981

	cons	p(-1)	p(-2)	w	q	k	y	tim
1. Agric.	-5.2431	0.2827	-0.2917	0.4990	0.6901	1.1915	-0.4102	-0.0810
	(2.2066)	(2.1603)	(2.2272)	(4.3018)	(3.4680)	(4.1110)	(1.5961)	(5.6776)
2. Coal	0.3192	0.3762	-0.3145	0.1068	1.2278	0.0236	-0.0213	-0.0151
	(0.2155)	(2.0188)	(2.3042)	(0.6406)	(3.0854)	(0.0731)	(0.0920)	(1.1845)
3. Mining	2.4765	0.5466	-0.2004	-0.1790	0.8270	-0.2634	-0.1417	0.0131
	(1.2044)	(4.1322)	(1.8376)	(2.8153)	(8.1300)	(0.8160)	(1.3941)	(1.1045)
4. Petrol	-0.1220	0.0428	0.0285	1.3773	0.0505	-0.0046	-0.0489	0.0249
	(0.2483)	(1.0193)	(0.7794)	(26.5421)	(0.2353)	(0.4925)	(0.8201)	(0.8829)
5. Food	-4.2752	-0.0688	0.5723	-1.0076	1.4247	2.5948	-1.6144	-0.0360
	(0.7123)	(0.4804)	(4.1896)	(5.8005)	(10.5385)	(2.6736)	(3.9260)	(0.7560)
6. Drink	8.8551	0.6525	-0.4297	0.1486	0.4083	-0.9034	-0.5515	0.0807
	(2.0029)	(4.8703)	(3.2878)	(1.5098)	(2.5970)	(0.9313)	(1.7918)	(1.5372)
7. Tobacco	27.8747	0.5528	-0.0952	-0.0043	0.8119	-2.9549	-1.7390	0.2103
	(4.1055)	(5.4713)	(0.8067)	(0.0654)	(5.6843)	(2.6470)	(4.8879)	(2.8255)
8. Coal Prds	-13.1404	0.0603	-0.0168	-0.3699	1.8504	1.0783	0.8638	-0.0448
	(1.8459)	(0.3216)	(0.1308)	(2.6322)	(5.3645)	(1.1193)	(3.3458)	(0.6837)
9. Petrol Prds	4.0513	-0.3770	0.1914	0.3604	0.5705	0.1604	-0.7483	0.0364
	(0.6444)	(2.8815)	(2.1373)	(2.0858)	(6.6419)	(0.1852)	(3.3258)	(0.5603)
10. Chems	1.1807	0.1457	-0.0029	0.1472	0.8156	-0.1950	0.1231	-0.0220
	(0.4865)	(0.8045)	(0.0241)	(0.7713)	(4.4077)	(0.5507)	(0.9809)	(1.0456)
11. Iron	-0.9383	0.5095	-0.2133	0.4399	0.4522	0.1065	0.0942	-0.0286
	(0.7521)	(2.5257)	(1.5245)	(2.1619)	(1.9719)	(0.6836)	(1.0934)	(2.3279)
12. Oth Metals	-10.3558	0.3824	0.2197	-1.0768	1.4940	0.9466	0.5629	0.0011
	(3.7209)	(2.9863)	(1.6933)	(3.5265)	(4.5988)	(2.1841)	(2.2340)	(0.0500)
13. Mech Eng.	3.6550	0.4688	-0.0711	0.4530	0.2096	-0.5024	0.0565	-0.0054
	(0.8075)	(3.6941)	(0.9154)	(4.8550)	(1.9647)	(0.7152)	(0.7153)	(0.2403)
14. Inst Eng.	3.0422	0.1991	0.1226	0.3083	0.3042	-0.2769	-0.2594	0.0190
	(3.5458)	(1.2323)	(1.1581)	(3.8407)	(3.2500)	(1.6295)	(3.1449)	(2.1892)
15. Elec Eng.	-0.1944	0.1554	0.0734	0.3923	0.3929	-0.0847	0.1577	-0.0206
	(0.0701)	(0.6518)	(0.4839)	(3.1858)	(2.7982)	(0.1898)	(1.5572)	(0.6908)
16. Ships	11.4845	0.3588	-0.2326	-0.4858	1.2531	-1.2694	-0.5886	-0.0066
	(2.7250)	(2.3195)	(1.4356)	(1.2118)	(3.6354)	(2.2486)	(2.3657)	(0.3155)
17. Motors	-0.2897	0.4263	-0.0011	0.0777	0.6765	-0.0065	0.0896	-0.0141
	(0.2502)	(2.3859)	(0.0092)	(0.8487)	(5.1616)	(0.0333)	(1.3950)	(0.7926)
18. Aerosp.	2.1999	0.0395	0.0717	0.0825	0.7151	-0.6568	0.1528	0.0373
	(1.2649)	(0.2856)	(0.8414)	(0.6030)	(4.4080)	(1.9062)	(2.2082)	(1.9015)
19. Oth Veh.	2.4362	0.2319	-0.1940	-0.1011	0.9099	-0.7078	0.1281	0.0496
	(1.7261)	(2.0312)	(2.2122)	(1.3916)	(7.4311)	(2.8323)	(1.7225)	(3.8865)
20. Metal Gds	2.2842	0.0385	0.1478	0.3428	0.5339	-0.3475	0.0289	0.0024
	(0.3137)	(0.1236)	(0.7591)	(2.0242)	(2.6858)	(0.3029)	(0.3540)	(0.0568)
21. Textiles	1.1656	0.6105	-0.1320	-0.3574	0.9144	-0.5817	0.3522	0.0247
	(0.2891)	(3.4125)	(1.0159)	(2.0254)	(4.3492)	(0.9771)	(3.0641)	(2.2470)
22. Clothing	-1.1243	0.7854	-0.1494	0.5448	-0.1787	-0.2673	0.4250	-0.0212
	(0.7536)	(2.8017)	(0.7354)	(4.7829)	(1.4043)	(1.1026)	(4.7883)	(3.0113)
23. Bricks	4.4126	0.2229	0.0763	0.3216	0.3329	-0.3921	-0.2674	0.0239
	(2.0710)	(2.1729)	(0.8251)	(3.2685)	(3.3018)	(1.0381)	(3.9216)	(0.8796)
24. Timber	-6.0331	0.5962	0.1822	0.2131	-0.0188	1.2231	0.0292	-0.0552
	(3.6973)	(2.6159)	(0.9909)	(1.1150)	(0.0844)	(2.8848)	(0.2635)	(4.6162)
25. Paper	-9.4344	0.1539	-0.1378	-0.4508	1.2593	1.7607	-0.4800	-0.0200
	(1.0402)	(0.8328)	(1.0290)	(2.7406)	(6.5097)	(1.3383)	(2.1120)	(0.3856)
26. Printing	2.5042	-0.0569	0.0580	0.3289	0.4670	-0.2501	-0.1565	0.0296
	(0.3975)	(0.3442)	(0.5388)	(2.6866)	(3.2798)	(0.2747)	(0.9784)	(0.7176)
27. Oth Manuf	4.2596	-0.0870	0.1383	-0.1299	1.0075	0.0765	-0.6829	0.0314
	(6.5353)	(0.5506)	(1.3547)	(0.7546)	(6.2015)	(0.6270)	(7.3101)	(2.2052)
28. Constr.	2.6290	0.8768	-0.8001	-0.1407	0.7717	-0.3404	-0.1194	0.0517
	(1.0907)	(3.2818)	(3.9070)	(0.4809)	(2.3928)	(1.6309)	(0.4478)	(1.6683)
29. Gas	3.1738	1.0441	-0.4190	0.0902	0.2664	-0.1810	-0.2234	0.0037
	(3.6219)	(7.1180)	(3.0037)	(0.8796)	(3.6730)	(1.6058)	(2.3752)	(0.4092)
30. Elec.	-1.6750	0.2448	0.2026	-0.1743	0.7543	-0.0045	0.2580	-0.0155
	(0.8883)	(1.5470)	(1.5934)	(1.6635)	(6.3942)	(0.0217)	(1.2813)	(0.6798)
31. Water	-10.1103	0.4769	-0.3484	0.1635	0.5687	1.2401	-0.1584	-0.0011
	(1.8133)	(3.8466)	(3.4031)	(1.8931)	(5.9584)	(1.9379)	(0.6468)	(0.0681)
32. Rail	16.1886	0.1076	0.3621	-0.0363	0.5679	-1.7821	0.2020	0.0029
	(0.9598)	(0.8166)	(3.3678)	(0.2166)	(5.6430)	(1.0924)	(1.2034)	(0.1990)
33. Road	9.7292	0.2368	-0.1346	0.3410	0.2007	-0.4041	-0.9978	0.0591
	(1.2261)	(1.0667)	(0.5941)	(1.4089)	(1.0420)	(0.6644)	(1.5738)	(0.8102)
34. Oth Trans	40.1265	0.1564	-0.2776	0.7084	0.3568	-4.3167	-0.0386	0.0011
	(5.5544)	(1.0196)	(2.7248)	(5.2429)	(3.7088)	(5.3898)	(0.2182)	(0.0992)
35. Comms	6.3558	0.3536	-0.2733	0.6971	0.1631	0.2818	-1.1613	0.0286
	(3.9480)	(2.6410)	(2.9726)	(7.8687)	(1.2419)	(1.8701)	(4.0909)	(2.1567)
36. Distn	-2.2132	0.7482	-0.3351	-0.0097	0.5502	-0.1087	0.3370	0.0002
	(0.8006)	(4.5015)	(3.3466)	(0.0672)	(4.6592)	(0.3122)	(1.9943)	(0.0089)
37. Bus.Serv	-6.8068	0.6279	-0.2742	1.1393	-0.3888	0.4543	0.5011	-0.0920
	(2.1128)	(3.6374)	(1.4224)	(3.7921)	(1.9444)	(1.3316)	(1.5196)	(3.9404)
38. Prof.Serv	3.4371	0.0630	-0.1166	0.2870	0.6623	-0.0668	-0.3802	0.0157
	(5.6147)	(0.4514)	(1.0400)	(3.0784)	(6.4430)	(0.7190)	(5.0390)	(1.3362)
39. Misc.Serv	1.6614	0.0323	0.1246	0.4713	0.4168	0.0286	-0.1825	-0.0049
	(0.7802)	(0.2878)	(1.5182)	(8.3293)	(4.7973)	(0.1049)	(1.6507)	(0.3065)

Table A5.5

Industrial wage equations 1957-1981

	cons	w(-1)	$\bar{w}^e$	int	inc	unr	$\bar{p}^e$	t2
1. Agric.	-3.3980	0.9395	0.7645	2.2878	0.0026	-4.3994	-1.0654	-0.1931
	(1.6458)	(7.5054)	(2.4545)	(2.0539)	(0.4961)	(1.6491)	(2.9535)	(0.2902)
2. Coal	-0.2658	-0.1721	0.3947	-0.2059	0.0162	-4.3241	1.0652	-1.9623
	(0.6846)	(0.8762)	(0.6931)	(0.2752)	(1.6956)	(2.5048)	(1.4844)	(1.8641)
3. Mining	7.2328	-0.0085	-0.4343	1.0478	0.0056	2.6679	0.5053	-5.4007
	(1.2893)	(0.0390)	(1.4086)	(1.5538)	(0.4052)	(1.2475)	(0.7613)	(3.4779)
4. Petrol	-6.2815	0.0530	-3.7735	0.4796	-0.1010	84.4161	3.7619	-10.1948
	(1.5304)	(0.3941)	(1.2701)	(0.3867)	(1.5996)	(5.0538)	(0.6986)	(1.6719)
5. Food	7.0483	0.0169	0.9418	-0.6500	-0.0070	2.7031	-0.1464	-0.7098
	(1.5479)	(0.1508)	(6.2423)	(1.4590)	(1.8466)	(2.7600)	(1.4139)	(1.5647)
6. Drink	-11.6135	-0.0443	2.6903	-6.4681	0.0019	6.0150	-1.0604	0.5406
	(1.4983)	(0.2523)	(4.3283)	(1.7923)	(0.1828)	(1.5542)	(2.6697)	(0.3958)
7. Tobacco	-32.0002	0.2890	0.8163	2.2350	0.0214	1.8966	0.1355	1.1748
	(2.0743)	(1.9347)	(1.9211)	(2.0524)	(1.4206)	(0.4449)	(0.4110)	(0.5229)
8. Coal Prds	7.1011	0.4238	0.5466	-0.5003	0.0288	-14.8649	0.7224	-0.4441
	(1.4135)	(1.5467)	(1.5062)	(1.4251)	(1.7390)	(2.0337)	(1.7254)	(0.2106)
9. Petrol Prds	2.2579	0.1761	1.0970	0.7297	-0.0043	-8.7099	-0.3831	1.4084
	(0.7597)	(1.0967)	(3.8375)	(0.8447)	(0.4870)	(2.0549)	(1.1556)	(1.1850)
10. Chems	-0.4623	-0.0837	0.8676	-0.1923	0.0056	1.1464	0.1876	-1.3829
	(1.1909)	(0.7066)	(6.0490)	(0.4072)	(1.6214)	(0.6991)	(2.7098)	(3.5321)
11. Iron	0.3475	0.4628	0.0101	-0.2075	0.0062	3.3661	0.3561	-2.8431
	(0.2739)	(2.0911)	(0.0467)	(0.9315)	(0.7879)	(2.1440)	(2.2028)	(3.3121)
12. Oth Metals	-0.9911	0.3766	0.3809	-0.8121	0.0069	-1.3377	0.0005	-1.2814
	(1.2087)	(2.3308)	(1.8485)	(3.0843)	(0.9443)	(1.0087)	(0.0037)	(1.5145)
13. Mech Eng.	-0.3209	0.3845	0.1785	0.5343	0.0036	1.0719	0.1745	-0.8923
	(0.0590)	(2.1467)	(0.7032)	(1.5593)	(0.7845)	(0.7440)	(1.6027)	(1.5190)
14. Inst Eng.	0.0347	0.3286	0.1552	0.4333	0.0147	-0.9174	0.4154	-2.6321
	(0.0693)	(2.8331)	(0.6467)	(1.3776)	(2.7928)	(0.5233)	(2.3200)	(3.8647)
15. Elec Eng.	-1.0255	0.2388	0.1304	1.1997	0.0036	-3.7631	0.2077	-0.8893
	(0.4934)	(1.3717)	(0.6699)	(3.8327)	(0.7873)	(1.6698)	(1.5205)	(1.6736)
16. Ships	-0.0229	-0.0134	0.9924	0.5117	0.0040	0.4781	-0.2164	-1.1171
	(0.0281)	(0.0988)	(5.0229)	(2.5677)	(1.0959)	(1.1355)	(1.4131)	(2.2729)
17. Motors	0.0997	0.7341	0.2896	-0.2981	0.0090	2.0113	-0.0025	-1.1318
	(0.2536)	(3.9787)	(1.5026)	(1.5487)	(1.9610)	(1.0609)	(0.0178)	(2.0165)
18. Aerosp.	10.9452	-0.5902	2.6017	4.0858	-0.0057	2.4574	-1.8424	1.3798
	(3.2291)	(2.2635)	(3.7670)	(2.9054)	(0.7422)	(1.1162)	(3.4223)	(1.4953)

(....cont)

(Table A5.5 cont.)

	cons	w(-1)	$\bar{w}^e$	int	inc	unr	$\bar{p}^e$	t2
19. Oth Veh.	-1.1416	0.3624	0.2322	-0.0700	-0.0045	5.6989	-0.0253	-4.2186
	(3.5498)	(2.2856)	(0.5700)	(0.2273)	(0.4280)	(1.7953)	(0.0663)	(3.5657)
20. Metal Gds	-0.5772	0.7567	0.0605	0.2109	0.0077	-1.1798	0.2263	-1.4435
	(0.7423)	(3.4535)	(0.2931)	(0.7336)	(1.1883)	(0.8014)	(1.8110)	(2.1505)
21. Textiles	-0.4038	-0.1100	0.9417	0.0176	0.0012	1.6659	0.0930	-1.3038
	(2.7169)	(0.8474)	(7.4701)	(0.1694)	(0.3723)	(1.6949)	(1.3699)	(2.8715)
22. Clothing	0.3536	0.0589	0.5786	-0.0805	0.0081	-2.3503	0.5209	0.0616
	(0.7571)	(0.3779)	(4.6664)	(0.3826)	(1.8776)	(1.8151)	(5.2916)	(0.1258)
23. Bricks	-0.3668	0.0655	0.5332	0.0192	0.0057	0.1298	0.4493	-1.4461
	(1.1083)	(0.3174)	(2.1377)	(0.0456)	(0.9159)	(0.0828)	(3.3667)	(1.9709)
24. Timber	-5.8312	0.4018	0.3447	1.0094	0.0149	-3.0410	0.3452	0.0389
	(5.6710)	(2.6894)	(2.1132)	(4.4184)	(3.3567)	(2.1866)	(3.1956)	(0.0764)
25. Paper	-3.6114	0.6355	0.2233	0.3111	0.0157	-7.4829	0.1710	-0.3181
	(0.8418)	(5.5671)	(0.7835)	(0.9384)	(4.0153)	(3.4026)	(1.3086)	(0.6168)
26. Printing	-1.5813	0.8580	0.1191	-0.7556	0.0078	6.0081	-0.0026	-1.6576
	(0.5772)	(3.1605)	(0.4398)	(1.2345)	(1.0801)	(2.0128)	(0.0196)	(2.0488)
27. Oth Manuf	-0.4143	0.2086	0.6507	0.1722	0.0046	-3.4212	0.2524	-0.1615
	(0.8070)	(1.6127)	(4.0865)	(1.1066)	(1.1851)	(2.5614)	(2.7104)	(0.3329)
28. Constr.	-0.1386	0.3253	0.3222	-0.1935	0.0044	1.0197	0.1929	-1.9088
	(0.1376)	(1.5972)	(1.3905)	(0.4661)	(0.7190)	(1.3991)	(1.5043)	(2.4881)
29. Gas	-0.6570	-0.0277	0.9814	0.3830	-0.0062	5.2447	0.0128	-0.9082
	(0.8624)	(0.1937)	(3.3792)	(0.4121)	(0.7890)	(1.7088)	(0.0790)	(1.0646)
30. Elec.	-0.1058	0.4469	0.5212	-0.0830	0.0190	5.8111	0.1035	-0.7350
	(0.1356)	(2.7500)	(1.9469)	(0.2080)	(3.7920)	(2.8125)	(0.9250)	(0.9610)
31. Water	0.8832	0.3406	0.9292	0.0293	0.0252	-3.6217	-0.3740	0.0093
	(0.2801)	(3.2489)	(3.4961)	(0.2242)	(6.0797)	(1.6819)	(2.5533)	(0.0159)
32. Rail	-27.1601	0.2119	0.9995	0.6762	-0.0120	1.3882	-0.5855	1.1083
	(1.7139)	(1.2951)	(3.4170)	(2.0585)	(2.5650)	(0.5123)	(3.6838)	(2.0103)
33. Road	3.2700	0.0438	1.7261	-0.6156	0.0106	3.0525	-1.1094	-0.9045
	(0.5701)	(0.2229)	(3.1713)	(0.6252)	(1.5484)	(0.9824)	(2.4338)	(1.0935)
34. Oth Trans	-11.7597	-0.0902	1.3948	-1.2886	0.0070	0.4690	-0.4869	0.0153
	(1.9335)	(0.8927)	(6.6490)	(1.5241)	(1.9886)	(0.2648)	(3.5808)	(0.0296)
35. Comms	-1.5143	0.0358	0.3581	0.7155	-0.0053	7.7506	0.5689	-1.1230
	(0.7721)	(0.1561)	(0.9378)	(0.5463)	(0.7185)	(2.9306)	(1.5370)	(1.3042)
36. Distn	-0.6748	0.4404	0.4710	0.6337	0.0057	-3.5115	-0.1234	-0.2740
	(0.5171)	(3.4290)	(3.0425)	(3.3049)	(1.7024)	(2.0831)	(1.8566)	(0.5714)
37. Bus.Serv	-10.3858	-0.3894	-0.0520	5.8102	-0.0077	-14.1203	1.3389	1.8969
	(2.7318)	(2.0477)	(0.1078)	(2.2501)	(1.4162)	(2.4521)	(2.1186)	(2.7740)
38. Prof.Serv	0.2819	0.5163	0.0931	1.5040	-0.0050	2.8447	-0.0681	-0.2402
	(0.3520)	(3.8352)	(0.2077)	(1.5276)	(0.6205)	(0.2303)	(0.2512)	(0.2130)
39. Misc.Serv	-7.9424	0.5114	0.7296	1.7626	-0.0045	0.2256	-0.2644	-0.0805
	(1.6326)	(3.6844)	(2.5661)	(1.6578)	(0.4290)	(0.0678)	(1.4208)	(0.0681)

Table A5.6

Industrial demand equations 1957-1981

	cons	y(-1)	p/$\bar{p}$	pm/$\bar{p}$	σ	tim
1. Agric.	5.0638	0.3768	-0.1004	0.0464	3.9641	0.8475
	(3.9603)	(2.3784)	(-1.5007)	(1.9459)	(3.6137)	(4.9900)
2. Coal	4.0244	0.5347	0.3251	0.0235	16.2309	0.2123
	(2.9119)	(3.2247)	(2.1599)	(2.0293)	(4.5534)	(1.3305)
3. Mining	4.5602	0.2063	-0.7997	0.0103	8.8621	0.2975
	(6.5163)	(1.5523)	(-4.8883)	(0.1818)	(3.6610)	(1.1851)
4. Petrol	0.4049	0.5092	0.0856	-0.3637	-5.0558	0.9245
	(0.5573)	(3.5005)	(1.0187)	(-1.0642)	(-0.9396)	(3.2228)
5. Food	8.4926	0.0246	-0.0210	0.0916	7.7324	0.5402
	(4.2353)	(0.1065)	(-0.2980)	(3.5924)	(4.0836)	(3.0929)
6. Drink	2.7390	0.5639	-0.0925	0.1008	-9.9277	0.1734
	(2.5326)	(3.3241)	(-1.2931)	(3.2099)	(-1.9474)	(0.7173)
7. Tobacco	4.7591	0.2573	-0.2282	-0.0336	-5.9457	-0.2111
	(5.1166)	(1.7194)	(-4.3634)	(-1.3636)	(-0.9571)	(-0.7187)
8. Coal Prds	4.0103	0.2671	0.4438	0.2145	5.4858	0.5020
	(3.3955)	(1.2528)	(3.8531)	(3.8022)	(1.7371)	(3.9070)
9. Petrol Prds	5.0396	0.1841	-0.7984	0.3966	5.7793	0.7342
	(8.8297)	(1.9754)	(-9.5701)	(4.5769)	(1.5167)	(3.8395)
10. Chems	5.1998	0.2875	-0.0974	0.2279	0.7579	0.5763
	(4.9717)	(2.0127)	(-0.6745)	(4.2390)	(0.3694)	(3.9846)
11. Iron	6.6420	0.1284	-0.5197	0.3722	11.3650	0.4529
	(5.0939)	(0.7363)	(-2.4606)	(2.7448)	(5.1367)	(4.5768)
12. Oth Metals	6.7231	0.0451	-0.2223	0.2042	6.5561	0.9586
	(8.2118)	(0.3856)	(-2.4519)	(5.4038)	(0.7834)	(5.4485)
13. Mech Eng.	0.3574	0.9495	-0.4725	0.0498	10.9960	0.3250
	(0.3537)	(7.3448)	(-2.2173)	(1.1175)	(4.7913)	(1.9780)
14. Inst Eng.	1.7954	0.6385	0.2613	0.0945	0.0819	0.8427
	(2.6127)	(4.5980)	(1.0868)	(2.4489)	(0.0382)	(6.9502)
15. Elec Eng.	3.9930	0.4575	0.6069	0.0484	6.3028	0.6776
	(4.6236)	(3.9516)	(3.6633)	(1.9922)	(2.4401)	(4.2154)
16. Ships	1.2508	0.8502	-0.5403	0.0132	3.8568	0.5182
	(1.4606)	(7.2384)	(-6.1275)	(0.2524)	(3.2544)	(4.5160)
17. Motors	5.4093	0.2194	0.1316	0.4974	8.7721	0.7345
	(3.2505)	(0.9058)	(0.4515)	(3.1419)	(4.9011)	(4.9485)
18. Aerosp.	8.2042	-0.0140	1.8558	-0.0396	3.5740	0.3731
	(5.3788)	(-0.0654)	(4.4019)	(-0.7057)	(1.9788)	(2.2419)
19. Oth Veh.	4.8979	0.3792	1.3035	0.0431	4.8537	0.6430
	(5.4873)	(3.2816)	(7.9724)	(2.3032)	(2.1811)	(5.5240)
20. Metal Gds	4.7307	0.4014	0.0502	0.1462	1.9281	0.5602
	(3.8107)	(2.5657)	(0.1949)	(2.4517)	(0.7960)	(5.2586)
21. Textiles	2.3249	0.6946	-0.2618	0.1509	3.4625	0.4020
	(2.0918)	(4.6314)	(-0.9804)	(3.0931)	(1.6791)	(3.1268)
22. Clothing	3.4550	0.5366	-0.3343	0.1065	6.1911	0.5606
	(2.7852)	(3.2131)	(-1.4139)	(2.8627)	(3.4385)	(4.4158)
23. Bricks	6.7323	-0.0009	-0.7933	0.2047	7.0983	-0.0399
	(8.8665)	(-0.0077)	(-3.7957)	(4.1016)	(6.3289)	(-0.3367)
24. Timber	9.0167	-0.2949	0.2107	0.3270	-5.9363	0.2821
	(7.0018)	(-1.5820)	(1.0716)	(4.8057)	(-1.0327)	(2.7786)
25. Paper	5.6514	0.1790	-0.9471	0.2984	4.3332	1.1222
	(7.1167)	(1.5420)	(-5.6478)	(5.0781)	(0.9385)	(7.6410)
26. Printing	6.4674	0.0694	0.1109	0.1941	-0.2045	0.6198
	(9.5659)	(0.7029)	(0.9565)	(4.8990)	(-0.1478)	(5.3725)
27. Oth Manuf	5.8024	0.2219	-1.1987	0.0394	1.8895	0.9815
	(6.7706)	(1.7684)	(-7.4202)	(0.8947)	(1.4041)	(9.1061)
28. Constr.	1.2382	0.8323	-0.6678	0.0918	5.8471	0.8963
	(1.6204)	(9.8763)	(-7.1542)	(2.7230)	(4.1025)	(3.4361)
29. Gas	0.8297	0.8545	-0.1647	0.0307	0.8616	0.9195
	(0.8738)	(7.1516)	(-1.4496)	(0.7254)	(0.7182)	(5.4020)
30. Elec.	-0.5173	1.0644	0.2824	0.0153	33.2689	0.1802
	(-1.1260)	(18.3143)	(2.9271)	(2.0553)	(3.4157)	(1.0302)
31. Water	1.9775	0.6475	-0.1534	0.0450	-38.6526	1.1319
	(2.7379)	(5.2857)	(-1.8719)	(2.7820)	(-1.9774)	(6.2801)
32. Rail	1.2384	0.8154	0.2825	0.0100	2.6221	0.4670
	(1.0028)	(5.1255)	(1.6056)	(0.4569)	(1.1450)	(2.0330)
33. Road	1.8707	0.7101	-0.1222	0.1140	13.8191	0.8114
	(1.7417)	(4.5307)	(-1.8846)	(2.9693)	(2.9754)	(4.8696)
34. Oth Trans	4.1494	0.4684	-0.4427	0.0913	3.0712	0.7663
	(5.0742)	(4.5344)	(-2.8804)	(3.4501)	(2.3731)	(5.4030)
35. Comms	2.7534	0.6037	-0.1794	0.0486	-0.8074	0.2553
	(4.1680)	(6.4286)	(-3.2129)	(3.3313)	(-0.4265)	(1.5162)
36. Distn	6.8642	0.2483	0.4052	0.0037	7.4918	0.6309
	(10.1183)	(3.3368)	(6.9972)	(0.5699)	(4.5741)	(3.8217)
37. Bus.Serv	3.6215	0.5228	0.0547	0.0388	8.2709	0.3902
	(3.0189)	(3.2750)	(0.9532)	(1.6125)	(3.7075)	(2.0819)
38. Prof.Serv	5.3914	0.2219	-1.1742	0.2857	0.9229	0.5134
	(4.1169)	(1.2862)	(-4.0951)	(3.3913)	(0.3893)	(2.7285)
39. Misc.Serv	3.2928	0.6400	-0.0024	0.0313	0.6965	0.0082
	(1.8650)	(3.3810)	(-0.0170)	(1.2504)	(4.6992)	(0.0002)

(....cont)

(Table A5.6 cont.)

Table A5.7

Estimated equation diagnostics

Industry	Value objective fn. (L)	Employment eqn Price eqn Wage eqn Output eqn	RSS	s. error regression	R^2
1. Agric.	76.8193		0.0069	0.0166	0.9969
			0.0117	0.0216	0.9982
			0.0124	0.0223	0.9993
			0.0091	0.0190	0.9849
2. Coal	80.8458		0.0128	0.0226	0.9966
			0.0415	0.0408	0.9973
			0.0928	0.0609	0.9945
			0.1032	0.0642	0.9597
3. Mining	70.9138		0.0345	0.0371	0.9620
			0.0113	0.0213	0.9987
			0.0805	0.0567	0.9947
			0.0359	0.0379	0.9666
4. Petrol	73.3697		0.4573	0.1352	0.9649
			0.3308	0.1150	0.9985
			2.2316	0.2988	0.9771
			3.8760	0.3938	0.9800
5. Food	79.4958		0.0046	0.0136	0.9813
			0.0146	0.0242	0.9984
			0.0131	0.0229	0.9992
			0.0042	0.0130	0.9875
6. Drink	85.5285		0.0107	0.0207	0.8780
			0.0409	0.0404	0.9920
			0.0889	0.0596	0.9957
			0.0116	0.0216	0.9947
7. Tobacco	77.5558		0.0235	0.0307	0.9228
			0.0414	0.0407	0.9942
			0.2008	0.0896	0.9920
			0.0127	0.0226	0.9294
8. Coal Prds	80.6044		0.0845	0.0581	0.9458
			0.1673	0.0818	0.9912
			0.2638	0.1027	0.9870
			0.0792	0.0563	0.9175
9. Petrol Prds	82.8008		0.0560	0.0473	0.9343
			0.1106	0.0665	0.9930
			0.0816	0.0571	0.9959
			0.0505	0.0450	0.9865

(cont...)

(Table A5.7 cont.)

	L	RSS	s.e.	R^2
10. Chems	86.3575	0.0072	0.0169	0.8633
		0.0165	0.0257	0.9974
		0.0105	0.0205	0.9994
		0.0243	0.0312	0.9912
11. Iron	75.1254	0.0272	0.0330	0.9765
		0.0316	0.0355	0.9969
		0.0271	0.0329	0.9984
		0.1572	0.0793	0.7644
12. Oth Metals	99.2055	0.0066	0.0163	0.9858
		0.0723	0.0538	0.9933
		0.0331	0.0364	0.9979
		0.0228	0.0302	0.8948
13. Mech Eng	90.9970	0.0081	0.0180	0.9700
		0.0033	0.0115	0.9996
		0.0161	0.0254	0.9991
		0.0247	0.0315	0.9653
14. Inst Eng	85.9149	0.0087	0.0186	0.9228
		0.0054	0.0147	0.9991
		0.0255	0.0319	0.9985
		0.0373	0.0386	0.9914
15. Elec Eng	97.4993	0.0093	0.0193	0.9206
		0.0069	0.0166	0.9989
		0.0163	0.0256	0.9989
		0.0183	0.0271	0.9905
16. Ships	86.8102	0.0099	0.0199	0.9923
		0.1487	0.0771	0.9758
		0.0099	0.0199	0.9994
		0.0866	0.0589	0.8034
17. Motors	89.5607	0.0084	0.0184	0.9700
		0.0124	0.0223	0.9986
		0.0309	0.0352	0.9982
		0.0775	0.0557	0.9315
18. Aerosp.	71.6462	0.0187	0.0274	0.9816
		0.0567	0.0476	0.9954
		0.0206	0.0287	0.9988
		0.4796	0.1385	0.0002
19. Oth Vehs	74.0106	0.0261	0.0323	0.9906
		0.0277	0.0333	0.9977
		0.0654	0.0512	0.9949
		0.1468	0.0766	0.8965
20. Metal Gds	85.9540	0.0070	0.0167	0.9570
		0.0152	0.0247	0.9985
		0.0222	0.0298	0.9985
		0.0706	0.0531	0.7552

(cont...)

(Table A5.7 cont.)

	L	RSS	s.e.	R^2
21. Textiles	115.3965	0.0094	0.0195	0.9956
		0.0314	0.0354	0.9939
		0.0250	0.0316	0.9986
		0.0451	0.0425	0.8639
22. Clothing	83.7527	0.0060	0.0155	0.9950
		0.0074	0.0172	0.9986
		0.0155	0.0249	0.9990
		0.0329	0.0363	0.8407
23. Bricks	79.7671	0.0080	0.0179	0.9861
		0.0085	0.0185	0.9991
		0.0369	0.0384	0.9979
		0.0314	0.0354	0.9617
24. Timber	106.0004	0.0036	0.0119	0.9651
		0.0161	0.0254	0.9982
		0.0155	0.0249	0.9990
		0.0525	0.0458	0.9029
25. Paper	83.6123	0.0128	0.0226	0.9614
		0.0387	0.0393	0.9958
		0.0212	0.0291	0.9989
		0.0317	0.0356	0.9102
26. Printing	83.8097	0.0052	0.0145	0.9542
		0.0144	0.0240	0.9986
		0.0202	0.0284	0.9987
		0.0110	0.0210	0.9858
27. Oth Manuf	85.8266	0.0057	0.0151	0.9657
		0.0247	0.0314	0.9968
		0.0131	0.0229	0.9993
		0.0503	0.0449	0.9717
28. Constr.	82.1878	0.0072	0.0170	0.9476
		0.0285	0.0338	0.9974
		0.0200	0.0283	0.9985
		0.0180	0.0268	0.9482
29. Gas	92.7327	0.0160	0.0253	0.9763
		0.0230	0.0303	0.9945
		0.0535	0.0463	0.9969
		0.0258	0.0321	0.9950
30. Elec	87.8166	0.0114	0.0214	0.9826
		0.0272	0.0330	0.9961
		0.0321	0.0358	0.9985
		0.0175	0.0264	0.9933
31. Water	92.7842	0.0335	0.0366	0.9266
		0.0247	0.0314	0.9975
		0.0298	0.0345	0.9980
		0.0068	0.0165	0.9882

(cont...)

(Table A5.7 cont.)

	L	RSS	s.e.	R^2
32. Rail	81.3307	0.0135	0.0232	0.9950
		0.0100	0.0200	0.9987
		0.0129	0.0227	0.9993
		0.0183	0.0270	0.9044
33. Road	74.9756	0.0032	0.0113	0.9751
		0.0752	0.0549	0.9921
		0.0307	0.0351	0.9983
		0.0187	0.0274	0.9776
34. Oth Trans	93.6919	0.0063	0.0159	0.9172
		0.0245	0.0313	0.9967
		0.0266	0.0326	0.9985
		0.0141	0.0237	0.9891
35. Comms	83.8859	0.0042	0.0130	0.9666
		0.0162	0.0254	0.9984
		0.0432	0.0416	0.9974
		0.0045	0.0135	0.9984
36. Distn	85.2587	0.0043	0.0131	0.9759
		0.0105	0.0205	0.9985
		0.0109	0.0209	0.9993
		0.0030	0.0109	0.9942
37. Bus.Serv	73.0020	0.0050	0.0141	0.9944
		0.0415	0.0407	0.9945
		0.0074	0.0172	0.9995
		0.0099	0.0199	0.9962
38. Prof.Serv	94.9893	0.0093	0.0193	0.9745
		0.0167	0.0259	0.9982
		0.0496	0.0446	0.9971
		0.1001	0.0633	0.9315
39. Misc.Serv	75.7834	0.0044	0.0133	0.9374
		0.0084	0.0184	0.9992
		0.0586	0.0484	0.9960
		0.0109	0.0209	0.9713

Table A6.1

Measures of Industrial Characteristics

ind	pr	conc68	conc79	conc	kout	prodpos	imrat	exrat	vardem	varcost
5	.3789	70.4	51.8	.41	.16	.3225	.21	.06	.7180	.4370
6	.0887	69.8	58.4	.48	.41	.0815	.19	.22	.6810	.5200
7	.2238	99.7	99.0	.92	1.06	.0	.07	.20	.5990	.4610
8	.0294	93.7	95.0	.95	10.87	.7430	.00	.00	.6590	.7360
9	.0385	86.8	68.3	.51	1.00	.9329	.25	.15	.8698	.7931
10	.0171	72.1	58.5	.46	.70	.7017	.22	.03	.8400	.5700
11	.1636	98.3	63.9	.55	.47	.9668	.14	.17	.4190	.5690
12	.4205	74.9	55.1	.34	.23	.9610	.39	.22	.5070	.4570
13	.1288	52.3	32.9	.23	.27	.4844	.31	.44	.6050	.5320
14	.1209	48.1	33.1	.15	.25	.1823	.56	.51	.9040	.4650
15	.0539	77.3	62.3	.40	.25	.4733	.36	.28	.7520	.5240
16	.0278	57.4	73.0	.54	.32	.2060	.26	.13	.1930	.4850
17	.2326	90.8	65.3	.44	.28	.3323	.33	.29	.5860	.5200
18	.0078	94.3	78.0	.44	.27	.0758	.44	.45	.8660	.4890
19	.0079	86.5	89.7	.37	.53	.6734	.59	1.39	.3940	.5200
20	.0144	54.7	31.6	.20	.24	.8610	.38	.33	.5230	.5310
21	.2107	53.0	46.5	.33	.41	.6268	.28	.26	.1880	.4670
22	.4034	28.4	24.7	.17	.15	.1233	.30	.18	.3540	.3580
23	.0846	65.4	48.3	.43	.36	.8675	.12	.14	.7210	.5410
24	.8579	23.6	14.7	.11	.08	.5428	.24	.05	.5760	.4830
25	.0072	52.4	43.2	.30	.54	.0897	.32	.08	.5530	.4900
26	.0348	30.6	23.9	.23	.59	.6598	.05	.11	.8010	.5090

Table A6.2

Intervals for classification of industries by characteristics
(as used in the analysis of Tables 6.2 and 6.5)

Var.	Low	Medium	High
πgrp1	<0.20		>0.20
πgrp2	<0.33		>0.33
conc	<0.25	]0.25,0.48]	>0.48
kout	<0.20	]0.20,0.37]	>0.37
prodpos	<0.34	]0.34,0.75]	>0.75
imrat	<0.18		>0.18
exrat	<0.10	]0.10,0.27]	>0.27
vardem	<0.43	]0.43, 0.76]	>0.76
varcost	<0.52		>0.52

SECTOR	Primary	Manufacturing	Tertiary
industry	1-4	5-26	32-39

(1)

Figure A7

Fortran programme used for generation of simulations

```
      INTEGER T,TL,TLL
      REAL IO,IPPR,LUP,LRR,LT1,LT2,LT3,INCPOL,LKL,KI,LSMA,MU,LSI
      DIMENSION W27(39),P27(39),AGGW(28),WTD(28,40),WTMC(28,40),
     + IO(40,40),UNI(28,40),UNRSEC(28),AGGP(28),DGDP(28),TIM(28),
     + TSQ(28),UNR(28),LUP(28),LRR(28),LT1(28),LT2(28),LT3(28),
     + INCPOL(28),WRONG(28),COMP(28),LKL(28),EMI(28,39),WI(28,39),
     + PNI(28,39),KI(28,39),PMI(28,39),PI(28,39),YI(28,39),DLUP(28),
     + DLRR(28),DINPOL(28),DAGGW(28),DAGGP(28),DT1(28),DT2(28),
     + DT3(28),DCOMP(28),EXPDW(28),EXPW(28),EXPDP(28),EXPP(28),
     + B(30,39),TOTVAL(28),TOTWVL(28),TOTY(28),PIXX(28,39),
     + WIXX(28,39),VAL(28,39),WVAL(28,39),XXAGGP(28),XXAGGW(28),
     + WTDC(28,39),PRNI(28,39),P22(39),IPPR(28,39),LSI(28,39),
     + XXUNR(28,39),XXTLS(28),XXTUN(28),XXTUNR(28),DEFL(28),T1(28),
     + T2(28),T3(28),DDEFL(28),DKI(28,39),DPNI(28,39),DYI(28,39),
     + DWI(28,39),LSMA(28,39),UNRMA(28,39),DLSMA(28,39),DURMA(28,39),
     + PNB(9,39),XXWI(28,39),XXPI(28,39),XXEMI(28,39),XXYI(28,39),
     + XXPN(28,39),XDAGGW(28),XDAGGP(28),XXUNI(28,39),
     + XXLSMA(28,39),XUNRMA(28,39),TLS(28),TUNR(28),TUN(28),
     + EREI(28,39),ERPI(28,39),ERWI(28,39),ERYI(28,39),
     + XB(28,39),XDTUNR(28),DTUNR(28),XDURMA(28,39),
     + DRAGW(28),XDRAGW(28),
     + DIVPPR(39),XXLSI(28,39),XXPNI(28,39),EMPG(28),XXTEMP(28)
C     Read in the data, and the parameters
      READ(20,*)(W27(I),I=1,39)
      READ(21,*)(P27(I),I=1,39)
      READ(22,*)(AGGW(T),T=1,28)
 100  FORMAT(8F10.5)
 99   FORMAT(6F12.5)
      DO 101 I=1,40
 101  READ(16,100)(WTD(T,I),T=1,28)
      DO 102 I=1,40
 102  READ(16,100)(WTMC(T,I),T=1,28)
      DO 103 I=1,40
 103  READ(16,100)(IO(J,I),J=1,40)
      DO 104 I=1,39
      READ(8,99)(UNI(T,I),T=1,28)
 104  CONTINUE
      DO 105 I=1,39
      READ(18,*)(PNB(K,I),K=1,9)
      READ(18,*)(XB(J,I),J=1,28)
 105  CONTINUE
      DO 500 I=1,39
      DO 501 N=1,4
      B(N,I)=XB(N,I)
 501  CONTINUE
      B(5,I)=-B(4,I)
      DO 503 N=6,12
      NL=N-1
      B(N,I)=XB(NL,I)
 503  CONTINUE
      B(13,I)=1-XB(9,I)-XB(10,I)-XB(11,I)
```

(2)

```
      DO 502 N=14,30
      NL=N-2
      B(N,I)=XB(NL,I)
 502  CONTINUE
 500  CONTINUE
      READ(8,99)(UNRSEC(T),T=1,28)
      READ(9,100)(AGGP(T),T=1,28)
      READ(9,100)(DGDP(T),T=1,28)
      READ(9,100)(TIM(T),T=1,28)
      READ(9,100)(TSQ(T),T=1,28)
      READ(9,100)(UNR(T),T=1,28)
      READ(9,100)(LUP(T),T=1,28)
      READ(9,100)(LRR(T),T=1,28)
      READ(9,100)(LT1(T),T=1,28)
      READ(9,100)(LT2(T),T=1,28)
      READ(9,100)(LT3(T),T=1,28)
      READ(9,100)(INCPOL(T),T=1,28)
      READ(9,100)(WRONG(T),T=1,28)
      READ(9,100)(COMP(T),T=1,28)
      READ(9,100)(LKL(T),T=1,28)
      DO 106 I=1,39
      READ(9,100)(EMI(T,I),T=1,28)
      READ(9,100)(WI(T,I),T=1,28)
      READ(9,100)(PNI(T,I),T=1,28)
      READ(9,100)(KI(T,I),T=1,28)
      READ(9,100)(PMI(T,I),T=1,28)
      READ(9,100)(PI(T,I),T=1,28)
      READ(9,100)(YI(T,I),T=1,28)
 106  CONTINUE
C     Construct aggregate wages and aggregate prices from
C     actual industrial wages and prices
      DO 113 T=1,28
      TOTVAL(T)=0.0
      TOTWVL(T)=0.0
      TOTY(T)=0.0
 113  CONTINUE
      DO 110 T=1,28
      DO 111 I=1,39
      PIXX(T,I)=EXP(PI(T,I))*P27(I)
      WIXX(T,I)=EXP(WI(T,I))*W27(I)
      VAL(T,I)=PIXX(T,I)*EXP(YI(T,I))
      WVAL(T,I)=WIXX(T,I)*EXP(YI(T,I))
      TOTY(T)=TOTY(T)+EXP(YI(T,I))
      TOTVAL(T)=TOTVAL(T)+VAL(T,I)
      TOTWVL(T)=TOTWVL(T)+WVAL(T,I)
 111  CONTINUE
      XXAGGP(T)=TOTVAL(T)/TOTY(T)
      XXAGGW(T)=TOTWVL(T)/TOTY(T)
 110  CONTINUE
      XXPDIV=XXAGGP(27)
      XXWDIV=XXAGGW(27)
      DO 112 T=1,28
      XXAGGP(T)=ALOG(XXAGGP(T)/XXPDIV)
      XXAGGW(T)=ALOG(XXAGGW(T)/XXWDIV)
 112  CONTINUE
```

(3)

```
      DO 800 T=2,28
      TL=T-1
      XDAGGP(T)=XXAGGP(T)-XXAGGP(TL)
      XDAGGW(T)=XXAGGW(T)-XXAGGW(TL)
      DAGGP(T)=AGGP(T)-AGGP(TL)
      DAGGW(T)=AGGW(T)-AGGW(TL)
      DRAGW(T)=DAGGW(T)-DAGGP(T)
 800  CONTINUE
C     Note that xxaggp and xxaggw will be overwritten later
C     with figs built from industrial fitted values
C
C     Construct input prices within the programme
      DO 117 I=1,39
      P22(I)=EXP(PI(22,I))
      DO 118 T=1,28
      WTDC(T,I)=WTD(T,I)*EXP(PI(T,I))/P22(I)
      PRNI(T,I)=WTDC(T,I)+WTMC(T,I)
 118  CONTINUE
 117  CONTINUE
      DO 122 T=1,28
      DO 123 I=1,39
      IPPR(T,I)=0.0
 123  CONTINUE
 122  CONTINUE
      DO 119 T=1,28
      DO 120 I=1,39
      DO 121 J=1,39
      IPPR(T,I)=IPPR(T,I)+(PRNI(T,J)*IO(I,J))
 121  CONTINUE
 120  CONTINUE
 119  CONTINUE
      DO 124 I=1,39
      DIVPPR(I)=IPPR(27,I)
      DO 125 T=1,28
      IPPR(T,I)=ALOG(IPPR(T,I)/DIVPPR(I))
 125  CONTINUE
 124  CONTINUE
C
C     Generate aggregate and local unemployment rates within prog
      DO 127 T=1,28
      DO 128 I=1,39
      LSI(T,I)=EXP(EMI(T,I))+UNI(T,I)
      XXUNR(T,I)=(LSI(T,I)-EXP(EMI(T,I)))/LSI(T,I)
      TLS(T)=TLS(T)+LSI(T,I)
      TUN(T)=TUN(T)+UNI(T,I)
 128  CONTINUE
      TUNR(T)=TUN(T)/TLS(T)
 127  CONTINUE
C     Some data manipulation.
      DO 129 T=1,28
      T1(T)=LT1(T)
      T2(T)=ALOG(1-LT2(T))
      T3(T)=ALOG(1+LT3(T))
      DEFL(T)=AGGP(T)+T1(T)+T2(T)+T3(T)
      UNR(T)=EXP(UNR(T))
```

(4)

```
 129  CONTINUE
      DO 130 T=2,28
      TL=T-1
      DDEFL(T)=DEFL(T)-DEFL(TL)
      DLUP(T)=LUP(T)-LUP(TL)
      DLRR(T)=LRR(T)-LRR(TL)
      DINPOL(T)=INCPOL(T)-INCPOL(TL)
      DAGGW(T)=AGGW(T)-AGGW(TL)
      DAGGP(T)=AGGP(T)-AGGP(TL)
      DT1(T)=T1(T)-T1(TL)
      DT2(T)=T2(T)-T2(TL)
      DT3(T)=T3(T)-T3(TL)
      DCOMP(T)=COMP(T)-COMP(TL)
      DTUNR(T)=TUNR(T)-TUNR(TL)
 130  CONTINUE
      DO 140 T=2,28
      DO 141 I=1,39
      TL=T-1
      DKI(T,I)=KI(T,I)-KI(TL,I)
      DPNI(T,I)=PNI(T,I)-PNI(TL,I)
      DYI(T,I)=YI(T,I)-YI(TL,I)
      DWI(T,I)=WI(T,I)-WI(TL,I)
 141  CONTINUE
 140  CONTINUE
      DO 142 T=3,28
      DO 143 I=1,39
      TLL=T-2
      TL=T-1
      LSMA(T,I)=0.5*(EXP(EMI(TL,I))+EXP(EMI(TLL,I))) +
     +              0.5*(UNI(TL,I)+UNI(TLL,I))
      UNRMA(T,I)=0.5*(UNI(TL,I)+UNI(TLL,I))/LSMA(T,I)
      LSMA(T,I)=ALOG(LSMA(T,I))
 143  CONTINUE
 142  CONTINUE
      DO 144 T=4,28
      DO 145 I=1,39
      TL=T-1
      DLSMA(T,I)=LSMA(T,I)-LSMA(TL,I)
      DURMA(T,I)=UNRMA(T,I)-UNRMA(TL,I)
 145  CONTINUE
 144  CONTINUE
      NSCEN=0
C
C ********
C Return here if wish to run alternative scenario
C ********
C
 701  CONTINUE
      NSCEN=NSCEN+1
 804  IF (NSCEN .EQ. 1) GO TO 700
      WRITE(27,710)
 710  FORMAT(1X,'SCENARIO TWO')
      INCPOL(19)=-4.5
      INCPOL(20)=-4.5
      GO TO 702
```

(5)

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700   WRITE(27,711)
711   FORMAT(1X,'SCENARIO ONE')
702   CONTINUE
      WRITE(27,851)
851   FORMAT(1X,'EXPDP+EXPDW, DAGGP+DAGGW EACH TIME ROUND LOOP')
C
C     Begin the simulation period-by-period
C
C      Set the starting values
      XXAGGW(2)=AGGW(2)
      XXAGGP(2)=AGGP(2)
      XDAGGP(2)=AGGP(2)-AGGP(1)
      XXTUNR(2)=UNRSEC(2)
      XXTUNR(3)=UNRSEC(3)
      XDTUNR(2)=DTUNR(2)
      XDTUNR(3)=DTUNR(3)
      XXTUN(1)=TUN(1)
      XXTUN(2)=TUN(2)
      XXTUN(3)=TUN(3)
      DO 175 I=1,39
      XUNRMA(3,I)=UNRMA(3,I)
      XUNRMA(4,I)=UNRMA(4,I)
      XXPNI(1,I)=PNI(1,I)
      XXPNI(2,I)=PNI(2,I)
      XXPNI(3,I)=PNI(3,I)
      XXEMI(1,I)=EMI(1,I)
      XXEMI(2,I)=EMI(2,I)
      XXEMI(3,I)=EMI(3,I)
      XXYI(1,I)=YI(1,I)
      XXYI(2,I)=YI(2,1)
      XXYI(3,I)=YI(3,I)
      XXWI(1,I)=WI(1,I)
      XXWI(2,I)=WI(2,I)
      XXWI(3,I)=WI(3,I)
      XXPI(1,I)=PI(1,I)
      XXPI(2,I)=PI(2,I)
      XXPI(3,I)=PI(3,I)
      XXPI(4,I)=PI(4,I)
      XXUNI(1,I)=UNI(1,I)
      XXUNI(2,I)=UNI(2,I)
      XXUNI(3,I)=UNI(3,I)
175   CONTINUE
C     ********
C     ********
C     Time path starts here
      DO 162 T=3,28
       WRITE(28,614)T
       WRITE(27,614)T
614   FORMAT(1X,'******    TIME IS',I6)
      TL=T-1
      TLL=T-2
C Generate moving average sectoral unemployment rates from within prog
      IF (T .LE. 4) GO TO 803
      DO 177 I=1,39
      XXLSMA(T,I)=0.5*(EXP(XXEMI(TL,I))+EXP(XXEMI(TLL,I))) +
```

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```
     +            0.5*(XXUNI(TL,I)+XXUNI(TLL,I))
      XUNRMA(T,I)=0.5*(XXUNI(TL,I)+XXUNI(TLL,I))/XXLSMA(T,I)
      XDURMA(T,I)=XUNRMA(T,I)-XUNRMA(TL,I)
      XXLSMA(T,I)=ALOG(XXLSMA(T,I))
177   CONTINUE
803   CONTINUE
C     Generate expected wage and price change
      EXPDW(T)=AGGW(T)-AGGW(TL)
      EXPDP(T)=AGGP(T)-AGGP(TL)
      WRITE(27,*)DGDP(T)
160   CONTINUE
      XITDW=EXPDW(T)
      XITDP=EXPDP(T)
      CALL EDW ( EXPDW(T),XDAGGP(TL),XDTUNR(TL),INCPOL(T),DT1(T),
     +         DT2(T),DLUP(T),TIM(T),DGDP(T),DCOMP(TL))
      CALL EDP ( EXPDP(T),XDAGGP(TL),DT2(T),DLUP(T),
     +         TIM(T),DGDP(T),DCOMP(TL))
      WRITE(27,*)EXPDP(T),EXPDW(T),DAGGP(T),DAGGW(T)
      EXPW(T)=XXAGGW(TL)+EXPDW(T)
      EXPP(T)=XXAGGP(TL)+EXPDP(T)
C     Now generate values for expected input prices.
      DO 150 I=1,39
      XXPN(T,I)=
     +       PNB(1,I)+(PNB(2,I)*XXPNI(TL,I))+(PNB(3,I)*XXPNI(TLL,I))+
     +    (PNB(4,I)*EXPP(T))+(PNB(5,I)*XXAGGP(TL))+(PNB(6,I)*EXPW(T))+
     +    (PNB(7,I)*TIM(T))+(PNB(8,I)*DGDP(T))+(PNB(9,I)*COMP(T))
150   CONTINUE
      IF (T .EQ. 3) GO TO 162
C   Obtain wage, price, output, and employment for each industry
C   in turn.
      DO 153 I=1,39
      XXWI(T,I)=WI(T,I)
      XXPI(T,I)=PI(T,I)
      XXEMI(T,I)=EMI(T,I)
      XXYI(T,I)=YI(T,I)
      ITERCT=0
550   CONTINUE
      ITERCT=ITERCT+1
      IF (I .EQ. 4) GO TO 153
      XITW=XXWI(T,I)
      XITP=XXPI(T,I)
      XITY=XXYI(T,I)
      XITEM=XXEMI(T,I)
      CALL WAG (B(17,I),B(18,I),B(19,I),B(20,I),B(5,I),B(6,I),
     +         B(7,I),B(8,I),B(21,I),B(22,I),B(23,I),B(24,I),
     +         XXWI(T,I),XXWI(TL,I),EXPW(T),XXPN(T,I),KI(T,I),
     +         XXYI(T,I),TIM(T),INCPOL(T),XUNRMA(T,I),EXPP(T),
     +         T2(T))
      IF (NSCEN .NE. 1) GO TO 790
      ERWI(T,I)=WI(T,I)-XXWI(T,I)
790   CONTINUE
      XXWI(T,I)=XXWI(T,I)+ERWI(T,I)
      CALL PRI (B(9,I),B(10,I),B(11,I),B(12,I),B(13,I),B(14,I),
     +         B(15,I),B(16,I),XXPI(T,I),XXPI(TL,I),XXPI(TLL,I),
     +         XXWI(T,I),XXPN(T,I),KI(T,I),XXYI(T,I),
```

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```
     +         TIM(T) )
      IF (NSCEN .NE. 1) GO TO 791
      ERPI(T,I)=PI(T,I)-XXPI(T,I)
791   CONTINUE
      XXPI(T,I)=XXPI(T,I)+ERPI(T,I)
      CALL DEM (B(25,I),B(26,I),B(27,I),B(28,I),B(29,I),B(30,I),
     +         XXYI(T,I),XXYI(TL,I),XXPI(T,I),EXPP(T),PMI(T,I),
     +         DGDP(T),TIM(T) )
      IF (NSCEN .NE. 1) GO TO 792
      ERYI(T,I)=YI(T,I)-XXYI(T,I)
792   CONTINUE
      XXYI(T,I)=XXYI(T,I)+ERYI(T,I)
      CALL EMP (B(1,I),B(2,I),B(3,I),B(4,I),B(5,I),B(6,I),B(7,I),
     +         B(8,I),XXEMI(T,I),XXEMI(TL,I),XXEMI(TLL,I),XXWI(T,I),
     +         XXPN(T,I),KI(T,I),XXYI(T,I),TIM(T) )
      IF (NSCEN .NE. 1) GO TO 793
      EREI(T,I)=EMI(T,I)-XXEMI(T,I)
793   CONTINUE
      XXEMI(T,I)=XXEMI(T,I)+EREI(T,I)
522   FORMAT(1X,'INDUSTRY ',I3,5F10.4)
      CRIT1=AMAX1(ABS(XITW-XXWI(T,I)),ABS(XITP-XXPI(T,I)))
      IF (CRIT1 .GT. 0.005) GO TO 550
      CRIT2=AMAX1(ABS(XITEM-XXEMI(T,I)),ABS(XITY-XXYI(T,I)))
      IF (CRIT2 .GT. 0.002) GO TO 550
      IF (NSCEN .NE. 3) GO TO 524
      WRITE(28,522)I,EMI(T,I),PI(T,I),WI(T,I),YI(T,I),UNI(TL,I)
      WRITE(28,523)XXEMI(T,I),XXPI(T,I),XXWI(T,I),XXYI(T,I),
     + XXUNI(TL,I),ITERCT
523   FORMAT(13X,4F10.4,F12.4,6X,I8)
524   CONTINUE
153   CONTINUE
C     Construct aggregate wages and aggregate prices
C     from generated industrial wages and prices (to be
C     used next time round the time loop)
      TOTVAL(T)=0.0
      TOTWVL(T)=0.0
      TOTY(T)=0.0
      XXAGGP(T)=0.0
      XXAGGW(T)=0.0
      DO 164 I=1,39
      PIXX(T,I)=EXP(XXPI(T,I))*P27(I)
      WIXX(T,I)=EXP(XXWI(T,I))*W27(I)
      VAL(T,I)=PIXX(T,I)*EXP(XXYI(T,I))
      WVAL(T,I)=WIXX(T,I)*EXP(XXYI(T,I))
      TOTY(T)=TOTY(T)+EXP(XXYI(T,I))
      TOTVAL(T)=TOTVAL(T)+VAL(T,I)
      TOTWVL(T)=TOTWVL(T)+WVAL(T,I)
164   CONTINUE
      XXAGGP(T)=TOTVAL(T)/TOTY(T)
      XXAGGW(T)=TOTWVL(T)/TOTY(T)
      XXAGGP(T)=ALOG(XXAGGP(T)/XXPDIV)
      XXAGGW(T)=ALOG(XXAGGW(T)/XXWDIV)
      XDAGGW(T)=XXAGGW(T)-XXAGGW(TL)
      XDAGGP(T)=XXAGGP(T)-XXAGGP(TL)
      XDRAGW(T)=XDAGGW(T)-XDAGGP(T)
```

(8)

```
      DEPCR=AMAX1(0.06,0.06+0.75*(XDAGGP(TL)-0.06))
      WRITE(27,*)DGDP(T)
C     Generate aggregate and local unemployment rates within prog
C     These can be used next time around loop for complete dynamism
      XXTEMP(T)=0.0
      EMPG(T)=0.0
      XXTUN(T)=0.0
      XXTLS(T)=0.0
      DO 198 I=1,39
      GAIN = EXP(XXEMI(T,I))-EXP(EMI(T,I))
      IF (GAIN .GT. 0.0) EMPG(T)=EMPG(T)+GAIN
198   CONTINUE
      ADDTOT=0.0
      DO 770 I=1,39
      ADD=(0.3*(EXP(XXEMI(T,I))-EXP(EMI(T,I))))
     +    +(0.7*( EMPG(T)*UNI(T,I)/TUN(T) ))
     +    -UNI(T,I)
      ADDTOT=ADDTOT+AMAX1(0.0,ADD)
770   CONTINUE
      EMPG(T)=EMPG(T)+ADDTOT
      DO 170 I=1,39
      GAIN=EXP(XXEMI(T,I))-EXP(EMI(T,I))
      UNLOSS = (0.3*GAIN) +(0.7*EMPG(T)*UNI(T,I)/TUN(T))
      IF (GAIN .GT. 0.0)  XXUNI(T,I) =AMAX1(0.0, (UNI(T,I) - UNLOSS))
      IF (GAIN .LE. 0.0) XXUNI(T,I)=UNI(T,I) - GAIN -
     + (0.7*EMPG(T)*UNI(T,I)/TUN(T))
      XXLSI(T,I)=EXP(XXEMI(T,I))+XXUNI(T,I)
      XXUNR(T,I)=(XXLSI(T,I)-EXP(XXEMI(T,I)))/XXLSI(T,I)
      XXTUN(T)=XXTUN(T)+XXUNI(T,I)
      XXTLS(T)=XXTLS(T)+XXLSI(T,I)
170   CONTINUE
      XXTUNR(T)=XXTUN(T)/XXTLS(T)
      XDTUNR(T)=XXTUNR(T)-XXTUNR(TL)
814   CONTINUE
      IF (NSCEN .EQ. 2) GO TO 772
C
C     Construct input prices within the programme
C     These can be used next time round thev  loop
C
      DO 190 I=1,39
      WTDC(T,I)=WTD(T,I)*EXP(XXPI(T,I))/P22(I)
      PRNI(T,I)=WTDC(T,I)+WTMC(T,I)
190   CONTINUE
      DO 191 I=1,39
      XXPNI(T,I)=0.0
191   CONTINUE
      DO 192 I=1,39
      DO 193 J=1,39
      XXPNI(T,I)=XXPNI(T,I)+(PRNI(T,J)*IO(I,J))
193   CONTINUE
192   CONTINUE
      DO 194 I=1,39
      XXPNI(T,I)=ALOG(XXPNI(T,I)/DIVPPR(I))
194   CONTINUE
      DO 905 I=1,39
```

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```
999    FORMAT(1X,3F10.5)
905    CONTINUE
772    CONTINUE
162    CONTINUE
C      ********
C      ********
C   Write out the results
       WRITE(27,708)
 708    FORMAT('DGDP')
       WRITE(27,*)(DGDP(T),T=2,28)
       WRITE(27,606)
 606    FORMAT(1X,'ACTUAL (READ AND CONSTRUCTED), FITTED TOT UN RATES
     +  AFTER LOOP')
       WRITE(27,630)
 630    FORMAT('UNRSEC')
       WRITE(27,*)(UNRSEC(T),T=2,28)
       WRITE(27,631)
 631    FORMAT('TUNR')
       WRITE(27,*)(TUNR(T),T=2,28)
       WRITE(27,632)
 632    FORMAT('XXTUNR')
       WRITE(27,*)(XXTUNR(T),T=2,28)
       WRITE(27,852)
 852    FORMAT(1X,'XDAGGP+DAGGP, XDAGGW+DAGGW AFTER LOOP')
       WRITE(27,900)
 900    FORMAT('XDAGGP')
       WRITE(27,*)(XDAGGP(T),T=2,28)
       WRITE(27,901)
 901    FORMAT('DAGGP')
       WRITE(27,*)(DAGGP(T),T=2,28)
       WRITE(27,902)
 902    FORMAT('XDAGGW')
       WRITE(27,*)(XDAGGW(T),T=2,28)
       WRITE(27,903)
 903    FORMAT('DAGGW')
       WRITE(27,*)(DAGGW(T),T=2,28)
       WRITE(27,913)
 913    FORMAT('XDRAGW')
       WRITE(27,*)(XDRAGW(T),T=2,28)
       WRITE(27,914)
 914    FORMAT('DRAGW')
       WRITE(27,*)(DRAGW(T),T=2,28)
       WRITE(27,853)
 853    FORMAT(1X,'FINALLY, THE INDUSTRIAL FIGURES')
       DO 600 I=1,39
       WRITE(27,1000) I
1000    FORMAT('EMIXX',I1)
       WRITE(27,*)(XXEMI(T,I),T=4,28)
       WRITE(27,1001) I
1001    FORMAT('EMI',I1)
       WRITE(27,*)(EMI(T,I),T=4,28)
       WRITE(27,1002) I
1002    FORMAT('PIXX',I1)
       WRITE(27,*)(XXPI(T,I),T=4,28)
       WRITE(27,1003) I
```

(10)

```
1003    FORMAT('PI',I1)
       WRITE(27,*)(PI(T,I),T=4,28)
       WRITE(27,1004) I
1004    FORMAT('WIXX',I1)
       WRITE(27,*)(XXWI(T,I),T=4,28)
       WRITE(27,1005) I
1005    FORMAT('WI',I1)
       WRITE(27,*)(WI(T,I),T=4,28)
       WRITE(27,1006) I
1006    FORMAT('YIXX',I1)
       WRITE(27,*)(XXYI(T,I),T=4,28)
       WRITE(27,1007) I
1007    FORMAT('YI',I1)
       WRITE(27,*)(YI(T,I),T=4,28)
 600    CONTINUE
       IF (NSCEN .EQ. 1) GO TO 701
       IF (NSCEN .EQ. 2) GO TO 701
        STOP
        END
       SUBROUTINE EDW (EXPDW,DAGGPL,DUNL,INCPOL,DT1,DT2,DLUP,
     +      TIM,DGDP,DCOMPL)
       REAL INCPOL
       EXPDW=0.02576950 + 0.6496389*DAGGPL - 1.644326*DUNL +
     +      0.008385303*INCPOL + 1.347447*DT1 - 0.6940334*DT2 +
     +      0.0703516*DLUP + 0.002343638*TIM + 0.4593500*DGDP +
     +      0.1703555*DCOMPL
       RETURN
       END
       SUBROUTINE EDP (EXPDP,DAGGPL,DT2,DLUP,
     +              TIM,DGDP,DCOMPL)
       EXPDP=-0.01317044 + 0.60590751*DAGGPL - 0.8177866*DT2 +
     +       0.03339065*DLUP + 0.003049686*TIM + 0.4214501*DGDP +
     +       0.1997418*DCOMPL
       RETURN
       END
       SUBROUTINE EMP (A0,A1,A2,A3,A4,A5,A6,A7,EM,EML,EMLL,W,EPN,
     +              K,Y,TIM)
       REAL K
       EM=A0 + A1*EML + A2*EMLL + A3*W + A4*EPN + A5*K + A6*Y + A7*TIM
       RETURN
       END
       SUBROUTINE PRI (B0,B1,B2,B3,B4,B5,B6,B7,P,PL,PLL,W,EPN,
     +              K,Y,TIM)
       REAL K
       P=B0 + B1*PL + B2*PLL + B3*W + B4*EPN + B5*K + B6*Y +
     +   B7*TIM
       RETURN
       END
       SUBROUTINE WAG (C0,C1,C2,C3,A4,A5,A6,A7,C6,C7,C8,C10,W,WL,
     +              EXPW,EPN,K,Y,TIM,INC,UNRMA,EXPP,T2)
       REAL K,INC
       W = C0 + C1*WL + C2*EXPW + C3*(A4*EXPN+A5*KI+A6*YI+A7*TIM) +
     +     C6*INC + C7*UNRMA + C8*EXPP + C10*T2
       RETURN
       END
```

(11)

```
       SUBROUTINE DEM (D0,D1,D2,D3,D4,D5,Y,YL,P,EXPP,PM,SIG,TIM)
       Y=D0 + D1*YL + D2*(P-EXPP) + D3*(PM-EXPP) + D4*SIG + D5*TIM
       RETURN
       END
```

Data Appendix

Chapter 3

The primary source of data used in the analysis of Chapter 3 is McMaster and Pissarides (1984). A nineteen sector disaggregation of the economy is employed here, as documented in Table DA1. The original data set provides quarterly observations for the years 1963-82, and was obtained as follows:

Vacancies (V): end of quarter monthly data upto the second quarter of 1976. Quarterly data for 1976Q3 onwards. Source: *Department of Employment Gazette* (*DEG*).

Unemployment (U): end of quarter monthly data. Individuals are classified according to the industry in which they last worked. Source: *DEG* .

Employment (E): end of quarter monthly data for all employees in employment. Source: *DEG* .

Wages (W): end of quarter monthly data for the Average Earnings Index, all employees. Series for sectors 'Coal, petrol, and chems' and 'Engineering and electrical goods' were obtained from the data on their component SIC orders (IV+V, and VIII+X respectively), using employment as weights. Source: *DEG* .

Output (Y): quarterly data of the Index of Industrial Production for all sectors except 'Misc. Services'. For this sector, the quarterly index of output at constant factor cost is used. Output figures are seasonally adjusted. Source: *Monthly Digest of Statistics* (*MDS*).

Prices: as described in the text, the price series employed is the consumer price deflator employed in the National Institute's macromodel. Twelve month forward expectations are derived from the model itself.

Incomes policy: bi-annual, zero/one dummies are employed to capture the impact of incomes policy (zero means 'policy-off', one means 'policy-on'). Details provided in Table 3.2 of the text.

Actual and Normal Hours: derived from the more disaggregated industrial database maintained by the Cambridge Growth Project. See details of data used in Chapter 5 below.

Chapter 4

As described in the text, the data on the timing and frequency of wage settlements used in the analysis of chapter 4 was provided by the University of Aberdeeen, and was collated from the Department of Employment publication "Time rates of pay and hours of work". See Elliott, Steele, and Bell (1977) for details.

Data used in the explanation of wage bargaining frequency was obtained as follows:

WHPR: Wholesale price index for manufacturing output. Source: *Economic Trends Annual Supplement, ETAS* .

FC: Wholesale price index for materials and fuels. Source: *ETAS* .

PRODY: Aggregate and sectoral output-per-man. Source: measures derived from the employment and output series used in Chapter 3 above.

T1: The 'employment tax' faced by the firm. Source: Layard and Nickell (1985) (LN).

T2: Income tax rate (annual figures). Source: LN.

T3: Indirect tax rate (annual figures). Source: LN.

Table DA1

Nineteen-sector Industrial Classification based on 1968 SIC

Industry title	SIC Order(s)
Mining and quarrying	II
Food, Drink, and Tobacco	III
Coal, Petroleum, Chemical and allied products	IV-V
Metal Manufacture	VI
Engineering and Electrical goods	VII-IX
Ship building	X
Vehicles	XI
Metal Goods nes	XII
Textiles	XIII
Leather, Leather Goods, and Fur	XIV
Clothing and Footwear	XIV
Bricks, Pottery, and Glass	XVI
Timber, Fuurniture, etc.	XVII
Paper, Printing and Publishing	XVIII
Other Manufacturing	XIX
Construction	XX
Gas, Electricity and Water	XXI
Transport and Communications	XXII
Miscellaneous Services	XXVI

WDTD: Deviation of world trade from trend. Source: LN.

COMP: International competitiveness. Source: LN.

AD: Adjusted deficit as a proportion of potential GDP. Source: LN.

RR: Replacement ratio. Source: LN.

STOCKS: Stock of finished goods at 1975 prices relative to total output. Source: *ETAS* .

UN: Aggregate unemployment rate. Source: *ETAS* .

UP: The measure of union power is given by the level of trade union membership as a proportion of total unemployment. Source: *Annual Abstrct of Statistics*(*AAS*).

STRIKE: Strike activity; number of stoppages beginning in the year (all industries). Source: *AAS* .

PROFITS: Profits for ICC's. Source: Wadhwani (1984).

UNCERT1: Square of the standard error of a sliding regression of price inflation on its own lagged values.

UNCERT2: Variance of price inflation over the preceeding four quarters

UNCERT3: The absolute gap between the actual and expected inflation rate as defined by the National Institute's macromodel.

Incomes policies: Quarterly, zero/one dummies are employed to capture the impact of incomes policy (zero means 'policy-off', one means 'policy-on'). Details provided in Table 4.4 of the text.

Chapter 5

The data used in the empirical work of Chapter 5 are, in the most part, based on annual observations on 39 industrial groups for the UK obtained from the Cambridge Growth Project databank. The industrial groups are closely related to the groups distinguished in the 1968 Standard Industrial Classification, although the precise Classes and Groups of the 1968 SIC used in the construction of the data set are described in Table 5.1 of the text. Full details of the industrial data are provided in Barker and Peterson (1987).

The original data on industry man-hours, employment, wages and salaries, and employers' contributions were provided by the Institute for Employment Research at the University of Warwick. Data on normal hours and overtime rates were obtained from the Department of Employment publication *Time Rates of Wages and Hours of Work.* The data on industry output were obtained from the Central Statistical Office's commodity flow accounts adjusted for the CGP classification. The data on producer price indices of industry output were obtained from a number of published sources, including the Department of Trade and Industry's publication *British Business, AAS* , *MDS* , and the Department of Energy's *Energy Trends.*

The employment variable, n, employed in the regression analysis is the number (000's) employed in the industry, including the self-employed. Nominal wage rates in the industry are obtained by dividing total industrial labour costs, including both employees' wages and salaries and employers' national insurance contributions (£m), by the number employed in the industry. An adjustment is then made to take into account overtime payments. In this, wage rates are obtained by deflating hourly earnings using the overtime premium paid on the number of hours worked in excess of normal hours. The industrial price indices (1975=1.00), p, provide the price of home sales by home producers. Indices for the price of material inputs, q, are constructed as a weighted average of the price of domestic industrial output, with weights obtained from the

Business Monitor *Input-Output Tables*1979. Industrial capital stock measures, k, represents an accumulation of gross investment (measured in 1975 prices £1975m) in the industry, assumed to depreciate at a rate of 10% pa. Industrial output, y, is gross value added by industry in 1975 prices (£1975m).

Finally, turning to aggregate variables employed in the analysis, variables T1, T2, T3, UP, UN, RR, and COMP are as defined above (under chapter 4). The incomes policy variable employed here, INC, is constructed in Whitley (1986) and attempts to provide a quantitative and continuous measure of incomes policy effects which reflects both the size of the downward pressure on wages exerted by policy, but also the government's and the unions' attitudes towards the policy. Finally, σ, deviations from trend GDP are obtained as the residuals from a regression explaining GDP in terms of a cubic in time.

Chapter 6

The following variables were constructed for use in the analysis of Chapter 6, and are listed in Tables A6.1 and A6.2

conc68 Weighted sum of three-digit industrial cioncentration ratios derived from the 1968 Business Monitor Report on the Census of Production.

conc79 As above, with concentration ratios derived from the 1979 Business Monitor Report.

conc Figures for 'conc79' are adjusted to provide the proportion of the total domestic output of a product that is produced by the five largest firms in the industry following Kumar (1985).

kout industrial capital-output ratios measured in 1968, using the industrial figures described under chapter 5 above.

prodpos proportion of total gross output taken up by intermediate demand, as given in the Business Monitor *Input-Output Tables*1979.

imrat ratio of imported industrial product to total domestic demand, both measured in £1975 and evaluated in 1979.

exrat ratio of exported industrial product relative to total domestic demand, both measured in £1975 and evaluated in 1979.

vardem variance of nominal demand in the industry over the sample period, 1954-1981.

varcost variance of material input costs to the industry, measured as described under chapter 5 above, over the sample period, 1954-1981.

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