WAGES AND EMPLOYMENT IN NON-COMPETITIVE LABOUR MARKETS

by

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ABSTRACT

This thesis consists of an introduction and two parts. Part I deals with wage and employment determination under labour bargaining, and is formed of chapters 1 and 2. Part II looks at the role of inflation expectations in macroeconomic models, and is divided into chapters 3, 4 and 5.

Chapter 1 sets forth and tests a model of labour bargaining in which the firm and the union are only constrained by the other party's available market alternatives if these are credible. Empirical findings, based on a panel of UK manufacturing firms, show some support for the main predictions of the model.

Chapter 2 generalizes the theoretical framework developed in the previous chapter and explores its robustness with respect to changes to some of the assumptions.

Chapter 3 assesses the literature on the relationship between inflation expectations, wage and price flexibility and variability of output. Expectations of future price changes may have a destabilizing effect on output if expected inflation moves procyclically.

Chapter 4 looks at an overlapping wage contract model and derives analytical conditions for output destabilization to occur as wages and prices become more flexible. A new classical specification of the supply side is then considered, and price rigidity is established to be neither a necessary nor a sufficient condition for increased output volatility.

Chapter 5 analyses a monopolistically competitive framework

with synchronized wage setting. Explicit consideration of the expected inflation effect makes employment and output variability more likely to increase with contract length.

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INTRODUCTION

This thesis is composed of two parts. Part I is concerned with labour bargaining and the determination of wages and employment. Part II studies the relationship between wage and price flexibility, inflation expectations, and variability of output.

Recent analyses of the employment relationship recognize the importance of non-competitive elements in the labour market. Job-specific investment on the side of both the firm and the workers generates *ex post* monopolistic rents for the incumbent employees vis-à-vis workers from outside the firm. The pervasiveness of asymmetric information between firm and workers in the form of adverse selection or moral hazard provides a further rationale for departures from the Walrasian spot paradigm of the labour market (Akerlof and Yellen (1986)).

The first section of the thesis (chapters 1 and 2) focusses on labour bargaining. The literature originated by McDonald and Solow (1981) endeavours to explain wages and employment as the outcome of a bargaining between the firm and the union of its workers. If negotiations have both wages and employment as arguments, as assumed by McDonald and Solow, the bargaining is efficient (in the sense of Leontief (1946)) since it leaves no unexploited gains from trade. If the firm and the union only bargain over the wage, and employment is left at the discretion of the firm, one has right-to-manage (Nickell and Andrews (1983)). If the relative bargaining strength of the parties over wages is different than over employment, the negotiations may take the form of a sequential bargaining as set out by Manning (1987). Finally, if the union unilaterally sets the wage and the firm is left free to decide on the employment level, the situation is described as a monopoly union (surveys on the various forms of bargaining are provided by Oswald (1985), Farber (1986), and Ulph and Ulph (1990)).

A different strand of the literature has explicitly addressed the issue of the extent to which employed and unemployed workers can be regarded as substitutes (*insider-outsider* models of the labour market: Lindbeck and Snower (1988), Blanchard and Summers (1986)). The relevance of this analysis lies in the possibility of accounting for the hysteretic behaviour of output and other real variables, and hence for the persistence of unemployment in the face of temporary negative shocks to the level of activity.

The game theoretical literature on bargaining has in the meantime undergone impressive developments after the seminal work by Rubinstein (1982) (important contributions were put forward by Shaked and Sutton (1984), Binmore, Rubinstein and Wolinsky (1986), Binmore, Shaked and Sutton (1989); useful expositions are Sutton (1986), Kreps (1990), and Osborne and Rubinstein (1990)). This research programme explicitly relates the bargained outcome to strategic behaviour by rational players. The structure of the game is analysed in its extensive form, rather than in the more conventional normal form as in the traditional axiomatic analysis. The solution to the game is required to meet the (sub-game) perfectness condition.

This *strategic* approach to bargaining games clarifies the role of the fall-back positions of the players and of the outside opportunities which are available to them if negotiations with the incumbent partner were to break down (*outside options*). A particularly startling implication of assuming that the parties behave strategically is that their outside options should only actually affect the negotiated outcome insofar as they act as binding constraints on the players. Otherwise, they should not be regarded as credible and should thus be completely ineffective.

The previous analysis seems to be particularly suited to characterize labour bargains between a firm and the union of its currently employed workers. Each party can be regarded as endowed with an outside option which consists of interrupting the relationship with its incumbent partner and taking up a market alternative, i.e. to quit and look for a new job (*workers*), or firing (a part of) the current workforce and hiring new employees (*firms*). According to the *outside option principle* (Binmore, Shaked and Sutton (1989)) these market alternatives should only matter if they represent credible threats. If they do, then the negotiated outcome should be entirely driven by these outside options. By contrast, if they are not credible the bargaining process should be determined by "insider" variables.

Chapter 1 develops and tests a model of wage and employment determination in which the importance of insider and outside factors can vary across firms and over time. Three bargaining regimes are identified: in two of them the outcome is dictated by outside market conditions, whilst in the third there is scope for insider factors. Econometric estimation on a panel of British manufacturing firms over the period 1972-1982 confirms the existence of such structural breaks in the rent sharing behaviour.

Chapter 2 provides some theoretical extensions to the model set out in the previous chapter. Different objective functions for the union are analysed and their comparative statics predictions are illustrated. Then, efficiency wage considerations are combined with the bargaining framework and the sensitivity of the latter to alternative informational assumptions is assessed. Finally, some implications of the analysis for union membership are considered.

The second part of the thesis (chapters 3, 4 and 5) studies the relationship between wage/price flexibility and variability of output, when aggregate demand depends on expected inflation *via* the *ex ante* real interest rate. The motivation for the analysis lies in the consideration that, contrary to static models, in a dynamic framework increased nominal flexibility may have perverse effects on the level of activity by exacerbating output fluctuations.

Following an exogenous demand shock, real money balances move counter-cyclically acting thus as an automatic stabilizer. Expected inflation, however, can move either pro- or counter-cyclically. Whether output destabilization ensues depends on the behaviour of the supply side of the economy (in particular, on the product market structure and the specific source of nominal rigidities), on the degree of serial autocorrelation of the demand disturbances, and on the process of expectations formation.

An obvious link with the first part of the thesis is provided by the presence of imperfections in the labour market. Nominal wage inflexibility requires some departures from the strictly competitive paradigm. The existence of bargaining over workers' remuneration, and possibly over manning levels, and the role played by insider factors contribute to making wages and employment less sensitive to labour market imbalances. An important difference with the analysis developed in the first part of the thesis lies however in the fact that labour bargaining yields *real* rigidities. It is increasing acknowledged, on the other hand, that an explanation of the main stylized facts of economic fluctuations requires both real and nominal rigidities (see e.g. Blanchard and Fischer (1989) and Ball and Romer (1990)).

The possible destabilizing role of expected inflation is already present in Keynes (1936, chap. 19). Tobin (1975) has formally shown that increased price flexibility might be destabilizing when inflation expectations are formed adaptively. More recently, DeLong and Summers (1986) have set forth the proposition that output variability might increase as wages and prices become more responsive to disequilibrium conditions in the labour and goods market, even under rational expectations. Chapter 3 assesses how alternative mechanisms of expectation formation and different specifications of the supply side of the economy may be critical in generating a destabilizing outcome.

In their original contribution, DeLong and Summers (1986) present simulation results which show that output variability increases over the cycle as wages become more flexible, in a staggered contract framework à-la Taylor (1979, 1980) augmented to allow for both autoregressive demand disturbances and the expected inflation effect on aggregate demand. Their results hold for a wide range of parameters of the model, and from this they conclude that policies aimed at enhancing the degree of flexibility of labour markets may be counterproductive.

DeLong and Summers are however unable to derive analytical results. In chapter 4 exact conditions are derived for destabilization to occur in a variant of Fischer's (1977) model with predetermined wage setting. It is shown that increased wage flexibility may either dampen or exacerbate output fluctuations, depending on the values of the parameters. The asymptotic variance of output decreases if demand shocks exhibit a low degree of serial correlation as in the simulations by DeLong and Summers (1986).

Chapter 4 also demonstrates that nominal inertia is not a necessary requirement for the expected inflation effect to exert a destabilizing influence. By making use of standard new classical specifications of the supply side, it is shown that inflation expectations can move either pro- or counter-cyclically depending on parameter values. Again, the degree of serial correlation of demand disturbances turns out to be crucial.

Chapter 5 generalizes a monopolistic competition model with synchronized contracts originally set out by Ball (1987). Employment and output variability under alternative contracting lengths are explored, and the externalities associated with the different regimes are evaluated under both white noise and autocorrelated demand disturbances. It is established that the presence of the expected inflation effect makes it unambiguously more likely that short contracts are desirable. The reason for this result lies in the fact that, under monopolistic competition, both labour demand and output supply directly depend on aggregate demand. Longer contracts lessen the variability of real wages, but at the same time increase the volatility of real balances and expected inflation over the cycle.

Finally, chapter 5 demonstrates that the expected inflation effect can be a channel for the effectiveness of stabilization policy. The presence of an element of intertemporal substitution in the economy creates the scope for active demand management (see also Buiter (1989)). It is shown that leaning-against-the-wind monetary rules dominate increased flexibility as a stabilization tool.

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PART I

CHAPTER 1

BARGAINING WITH OUTSIDE OPTIONS: WAGES AND EMPLOYMENT IN UK MANUFACTURING 1974-1982

1. Introduction

This chapter studies the determinants of wages and employment at the firm level. The main question which is addressed is the extent to which external market pressures are important relative to economic variables which are specific to the firm. One can interpret the former set of factors as *outsider variables*, and the latter as reflecting the importance of *insider variables*. The research is therefore a microeconomic investigation on insider versus outsider factors in wage and employment determination. It can thus provide some evidence on the role played by the currently incumbent workers in affecting the economic conditions at the workplace (see e.g. Lindbeck and Snower, 1986, 1988a). The issue has recently attracted considerable attention in view of its alleged capability of explaining the high and persistent levels of unemployment in Western countries[1].

The theoretical model developed in the first part of the chapter (section 2), and then tested in the second part (sections

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[1]Blanchard and Summers (1986, 1987); see also Lindbeck and Snower (1988b) and Layard and Bean (1989).

3-5), is a variant of the efficient bargains model of the labour market, modified in accordance to recent developments in non-cooperative game theory.

The classical model of union bargaining is set out in McDonald and Solow (1981). The firm and the union bargain over wages and employment simultaneously, and the outcome is thus efficient in the sense of Leontief (1946)[2]. Traditional (axiomatic) bargaining models, however, present some fundamental problems since they do not specify the structure of the game played by agents. The commonly adopted solution concept is the cooperative Nash solution to the bargaining problem (Nash, 1950, 1953). The *status quo* positions of the parties are given by their respective payoffs if the bargain terminates without an agreement. They are alternatively identified with the threats made during the negotiations.

Recent work in non-cooperative (strategic) game theory (Binmore, Rubinstein and Wolinsky, 1986; Sutton, 1986) suggests however that, in bargaining games which take place over time and in which the driving force to reach a settlement is the players'

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[2]Nickell and Andrews (1983), by contrast, assume that the bargain has the wage as the only argument. The level of employment is unilaterally chosen by the firm on its labour demand schedule, after wages have been set (right-to-manage). The literature on firm-union bargaining is surveyed by Oswald (1985) and Ulph and Ulph (1990).

impatience (the cake 'shrinks'), the *status quo* positions should correctly be identified with the utility levels attained by the parties while negotiations are in progress. The threats of the players should instead be modelled as *outside options* open to them. In the subgame-perfect equilibrium of the game, these threats would only be implemented if they are credible: either party must find it profitable to actually withdraw from the negotiations with the incumbent partner. If this is the case, then the latter should concede the former exactly the value of its outside option in order to avoid the breakdown of the relationship. If neither outside option is credible, however, they should play no role whatsoever on the outcome of the bargain: only the *status quo* of the parties and their payoff functions should determine how the joint surplus is divided[3].

The previous analysis applies quite naturally to the bargain between a firm and its incumbent labour force. The outside options of the parties can be seen as given by their external market alternatives, reflecting the role of outsider factors. By contrast, the *status quo* positions, and the players' impatience, represent insider factors in bargaining. There might thus exist regimes in which the outcome is essentially driven by outside market conditions, and cases in which insider factors are crucial.

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[3]Experimental support for this *outside option principle* has been provided by Binmore, Shaked and Sutton (1989).

The above considerations provide a neat theoretical framework to test the empirical relevance of insider/outsider models. The larger the weight of those firms which appear to be constrained by external market conditions, the more quantitatively relevant is the role played by outsider factors in explaining observed macroeconomic phenomena. It should be noticed that the analysis developed here is able to avoid a common shortcoming of the empirical literature on the subject, namely assuming that the relative weight of internal versus external factors is the same across firms and over time[4].

The model is estimated on a panel of UK manufacturing firms from 1974 until 1982[5]. The empirical findings confirm the existence of important structural breaks across firms in wage setting. They also seem to point out that the role played by insider factors is largely restricted to a small proportion of

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[4]Nickell and Wadhwani (1990) allow their measure of insider power to vary across industries, but not over time. Their wage equation is a combination of "insider" and "outsider" variables. However, it is simply postulated that the opportunity set of workers during a strike is the same as if they quit or are laid off. This assumption would not be easy to justify on search theoretic grounds, and effectively rules out the distinction between *status quo* and outside option for the union.

[5]This data set has already been analyzed by Nickell and Wadhwani (1988, 1990) and Wadhwani and Wall (1988a, 1988b).

firms during the sample period.

The structure of the chapter is as follows. In the next section the basic theoretical model is outlined. Section 3 presents the econometric methodology. In section 4 the use of *a priori* information on the classification of firms across regimes is discussed. Section 5 gives econometric estimates of wage and employment equations. Section 6 concludes.

2. Bargaining with outside options

The present section develops the basic theoretical model. The firm and the union are assumed to have objective functions defined over wages and employment and to bargain over both arguments. Following Binmore, Rubinstein and Wolinsky's (1986) strategic interpretation of non-cooperative bargaining games, the parties maximize their joint surplus over and above their *status quo* points. These are defined as the levels of utility, or profits, which the union and the firm would respectively receive in the event of a strike or a lockout. The maximization is subject to the constraint that the outcome of the bargain should deliver each party at least the level of utility/profits obtainable if it were to terminate the relationship with its incumbent partner and take up its market alternative. If the bargains are driven by strategic considerations, the 'threats' of the players should only actually affect the outcome insofar as they are credible.

The firm

The firm is assumed to be risk neutral and to operate under a constant returns to scale technology. Its objective function is

$$(1) \qquad \Pi(W,N) = P\cdot F(K,N) - WN - rK$$

where W is the wage, N the level of employment, P the output price, K the input of capital stock, and r the rental price of capital. The production function $F(\cdot,\cdot)$ is assumed to satisfy the Inada properties. The *status quo* is the level of profits (or losses) which the firm would make in the event of a lockout or a strike. Here the assumption is made that the *status quo* profits are simply proportional to the capital stock:

$$(2) \qquad \bar{\Pi} = -\rho K$$

where ρ is the cost per unit of capital which has to be borne whilst negotiations are in progress. The outside option is the level of profits if the firm were to replace its current labour force, or part of it, and employ workers from outside the firm. It is therefore given by

$$(3) \qquad \Pi^{\circ} = \Pi^{\circ}(u^{I},\tilde{W},z)$$

where u^I is the industry-specific unemployment rate ($\partial\Pi^{\circ}/\partial u^I >$ 0), $\tilde{W}$ is a measure of the relevant alternative wage ($\partial\Pi^{\circ}/\partial\tilde{W} < 0$), and z are hiring and firing costs (e.g., training costs and severance payments).

The union

The union is here defined as the party with whom the firm is negotiating. Its objective is to maximize the utility rents to its employed members from reaching an agreement:

$$(4) \qquad U(W,N) = N\cdot[V(W)-V(\tilde{W})]$$

where $V'(\cdot)>0$, $V''(\cdot)<0$. The *status quo* is given by

$$(5) \qquad \bar{U} = \bar{U}(s)$$

where s are strike funds plus possibly earnings while on strike. The outside option is

$$(6) \qquad U^{\circ} = U^{\circ}(u^{I}, \tilde{W}, b)$$

with $\partial U^{\circ}/\partial u^{I} < 0$, $\partial U^{\circ}/\partial \tilde{W} > 0$, and where b are unemployment benefits ($\partial U^{\circ}/\partial b > 0$).

The bargain

Without loss of generality it is assumed that the market options which are open to the parties are strictly more valuable to them than their *status quo* while bargaining: $\Pi^{\circ} > \bar{\Pi}$ and $U^{\circ} > \bar{U}$ [6]. In the light of the interpretation given to outside options and *status quo*, this assumption is not restrictive. The constrained Nash bargain between the firm and the union can thus be characterized as follows:

$$(7) \qquad \max_{(W,N)} \quad [U(W,N) - \bar{U}]^{\alpha} \, [\Pi(W,N) - \bar{\Pi}]^{1-\alpha}$$

subject to

$$(7a) \qquad U(W,N) \geq U^{\circ}(u^{I},\tilde{W},b)$$

$$(7b) \qquad \Pi(W,N) \geq \Pi^{\circ}(u^{I},\tilde{W},z)$$

where the parameter α reflects the relative bargaining strength of the union, and is possibly related to its size. Let λ and μ be the Kuhn-Tucker multipliers associated with the constraints (7a) and (7b) respectively. The first-order conditions are

$$(8a) \qquad \alpha N V'(W)[U-\bar{U}]^{\alpha-1}[\Pi-\bar{\Pi}]^{1-\alpha} - (1-\alpha)N[U-\bar{U}]^{\alpha}[\Pi-\bar{\Pi}]^{-\alpha} + \lambda N V'(W) - \mu N = 0$$

$$(8b) \qquad \alpha[V(W)-V(\tilde{W})][U-\bar{U}]^{\alpha-1}[\Pi-\bar{\Pi}]^{1-\alpha} + (1-\alpha)[U-\bar{U}]^{\alpha}[PF_N-W][\Pi-\bar{\Pi}]^{-\alpha} + \lambda[V(W)-V(\tilde{W})] + \mu[PF_N-W] = 0$$

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[6] If either outside option is lower than the corresponding *status quo*, it can never be binding and can thus be neglected.

(8c) $\lambda[U(W,N)-U^{\circ}(u^{I},\tilde{W},b)] = 0$

(8d) $\mu[\Pi(W,N)-\Pi^{\circ}(u^{I},\tilde{W},z)] = 0$

where (8c) and (8d) are the complementary slackness equations. One can either have an interior solution, in which neither constraint is binding, or a solution in which either constraint is satisfied as an equality. The following cases (i)-(iii) may thus arise.

(i) Interior solution ($\lambda=\mu=0$)

The first-order conditions can be written as

(9a) $$\frac{U_W}{U_N} = \frac{\Pi_W}{\Pi_N}$$

(9b) $$\frac{\alpha U_W}{U-\bar{U}} + \frac{(1-\alpha)\Pi_W}{\Pi-\bar{\Pi}} = 0$$

Equation (9a) is the *contract curve* (CC). It expresses the equality between the marginal rate of employment-wage substitution for the firm and the union. Equation (9b) is the *bargaining locus* (BL), which determines the division of the rents amongst the parties. In terms of the objective functions (1) and (4), equations (9a) and (9b) become respectively

$$(9a') \quad \frac{V'(W)}{V(W)-V(\tilde{W})} = - \frac{1}{PF_N(K,N)-W}$$

$$(9b') \quad \frac{\alpha V'(W)}{N[V(W)-V(\tilde{W})]-\bar{U}} - \frac{(1-\alpha)}{PF(K,N)-WN-rK-\bar{\Pi}} = 0$$

(ii) <u>Outside option binding for the union</u> (U°)- ($\lambda>0$)

By setting $\mu=0$ in (8a)-(8b) and using (8c) one obtains

$$(10a) \quad U(W,N) = U^{\circ}(u^{I},\tilde{W},b)$$

$$(10b) \quad V'(W)[PF_N(K,N)-W] + [V(W)-V(\tilde{W})] = 0$$

Equation (10a) is the outside option for the union, which must now be satisfied as an equality. The firm must concede the workers a wage-employment combination which yields the level of utility U° in order to prevent the labour force from quitting. Equation (10b) coincides with the contract curve (9a). The outcome of this constrained regime is thus efficient.

(iii) <u>Outside option binding for the firm</u> (Π°) - ($\mu>0$)

The union must concede the firm its outside option. The first-order conditions are now

$$(11a) \quad \Pi(W,N) = \Pi^{\circ}(u^{I},\tilde{W},z)$$

(11b) $V'(W)[PF_N(K,N)-W] + [V(W)-V(\tilde{W})] = 0$

Equation (11a) is the outside option for the firm. Equation (11b) is again the efficiency condition.

The above model can be represented on the (N,W) plane as in Fig. 1. The solid line CC is the contract curve, the dashed line BL is the bargaining locus, and U° and Π° are the outside option utility and profits for the union and the firm respectively. The only segment on the contract curve which is relevant from the point of view of bargaining is EE', which lies in between the outside options. If the bargaining locus BL intersects the contract curve along the segment EE', then the equilibrium wage-employment combination is given by the solution to the *unconstrained* Nash bargain. By contrast, if the BL curve intersects the CC schedule outside the segment EE' then the *constrained* Nash solution is given by the intersection of the CC curve with either U° or Π°. The outside options only affect the outcome insofar as they are biting.

3. Econometric issues

Let w^U, w^N and w^{π} be latent variables describing the level of wages under the regimes U°, interior Nash, and Π° respectively. Let n be the level of employment and x, y be the regressors for w and n respectively. Then the log-linearised version of the model described in the previous section can be written as follows:

(12a) $$w^U_{it} = x'_{it}\gamma^U + \varepsilon^U_{it}$$

(12b) $$w^N_{it} = x'_{it}\gamma^N + \varepsilon^N_{it}$$

(12c) $$w^\pi_{it} = x'_{it}\gamma^\pi + \varepsilon^\pi_{it}$$

(13) $$w_{it} = Me\{w^U_{it}, w^N_{it}, w^\pi_{it}\}$$

(14) $$n_{it} = y'_{it}\delta + \eta_{it}$$

where i=1,...,N; t=1,...,T, and where the operator Me selects the median value. It is further assumed that $\varepsilon_{it}=(\varepsilon^U_{it}, \varepsilon^N_{it}, \varepsilon^\pi_{it})' \sim N(0,\sigma^2 I_3)$ and $\eta_{it} \sim N(0,\tau^2)$ are independently distributed. Equations (12a)-(12c) and (13) describe the bargaining locus BL, with the level of wages written as the dependent variable. Equation (14) is the contract curve CC. Following the analysis of the previous section the rent sharing behaviour presents structural breaks across regimes, whereas the contract curve exhibits no such breaks since all efficient contracts lie on the same schedule.

In principle there exist sufficient exclusion restrictions to identify the single regimes in the bargaining locus. The outside option for the union (equation (12a)) is affected by variables such as unemployment benefits (see equation (6)), while the outside option for the firm (equation (12c)) depends on hiring and firing costs (see equation (3)). By contrast, the interior solution (12b) depends on firm specific variables such as profits (equations (9b), (9b')).

However, in the panel there are no available data at the firm level which would make it possible to identify each regime in terms of the above considerations only. Hence, I have proceeded to use theoretically grounded *a priori* information in order to have an initial allocation of firms across regimes. The classification is based on the rent-seeking behaviour of the union (as analysed for instance in Machin, 1989) and is discussed in the next section. The estimates obtained from the initial allocation of firms are then used in order to compute the probabilities that each observation falls into the different regimes, as explained in Appendix C. One can then recompute the estimates along the lines set out by Kiefer ((1980a); see also (1980b)).

Given the bargaining locus and the regimes, the contract curve is easily identified by variables reflecting the relative bargaining strength and by profits per head. The bargaining locus itself is identified by capital stock and output price in the contract curve. Equation (9b') can in fact be rewritten as[7]

[7] In the latter, $\bar{U}$ has been set equal to zero for convenience.

$$(9b'') \quad \frac{\alpha V'(W)}{V(W)-V(\tilde{W})} + \frac{(1-\alpha)}{\Pi/N-(r-\rho)(K/N)} = 0$$

It is thus apparent that the bargaining locus only depends on capital via the capital/labour ratio. After controlling for (K/N), the BL curve is unaffected by changes in K and in P which instead shift the CC curve. By contrast, the latter does not depend on the bargaining strength parameter α and on profits per head, Π/N. There exist therefore sufficient exclusion restrictions to enable the identification of all the equations of the model, conditional on the regimes.

Let us define the indicator variables $d^h_{it}=1$ if $w_{it}=w^h_{it}$, $d^h_{it}=0$ otherwise $(h=\Pi,N,U)$, and the corresponding selection matrices $D^h=\text{diag}\{d^h_{it}\}$. Then an initial estimate of the parameters of the model can be obtained by Weighted Generalized Instrumental Variables:

$$(15a) \quad {}^{0}\hat{\gamma}^{\pi}_{WGIVE} = [X'D^{\pi}Z(Z'D^{\pi}Z)^{-1}Z'D^{\pi}X]^{-1}X'D^{\pi}Z(Z'D^{\pi}Z)^{-1}Z'D^{\pi}w$$

$$(15b) \quad {}^{0}\hat{\gamma}^{N}_{WGIVE} = [X'D^{N}Z(Z'D^{N}Z)^{-1}Z'D^{N}X]^{-1}X'D^{N}Z(Z'D^{N}Z)^{-1}Z'D^{N}w$$

$$(15c) \quad {}^{0}\hat{\gamma}^{U}_{WGIVE} = [X'D^{U}Z(Z'D^{U}Z)^{-1}Z'D^{U}X]^{-1}X'D^{U}Z(Z'D^{U}Z)^{-1}Z'D^{U}w$$

$$(15d) \quad {}^{0}\hat{\sigma}^{2} = \frac{1}{NT}\{(w-X\hat{\gamma}^{\pi})'D^{\pi}(w-X\hat{\gamma}^{\pi}) + (w-X\hat{\gamma}^{N})'D^{N}(w-X\hat{\gamma}^{N})$$

$$+ (w-X\hat{\gamma}^{U})'D^{U}(w-X\hat{\gamma}^{U})\}$$

where Z is the matrix of instruments. The weighted estimation procedure must only be implemented for the bargaining locus (i.e. the 'wage' equation (12a)-(12c) and (13)). The contract curve (14) exhibits no structural breaks, and hence does not require the separation of the regimes.

Given an initial set of estimates for $\{\gamma^{\Pi},\gamma^{N},\gamma^{U},\sigma\}$ one can use the procedure described in Appendix C to compute $p^{h}_{it} \equiv \Pr(d^{h}_{it}=1)$, $h=\Pi,N,U$. These estimates can be used to form the matrices $\Omega^{h} \equiv \mathrm{diag}\{p^{h}_{it}\}$, and new WGIVE values can be obtained by replacing the matrices D^{h} with Ω^{h} in (15a)-(15d) to obtain the following expressions:

$$(16a)\qquad {}^{1}\hat{\gamma}^{\Pi}_{WGIVE} = [X'\Omega^{\Pi}Z(Z'\Omega^{\Pi}Z)^{-1}Z'\Omega^{\Pi}X]^{-1}X'\Omega^{\Pi}Z(Z'\Omega^{\Pi}Z)^{-1}Z'\Omega^{\Pi}w$$

$$(16b)\qquad {}^{1}\hat{\gamma}^{N}_{WGIVE} = [X'\Omega^{N}Z(Z'\Omega^{N}Z)^{-1}Z'\Omega^{N}X]^{-1}X'\Omega^{N}Z(Z'\Omega^{N}Z)^{-1}Z'\Omega^{N}w$$

$$(16c)\qquad {}^{1}\hat{\gamma}^{U}_{WGIVE} = [X'\Omega^{U}Z(Z'\Omega^{U}Z)^{-1}Z'\Omega^{U}X]^{-1}X'\Omega^{U}Z(Z'\Omega^{U}Z)^{-1}Z'\Omega^{U}w$$

$$(16d)\qquad {}^{1}\hat{\sigma}^{2} = \frac{1}{NT}\ \{(w-X\hat{\gamma}^{\Pi})'\Omega^{\Pi}(w-X\hat{\gamma}^{\Pi}) + (w-X\hat{\gamma}^{N})'\Omega^{N}(w-X\hat{\gamma}^{N})$$

$$+ (w-X\hat{\gamma}^{U})'\Omega^{U}(w-X\hat{\gamma}^{U})\}$$

Finally, in order to control for the firm-specific time-invariant fixed effects the Anderson-Hsiao (1981) procedure has been followed. The equations have been estimated in a differenced form, with lagged levels of the dependent variables being used as instruments[8]. Because of the switches between regimes, equations (15a)-(15c) and (16a)-(16c) must now be estimated simultaneously.

4. A priori information on regime switching

As discussed in the previous section, it would be extremely difficult to distinguish between regimes on the basis of endogenous information only. On the other hand, it is well known that the use of *a priori* information on sample separation improves the efficiency of the estimates in switching regression models (Kiefer, 1979; Schmidt, 1981).

The information used in the present chapter to provide an initial allocation of the firms is based on the responses of planned investment in capital stock and inventories to expected changes in output. Bean (1983) and Grout (1984) show that investment in capital stock is affected by the expected outcome of the bargains between the firm and the union. If the latter appropriates the *ex post* monopolistic rents which are generated after the physical investment has taken place, and if the firm anticipates this behaviour of the union, then investment is

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[8]Arellano (1989) shows that using twice lagged instruments in a level format, rather than in differences, in the Anderson-Hsiao procedure leads to lower asymptotic standard errors, under plausible conditions.

discouraged in the first place. Van der Ploeg (1987) analyses the issue as a dynamic game between the firm and the union, and explores the time inconsistency problems due to the union's incentive to renege its preannounced wage strategy. The planned changes in capital stock may thus provide a signal about the prevailing bargaining regime.

Analogously, Kahn (1987) shows that, if the firm plans its inventory holdings on the grounds of a stock-out avoidance motive, then the level of inventory investment is a positive function of the mark-up of prices over variable costs. In a bargaining framework the opportunity cost to the firm of stocking out, and hence the planned level of inventories, will be the greater the larger is the proportion of surplus which accrues to the firm.

In general, thus, the responses of investment in capital stock and inventories to expected changes in demand can be thought of as being highest when the firm receives most of the surplus, that is when the union must concede the firm its outside option level of profits. Conversely, the responses are smallest when the union receives its outside option[9].

The following taxonomy is thus proposed.

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[9]This statement critically hinges upon the assumption that the outside options are more sensitive to the business cycle than the *status quo*. This seems to be a reasonable assumption to make.

(a) Π°: the firm receives its outside option. The opportunity cost of not adjusting its stocks in the face of expected changes in demand is high. As expected output demand rises, the firm increases its investment in both capital stock and inventories. Conversely, when output is expected to fall the firm has to reduce inventories and investment. Hence, $\Delta Q^{e}\cdot\Delta^{2}K>0$ and $\Delta Q^{e}\cdot\Delta FG>0$, where Q^{e} is expected demand for output, K is capital stock and FG are inventories of finished goods.

(b) U°: the union receives its outside option. The opportunity cost to the firm of not investing in capital stock in the face of expected demand increases is small. Hence, $\Delta Q^{e}\cdot\Delta^{2}K\leq 0$.

(c) N: interior solution. The surplus is shared between the firm and the union. In this regime, the response of the firm to an expected demand increase is the "standard" one, i.e. it still invests in capital stock but now lets its inventories run down: $\Delta Q^{e}\cdot\Delta^{2}K>0$, $\Delta Q^{e}\cdot\Delta FG<0$.

The sample space is thus partitioned according to the classification rule presented in Table 1. Case I corresponds to the situation in which the union is constrained to concede the firm the outside option of the latter. Case II represents the interior (unconstrained) Nash solution. Finally, case III describes the situation in which the union receives its outside option.

The study makes use of a panel of 215 UK manufacturing firms from the EXSTAT data set from 1972 until 1982, collected by Sushil Wadhwani at LSE and described extensively in Wadhwani and

Wall (1988a, 1988b). The classification of firms across regimes is instead based on the CBI Industrial Trends Survey, which provides industry-wide information on the expected level of output and on planned investment in inventories and stocks of capital goods. After differencing the data and allowing for dynamics, the estimated regressions cover the period 1974-82.

In the sample, the average number of employees per firm experiences a dramatic fall from 9,078 in 1974 to 6,326 in 1982, i.e. a 30.3% decrease. In the same period nominal wages rise at a rate of 15.2% per year. The pattern of regime classification implied by the separation rule is shown in Table 2. According to the rule, 56% of the observations fall into regime Π°, in which the union is constrained to concede the firm its outside option. Another 23% of the observations are in regime N, in which the outcome is an interior Nash bargain. The remaining 21% of the cases are in regime U°, where the union receives its outside option.

These figures are consistent with the shrinking employment levels over time in the sample. The sharp increase in the unemployment rate in the manufacturing sector during the 70's and early 80's is likely to have created unfavourable conditions for unions. One would consequently expect to find a high proportion of observations in which firms realise their outside option.

The change over time in the composition of firms also reflects aggregate indicators of the labour market (see Table 3). Inflows have risen in 1975 and again in 1980-81, and correspondingly there has been an increase in the proportion of firms in Π^{0}. A rise in the number of firms in Π^0 has also been experienced in 1977-78, in which outflows have fallen. The proportion of observations in Π^0 relative to U^0 has instead fallen in 1976 and 1979 (decrease in inflows) and in 1982 (increase in outflows).

In Tables 4a and 4b the transitions between regimes are reported. If a unit is in Π^0 at time t, in more than 52 per cent of cases the same unit will be in Π^0 at time t+1 as well. If an observation is in N or U^0, however, it is more likely to shift to Π^0 in the following period than to remain in the same regime.

The allocation of firms to the different regimes seems thus to be tracing fairly closely the behaviour of aggregate flows into and out of unemployment. It is thus reasonable to rely upon the proposed sample separation rule as the starting point for the empirical analysis.

5. Econometric estimation

The bargaining locus has been estimated by making use of the following specification (lower case letters denote logs):

$$(17) \quad w_{it} = \gamma_0 + \gamma_1 w_{i,t-1} + \gamma_2 \Delta(k-n)_{it} + \gamma_3 (k-n)_{i,t-1} + \gamma_4 \Delta(\Pi/N)_{it} + \gamma_5 (\Pi/N)_{i,t-1} + \gamma_6 n_{i,t-1} + \gamma_7 \Delta w^I_{it} + \gamma_8 w^I_{i,t-1} + \gamma_9 \Delta u^I_{it} + \gamma_{10} u^I_{i,t-1} + \gamma_{11} (d-e)_{i,t-1} + \text{time dummies} + \varepsilon_{it}$$

where w are real wages, k is the capital stock, n the level of employment, Π profits, w^I the industry wage, u^I the industry unemployment rate, (d-e) the debt/equity ratio and the symbol Δ denotes the first difference operator. The dependent variable is average remuneration of all domestic employee, adjusted for cyclical overtime as explained in Appendix B. Care has been taken in endogenizing the current and lagged values of the capital/labour ratio and profits per employee and the lagged values of wages, employment, and the debt/equity ratio. Instruments are the excluded variables, twice lagged levels of the endogenous variables, industry union density (possibly related to bargaining strength), and financial variables (possibly related to profits).

Empirical estimates of the wage equation are presented in Tables 5-7b. Table 5 presents the estimates (15a)-(15d) corresponding to the initial allocation of firms. The hypothesis that the coefficients are the same for all regimes is clearly rejected: $F(31,1853)=3.280$. The most interesting finding is the behaviour of the industry wage. The coefficient is very high and very precisely determined in the outside options, Π^O and U^O, whereas it is much lower and insignificant in the interior regime, N. In principle, the industry wage might appear in N *via* the union's objective function. However, the empirical estimates clearly indicate that industry wages are crucial for the outside options. Profits per employee, by contrast, are only significant in N. Also, the differences between intercepts across regimes have the expected sign although they do not appear to be significant, i.e. $\gamma_0^{\pi^O} > \gamma_0^N > \gamma_0^{U^O}$. Union density was not significant when included amongst the regressors. This may be due to the fact that actual changes in density over the period where not closely related to changes in the effective group of "members", which are maybe better explained by lagged employment. The change in industry unemployment is significant in Π^o, but also in N. This is not what one would expect from the theory, and might simply reflect the possibility that industry unemployment affects the relative strength of the union in bargaining. The debt/equity ratio is correctly signed at U^o only[10]. A slightly disturbing feature of the results is that the Sargan criterion for the orthogonality of the instruments to the errors is marginally significant at 1%.

Table 6 gives a more parsimonious version of the wage equation. The coefficient on the industry wage in the interior regime has been set to zero. Similarly, profits per head and the debt-equity ratio are restricted not to appear at the outside options, and industry unemployment is excluded from U^o. These values are takes as the starting point for evaluating the probabilities p^h_{it} and re-estimate the parameters as described in (16a)-(16d).

A technical problem however arises when recomputing the estimates with the new probability weights. Since the estimated

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[10]Other financial variables, such as cash/liabilities ratio and market valuation ratio, were found to be insignificant after controlling for simultaneity.

standard error from Table 6 is large relative to the terms $x'_{it}\hat{\gamma}^k - x'_{i,t-1}\hat{\gamma}^h$ which are required to calculate the posterior probabilities[11], the estimates are bound to be contaminated by serious collinearity. Hence, the estimates which entirely rely on the posterior probabilities are not very meaningful.

In order to overcome this problem, a sensitivity analysis was performed by making use of a system of weights defined as follows:

$$(18) \qquad q^h_{it} = \lambda d^h_{it} + (1-\lambda)p^h_{it}$$

where λ=0.1,0.2,...,0.9. The parameter λ can be interpreted as a measure of the relative weight attached to the *a priori* allocation of the observations across the regimes.

Tables 7a and 7b report the estimation results for λ=0.7 and λ=0.3 respectively. The main features of the initial allocation tend to be replicated in each case. The coefficients on industry wages are always very large and significant at the outside options, whereas profits per employee are significant at the interior regime.

The employment equation reported in Table 8 has the following log-linearised form:

$$(19) \qquad n_{it} = \delta_0 + \delta_1 n_{i,t-1} + \delta_2 \Delta k_{it} + \delta_3 k_{i,t-1} + \delta_4 \Delta w_{it} + \delta_5 w_{i,t-1}$$

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[11]See Appendix C.

$$+ \delta_6 \Delta w^I_{it} + \delta_7 w^I_{i,t-1} + \delta_8 \Delta y^I_{it} + \delta_9 y^I_{i,t-1} + \delta_{10} \Delta u^I_{it}$$

$$+ \delta_{11} u^I_{i,t-1} + \delta_{12} \Delta p^I_{it} + \delta_{13} p^I_{i,t-1} + \text{time dummies} + \eta_{it}$$

where y^I is industry output. The dependent variable is the total number of domestic employees (both men and women). Current and lagged wages are instrumented, and so is n_{-1}. The equation above is similar to Nickell and Wadhwani's (1988) employment equation. The hypothesis that the coefficients are the same across regimes is easily accepted: F(35,1881) = 0.501. The capital stock, which identifies the rent sharing equation, is highly significant both in its current difference and in its lagged level. Own real wages have a negative sign, albeit not significantly so. Industry unemployment is negative as expected and well determined. Industry output is positive, and so is the index of industry price. Industry wages are positive, but not significant. As noted by Nickell and Wadhwani (1988), it would not be easy to rationalise a positive significant coefficient in terms of a bargaining model. Their preferred explanation for such a finding would rely on efficiency wage considerations. Lagged market valuation and debt-equity ratio were tried but they are both insignificant, after controlling for endogeneity. The marginal significance level of the Sargan criterion is greater than 2.5%.

The problems encountered when separating the regimes by making use of the posterior probabilities only are illustrated in Table 9, which shows the breakdown of the estimated number of firms across regimes and over time. The distribution of the observations in the whole sample is not very different from that obtained with the initial allocation (see Table 2), although the proportion of firms in Π^0 is now somewhat lower. Particularly sharp is the result for 1981, with almost all observations predicted to be in Π^0. However, the estimates pertaining to the other time periods are much less well differentiated. Hence, there is not enough variability in the sample to make it feasible to obtain a precise characterization of the regimes on the basis of endogenous information only.

6. Conclusions

This paper sets forth and tests a model of bargaining in which firm and workers are only constrained by the other party's outside options if these are credible. The observations in the sample have been allocated to different regimes consistently with the notion that the opportunity cost of investing in capital stock and inventories depends on the prevailing bargaining regime.

The main results are the following.

(i) The rent sharing behaviour exhibits structural breaks.

(ii) There is (indirect) evidence that investment decisions are affected by the bargaining regime.

(iii) The industry-wide wage level is a crucial determinant of wages in the outside options, but not in the interior regime.

(iv) Profits per employee are mainly important in the interior regime.

(v) In the sample period here considered, wage and employment determination has largely been driven by factors external to the firm.

Appendix A - The data

Employment, n. Number of domestic employees, EXSTAT item no. C15.

Wages, w. Remuneration of domestic employees (EXSTAT item no. C16)/Number of domestic employees.

Capital stock, k. Gross capital stock at current cost, from Wadhwani and Wall (1986).

Output, y. Sales/turnover, EXSTAT item no. C31.

Output price, p^I. Data constructed by S. Wadhwani and M. Wall (1988b). Trade and Industries until 1979 and British Business from 1980. Weights are given in Wholesales Prices Index: Principles and Procedures, CSO, 1980.

Unemployment rate by industry, u^I. Department of Employment Gazette.

Industry wage, w^I. Department of Employment Gazette.

Price of materials, pm^I. Price of stocks held as materials or fuel, Price Indices for Current Cost Accounting, CSO.

Market capitalization of equities. Datastream, item HMV.

Union density, u^I. Industry-specific union density, data provided by Paul Kong, University of Oxford.

Debt-equity ratio, d-e. (Total loan capital+borrowing repayable within 1 year)/(total equity capital and reserves + deferred tax less goodwill), Datastream, item 733.

Industry output, y^I. Real output per industry, Monthly Digest of Statistics, CSO.

Cash, m. Cash ratio: (total cash and equivalent)/ (total current liabilities), Datastream, item 743.

Expected change in output, ΔQ^e. Expected trend over the next four months with regard to the volume of output, excluding seasonal variation, CBI Industrial Trends Survey.

Expected change in Capital Expenditure, $\Delta^2 K$. Expected authorization of more or less capital expenditure in the next twelve months than in the previous twelve months (plant and machinery), CBI Industrial Trends Survey.

Expected change in stocks of finished goods, ΔFG. Expected trend over the next four months with regard to volume of stocks of finished goods, CBI Industrial Trends Survey.

Unemployment inflows and outflows. Department of Employment, unpublished data.

Appendix B - Cyclical correction of the wages series

(i) CSO data on product per head has been matched with the CBI Industrial Trends Survey on capacity/plant constraints. Let j denote the industrial subsector (metals, chemicals, engineering and allied industries, food drink and tobacco, textiles, other manufacturing). Then industry-specific cyclical factors were estimated as follows (1969-1986):

$$\widehat{(y-n)}_{jt} = \hat{\alpha}_{0j}(t) + \hat{\alpha}_{1j}\ln(CC)_{jt}$$

where $\alpha_{0j}(t)$ is a cubic polynomial of time. The industry cyclical residual is thus

$$\hat{u}_{jt} = (y-n)_{jt} - \hat{\alpha}_{0j}(t)$$

(ii) Next, data from the DOE New Earnings Survey is used:

E: gross weekly earnings (excluded those who were affected by absence)

w: average weekly hours (normal + overtime)

'Normal' earnings are defined as follows:

$$wN_{jt} = \left\{ \frac{40 + 5*1.3}{40 + (H_{jt}-40)*1.3} \right\} \cdot E_{jt}$$

(iii) We have then combined $\hat{u}_{jt}$ from (i) and $(wN/E)_{jt}$ from (ii) to estimate $\hat{\beta}_0$, $\hat{\beta}_1$ and $\hat{\beta}_2$:

$$\ln\left(\widehat{\frac{wN}{E}}\right)_{jt} = \hat{\beta}_0 + \hat{\beta}_1\hat{u}_{jt} + \hat{\beta}_2\hat{u}_{j,t-1}$$

(iv) The CSO industrial sector classification is matched with EXSTAT to run the following estimates at the firm level (1972-82):

$$(\widehat{y-n})_{it} = \hat{\gamma}_0(t) + \hat{\gamma}_1 \ln(CC)_{jt} \qquad i=1,\ldots,N$$

where $\gamma_0(t)$ is a quadratic polynomial. The firm-specific cyclical residual is thus constructed:

$$\hat{u}_{it} = (y-n)_{it} - \hat{\gamma}_0(t) \qquad t=72,\ldots,82$$

Using $\hat{u}_{jt}$ from (i) it is possible to estimate

$$\hat{u}_{it} = \hat{\delta}_0 + \hat{\delta}_1\hat{u}_{i,t+1} + \hat{\delta}_2\hat{u}_{jt} \qquad t=72,\ldots,81$$

and then backcast

$$\hat{u}_{i,71} = \hat{\delta}_0 + \hat{\delta}_1\hat{u}_{i,72} + \hat{\delta}_2\hat{u}_{j,71}$$

(v) The corrected wages series was finally constructed:

$$\ln(\hat{wN})_{it} = \ln(E)_{it} + \hat{\beta}_0 + \hat{\beta}_1 \hat{u}_{it} + \hat{\beta}_2 \hat{u}_{i,t-1}, \qquad t=72,\ldots,82$$

where $\hat{\beta}_0$, $\hat{\beta}_1$, $\hat{\beta}_2$ are taken from step (iii) (industry-specific coefficients) and $\hat{u}_{it}$ are taken from (iv) (firm-specific cyclical residuals).

Appendix C - Computation of the regime probabilities

Equations (12a)-(12c) and (13) in the text for wages can be written as

$$\text{(C1)} \qquad w_{it} = \sum_h d^h_{it} \cdot (x'_{it}\gamma^h + \varepsilon^h_{it})$$

where

$$d^h_{it} = \begin{cases} 1 & \text{if} \quad w^h_{it} = \mathrm{Me}\{w^\pi_{it}, w^N_{it}, w^U_{it}\} \\ 0 & \text{otherwise} \end{cases}$$

h=Π, N, U. Upon taking first differences,

$$\text{(C2)} \qquad \Delta w_{it} = \sum_h (d^h_{it}x'_{it} - d^h_{i,t-1}x'_{i,t-1}) + \sum_h (d^h_{it}\varepsilon^h_{it} - d^h_{i,t-1}\varepsilon^h_{i,t-1})$$

Given the assumptions on ε_{it} it follows that $\sum_h (d^h_{it}\varepsilon^h_{it} - d^h_{i,t-1}\varepsilon^h_{i,t-1}) \sim N(0, 2\sigma^2_\varepsilon)$. Hence,

$$\text{(C3)} \qquad \Pr(w^U_{it} < w^\pi_{it}) = \Pr(\varepsilon^U_{it} - \varepsilon^\pi_{it} < x'_{it}\gamma^\pi - x'_{it}\gamma^U)$$

$$= \Phi\left(\frac{(x'_{it}\gamma^\pi - x'_{i,t-1}\gamma^\pi) - (x'_{it}\gamma^U - x'_{i,t-1}\gamma^\pi)}{\sqrt{2}\ \sigma} \right)$$

$$\equiv \Phi\left(\frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\ \sigma} \right)$$

where $\hat{w}^{hk}_{it} \equiv x'_{it}\gamma^k - x'_{i,t-1}\gamma^h$ (when estimating the model in the differenced form (C2), the integrating factor for the *level* of wages can no longer be identified). Similarly,

$$\text{(C4)} \qquad \Pr(w^U_{i,t-1} < w^\pi_{i,t-1}) = \Phi\left(\frac{\hat{w}^{U\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma} \right)$$

We can now determine $\Pr(d^h_{is})=1$, $s=t-1,t$; $h=\Pi,N,U$. Starting with d^π, notice first that

$$\text{(C5)} \qquad \frac{1}{\sqrt{2}\,\sigma} \begin{bmatrix} \varepsilon^U - \varepsilon^\pi \\ \varepsilon^\pi - \varepsilon^N \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & -1/2 \\ -1/2 & 1 \end{bmatrix} \right)$$

and therefore

$$\text{(C6)} \qquad \Pr(w^U < w^\pi < w^N) = \Pr(\varepsilon^U - \varepsilon^\pi < x'\gamma^\pi - x'\gamma^U,\ \varepsilon^\pi - \varepsilon^N < x'\gamma^N - x'\gamma^\pi)$$

$$= \Phi\left(\frac{x'\gamma^\pi - x'\gamma^U}{\sqrt{2}\,\sigma} \right) \Phi\left(\frac{x'\gamma^N - x'\gamma^\pi}{\sqrt{2}\,\sigma} \right)$$

$$= \int_{-1/2}^{0} \phi\left(\frac{x'\gamma^\pi - x'\gamma^U}{\sqrt{2}\,\sigma}, \frac{x'\gamma^N - x'\gamma^\pi}{\sqrt{2}\,\sigma}; z \right) dz$$

by making use of the following relationship (see e.g. Cramer and Leadbetter, 1967):

$$\text{(C7)} \qquad \int_{-\infty}^{a} \int_{-\infty}^{b} \phi(x,y;\rho)\, dxdy = \Phi(a)\,\Phi(b) + \int_{0}^{\rho} \phi(a,b;z)\, dz$$

From (C6), one obtains

$$\text{(C8)} \qquad \Pr(w^U_{it}<w^\pi_{it}<w^N_{it}) = \Phi\left(\frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma}\right)\Phi\left(\frac{\hat{w}^{\pi N}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma}\right)$$

$$- \int_{-1/2}^{0} \phi\left(\frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma}, \frac{\hat{w}^{\pi N}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma}; z\right) dz$$

and

$$\text{(C9)} \qquad \Pr(w^U_{i,t-1}<w^\pi_{i,t-1}<w^N_{i,t-1}) = \Phi\left(\frac{\hat{w}^{U\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma}\right)\Phi\left(\frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{N\pi}_{it}}{\sqrt{2}\,\sigma}\right)$$

$$- \int_{-1/2}^{0} \phi\left(\frac{\hat{w}^{U\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma}, \frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{N\pi}_{it}}{\sqrt{2}\,\sigma}; z\right) dz$$

whence

$$\text{(C10)} \quad \Pr(d^\pi_{it}=1) = \frac{\Pr(w^U_{it}<w^\pi_{it}<w^N_{it})}{\Phi\left(\dfrac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma}\right)}$$

and

$$\text{(C11)} \quad \Pr(d^{\pi}_{i,t-1}=1) = \frac{\Pr(w^{U}_{i,t-1} < w^{\pi}_{i,t-1} < w^{N}_{i,t-1})}{\Phi\left(\dfrac{\hat{w}^{U\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma}\right)}$$

respectively. In an analogous fashion one obtains

$$\text{(C12)} \quad \Pr(d^{N}_{it}=1) = \left[\Phi\left(\frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma}\right)\right]^{-1} \cdot$$

$$\left[\Phi\left(\frac{\hat{w}^{\pi N}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma}\right) \Phi\left(\frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi N}_{it}}{\sqrt{2}\,\sigma}\right) + \right.$$

$$\left. - \int_{-1/2}^{0} \phi\left(\frac{\hat{w}^{\pi N}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma},\ \frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi N}_{it}}{\sqrt{2}\,\sigma}\ ;\ z\right) dz\right]$$

$$\text{(C13)} \quad \Pr(d^{N}_{i,t-1}=1) = \left[\Phi\left(\frac{\hat{w}^{U\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma}\right)\right]^{-1} \cdot$$

$$\left[\Phi\left(\frac{\hat{w}^{U\pi}_{it} - \hat{w}^{N\pi}_{it}}{\sqrt{2}\,\sigma}\right) \Phi\left(\frac{\hat{w}^{N\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma}\right) + \right.$$

$$\left. - \int_{-1/2}^{0} \phi\left(\frac{\hat{w}^{U\pi}_{it} - \hat{w}^{N\pi}_{it}}{\sqrt{2}\,\sigma},\ \frac{\hat{w}^{N\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma}\ ;\ z\right) dz\right]$$

$$\text{(C14)} \quad \Pr(d^{U}_{it}=1) = \left[\Phi\left(\frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma} \right) \right]^{-1} \cdot$$

$$\left[\Phi\left(\frac{\hat{w}^{\pi U}_{it} - \hat{w}^{\pi N}_{it}}{\sqrt{2}\,\sigma} \right) \Phi\left(\frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma} \right) + \right.$$

$$\left. - \int_{-1/2}^{0} \phi\left(\frac{\hat{w}^{\pi U}_{it} - \hat{w}^{\pi N}_{it}}{\sqrt{2}\,\sigma} , \frac{\hat{w}^{\pi\pi}_{it} - \hat{w}^{\pi U}_{it}}{\sqrt{2}\,\sigma} ; z \right) dz \right]$$

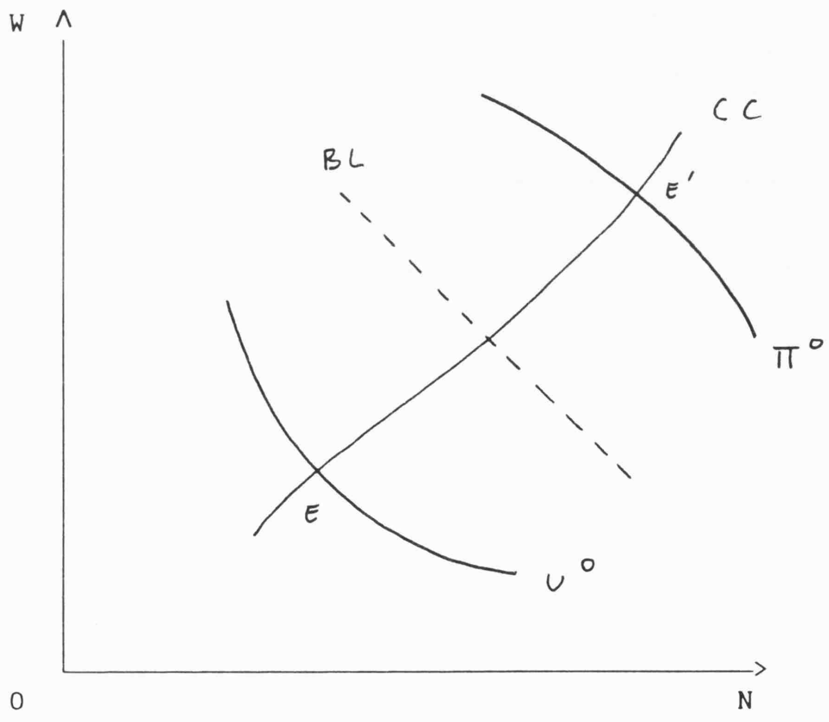
$$\text{(C15)} \quad \Pr(d^{U}_{i,t-1}=1) = \left[\Phi\left(\frac{\hat{w}^{U\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma} \right) \right]^{-1} \cdot$$

$$\left[\Phi\left(\frac{\hat{w}^{N\pi}_{it} - \hat{w}^{U\pi}_{it}}{\sqrt{2}\,\sigma} \right) \Phi\left(\frac{\hat{w}^{U\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma} \right) + \right.$$

$$\left. - \int_{-1/2}^{0} \phi\left(\frac{\hat{w}^{N\pi}_{it} - \hat{w}^{U\pi}_{it}}{\sqrt{2}\,\sigma} , \frac{\hat{w}^{U\pi}_{it} - \hat{w}^{\pi\pi}_{it}}{\sqrt{2}\,\sigma} ; z \right) dz \right]$$

The probabilities (C10)-(C15) can finally be computed by numerical integration.

Figure 1 - The Constrained Contract Curve



<u>Table 1</u> - Sample separation rule

		$\Delta Q^e \cdot \Delta FG$	
		> 0	< 0
$\Delta Q^e \cdot \Delta^2 K$	> 0	I (Π^o)	II (N)
	< 0	III (U^o)	

Table 2 - Number of firms in each regime per year

(row percentages in brackets)

	Π°	N	U°	
1974	117	45	48	210
	(56)	(21)	(23)	
1975	147	20	43	210
	(70)	(10)	(20)	
1976	51	70	89	210
	(24)	(33)	(42)	
1977	164	44	2	210
	(78)	(21)	(1)	
1978	142	38	32	212
	(67)	(18)	(15)	
1979	62	75	77	214
	(29)	(35)	(36)	
1980	132	59	24	215
	(61)	(27)	(11)	
1981	203	5	4	212
	(96)	(2)	(2)	
1982	45	78	83	206
	(22)	(38)	(40)	
Total	1063	434	402	1899
	(56)	(23)	(21)	

<u>Table 3</u> - Unemployment flows

(thousands)

Year	Inflows	Outflows
1974	2,969	2,843
1975	3,354	2,957
1976	2,970	2,941
1977	2,917	2,903
1978	2,308	2,398
1979	2,197	2,245
1980	2,709	2,061
1981	2,678	2,288
1982	2,718	2,562

Table 4a - Transition matrix

Initial regime (t)	Final regime (t+1) Π^o	N	U^o	
Π^o	631	304	264	1199
N	276	50	54	380
U^o	156	80	84	320
	1063	434	402	1899
	(56%)	(23%)	(21%)	

Table 4b - Conditional transition frequencies (per cent)

Initial regime (t)	Final regime (t+1) Π^o	N	U^o	
Π^o	52.63	25.35	22.02	100.00
N	72.63	13.16	14.21	100.00
U^o	48.75	25.00	26.25	100.00

Table 5 - Unrestricted wage equation

Dependent variable: w	Π°	N	U°
$w_{-1}^{\dagger}$	-0.008	-0.084	-0.043
	(0.071)	(0.706)	(0.348)
$k-n^{\dagger}$	0.012	0.014	0.015
	(0.620)	(0.709)	(0.747)
$\Pi/N^{\dagger}$	0.019	0.030	0.014
	(1.456)	(2.145)	(1.072)
$n_{-1}^{\dagger}$	0.119	0.116	0.122
	(2.753)	(2.661)	(2.792)
w^{I}	0.324	0.052	0.439
	(2.566)	(0.246)	(2.828)
Δu^{I}	-0.039	-0.124	-0.003
	(2.822)	(4.112)	(0.085)
$(d-e)_{-1}^{\dagger}$	0.016	0.049	-0.019
	(0.488)	(1.220)	(0.435)
$\gamma_0^h-\gamma_0^{U^{\circ}}$	0.204	0.007	-
	(1.259)	(0.036)	-
$\hat{\sigma}$	0.072		
Sargan (36)	60.324		
$F(31,1853)_{\Pi^0=N=U^0}$	3.280		
$F(16,1853)_{N=U^0}$	5.022		
$F(17,1853)_{\Pi^0=N}$	3.330		

Note: Absolute t-ratios in parenthesis. A dagger ($\dagger$) over a symbol indicates that the variable has been instrumented. The equation includes time dummies. The regime specific intercept is denoted by γ_0.

Additional instruments: industry output, industry price, price of materials, industry union density, cash liability ratio, twice lagged levels of endogenous variables.

Table 6 - Restricted wage equation

Dependent variable: w	Π°	N	U°
$w_{-1}^{\dagger}$	0.014	-0.073	-0.053
	(0.146)	(0.745)	(0.535)
$k-n^{\dagger}$	0.019	0.021	0.019
	(1.025)	(1.138)	(1.018)
$\Pi/N^{\dagger}$	-	0.011	-
	-	(2.882)	-
$n_{-1}^{\dagger}$	0.124	0.120	0.125
	(3.223)	(3.115)	(3.228)
w^{I}	0.356	-	0.490
	(3.561)	-	(4.003)
Δu^{I}	-0.043	-0.130	-
	(3.483)	(4.535)	-
$(d-e)_{-1}^{\dagger}$	-	0.035	-
	-	(1.993)	-
$\gamma_0^{h}-\gamma_0^{U^{\circ}}$	0.349	0.140	-
	(2.431)	(0.868)	-
$\hat{\sigma}$	0.071		
Sargan (36)	67.592		
$F(31,1853)_{\Pi^{0}=N=U^{0}}$	6.319		
$F(16,1853)_{N=U^{0}}$	7.816		
$F(17,1853)_{\Pi^{0}=N}$	4.302		

Note: As for Table 5.

Table 7a - Probability-weighted wage equation
(λ = 0.7)

Dependent variable: w	Π°	N	U°
$w_{-1}^{\dagger}$	0.219	0.103	0.205
	(2.781)	(1.333)	(3.322)
$k\text{-}n^{\dagger}$	0.014	0.019	0.010
	(0.708)	(0.955)	(0.515)
$\Pi/N^{\dagger}$	-	0.013	-
	-	(2.240)	-
$n_{-1}^{\dagger}$	0.033	0.026	0.031
	(1.162)	(0.929)	(1.102)
w^{I}	0.342	-	0.408
	(2.823)	-	(2.625)
Δu^{I}	-0.003	-0.086	-
	(0.170)	(2.325)	-
$(d\text{-}e)_{-1}^{\dagger}$	-	0.051	-
	-	(1.827)	-
$\gamma_0^{h}-\gamma_0^{U^{\circ}}$	0.074	-0.232	-
	(0.378)	(0.966)	-
$\hat{\sigma}$	0.078		
Sargan (36)	65.230		
$F(31,1853)_{\Pi^{o}=N=U^{o}}$	4.155		
$F(16,1853)_{N=U^{o}}$	5.454		
$F(17,1853)_{\Pi^{o}=N}$	3.560		

Note: As for Table 5.

Table 7b - Probability-weighted wage equation
(λ = 0.3)

Dependent variable: w	Π°	N	U°
$w_{-1}{}^{\dagger}$	0.081	-0.004	0.031
	(0.848)	(0.041)	(0.324)
$k-n^{\dagger}$	0.009	0.012	0.008
	(0.501)	(0.623)	(0.423)
$\Pi/N^{\dagger}$	-	0.011	-
	-	(2.531)	-
$n_{-1}{}^{\dagger}$	0.085	0.081	0.085
	(2.373)	(2.246)	(2.368)
w^{I}	0.310	-	0.455
	(3.013)	-	(3.524)
Δu^{I}	-0.043	-0.125	-
	(3.003)	(3.965)	-
$(d-e)_{-1}{}^{\dagger}$	-	0.034	-
	-	(1.775)	-
$\gamma_0^{h}-\gamma_0^{U^{\circ}}$	0.274	0.064	-
	(1.770)	(0.361)	-
$\hat{\sigma}$	0.072		
Sargan (36)	71.771		
$F(31,1853)_{\Pi^{o}=N=U^{o}}$	6.018		
$F(16,1853)_{N=U^{o}}$	7.550		
$F(17,1853)_{\Pi^{o}=N}$	3.967		

Note: As for Table 5.

Table 8 - Employment equation

Dependent variable: n	
$n_{-1}^{\dagger}$	0.252
	(3.447)
Δk	0.262
	(15.031)
k_{-1}	0.313
	(9.655)
$\Delta w^{\dagger}$	-0.153
	(1.553)
$w_{-1}^{\dagger}$	-0.179
	(1.546)
w_{-1}^{I}	0.163
	(1.250)
Δy^{I}	0.158
	(4.190)
y_{-1}^{I}	0.067
	(1.226)
u^{I}	-0.132
	(5.071)
Δp^{I}	0.033
	(2.409)
$\hat{\sigma}$	0.088
Sargan (73)	93.241
$F(35,1881)_{\Pi^o=N=U^o}$	0.501

Note: As for Table 5.

Additional instruments: profits per head, industry union density, cash/liabilities ratio, price of materials, market valuation ratio, debt/equity ratio, twice lagged levels of endogenous variables.

Table 9 - Estimated number of firms in each regime per year

(row percentages in brackets)

	Π^0	N	U^0	
1974	58	71	81	210
	(28)	(34)	(38)	
1975	97	68	45	210
	(46)	(32)	(22)	
1976	69	68	73	210
	(33)	(32)	(35)	
1977	75	66	69	210
	(36)	(31)	(33)	
1978	84	76	52	212
	(40)	(36)	(24)	
1979	84	73	57	214
	(39)	(34)	(27)	
1980	71	73	71	215
	(33)	(34)	(33)	
1981	173	32	7	212
	(82)	(15)	(3)	
1982	77	67	62	206
	(37)	(33)	(30)	
Total	788	594	517	1899
	(42)	(31)	(27)	

CHAPTER 2

LABOUR BARGAINING, EFFICIENCY WAGES, AND UNION MEMBERSHIP

1. Introduction

In the previous chapter a model of labour bargaining has been set out and tested. Since the emphasis was mainly upon empirical applications, the degree of complexity of the model has been kept at a minimum. The analytical form of the union objective function and the *status quo* and outside options of the parties have been restricted in order to allow the identification of the underlying equations. It has thus been possible to develop a simple model which generates sharp testable predictions.

It is important, however, to investigate whether the results which were obtained critically depend on the assumed specifications, or whether the findings are robust with respect to more general characterizations of the analytical set-up. While it is clearly not possible to test the identifying restrictions *per se*, it is however feasible to relax some of the restrictive assumptions and contrast the comparative statics predictions with those of the simple model.

The present chapter follows three main directions of research. First, a more general union objective function is analyzed (section 2). It is assumed that the union is concerned not only with the utility of its currently employed members, which was a maintained hypothesis in chapter 1, but cares about its unemployed members as well. Secondly, it is relaxed the assumption that workers are all identical and hence have the same outside option. When workers have a variety of reservation wages, they will leave the firm if the bargained outcome is less satisfactory than their outside option. But if, following Weiss (1980), workers' ability is positively correlated with their reservation wage, then the productivity implications of alternative wage settlements must be taken into account by rational firms and unions. Efficient bargains must thus be combined with efficiency wages considerations (section 3).

Finally, some implications of the previous analysis upon union membership are explored. If the *status quo* position for the union is identified with its outside option, it is possible to show that, for a variety of specifications of union objectives, membership plays no direct role (e.g. Farber (1986)). This statement no longer holds true, however, once a distinction is made between *status quo* and outside options. But if membership matters, and its size is endogenous and depends upon the negotiated outcome, then a question is whether an optimal size exists which maximizes the union objective function. These issues are analyzed in section 4. Section 5 provides a summary and draws some conclusions.

2. Union objective function and bargaining outcome

In the empirical research carried out in chapter 1 the union is assumed to maximize the utility rents to its employed members (equation (1.4)). This is a generalization of Dunlop's (1944) wage bill argument. However, the objective there used can be regarded as restrictive since it does not express any concern for the utility of the unemployed members. In the present section, by contrast, it is assumed that the union maximizes the expected utility of its representative member under a random layoff rule. It is shown that this generates some paradoxical effects from union size.

The objective function for the union is

$$(1) \qquad U(W,N) = \frac{N}{M}\cdot U(W) + \frac{M-N}{M}\cdot U(\tilde{W})$$

where W is the wage, N the level of employment, M membership, $\tilde{W}$ the certainty equivalent wage level for an unemployed worker, and where $U'(\cdot)>0$, $U''(\cdot)<0$, $U'(W)\to\infty$ as $W\to 0$, and $U'(W)\to 0$ as $W\to\infty$. Equation (1) possesses the appealing feature of being consistent with aggregation over individual members' preferences. An alternative behavioural assumption for the union holds that the *sum* of the utilities of its members is maximized:

$$(1') \qquad V(W,N) = N\cdot U(W) + (M-N)\cdot U(\tilde{W})$$

Utility (1') can be regarded as appropriate when redistribution takes place within the union. For all the purposes of the present section, the objective functions (1) and (1') are equivalent. Therefore one can limit oneself to the case of an expected-utility union (equation (1)). The implications of $U(\cdot,\cdot)$

and $V(\cdot,\cdot)$ are however very different once membership is endogenised. In section 4 both functional forms are discussed and their contrasting predictions are analysed.

The union maximizes the objective function (1). While bargaining, workers receive the utility level $\bar{U}$ (*status quo*). The outside option coincides with the utility of the unemployed members of the union:

$$(2) \qquad U^{0} = U(\tilde{W})$$

The firm maximizes profits:

$$(3) \qquad \Pi(W,N) = P\cdot F(N) - WN$$

where P is the output price and $F(\cdot)$ satisfies the Inada conditions. The *status quo* position and outside option are respectively equal to $\bar{\Pi}$ and Π^{0} [1].

The (symmetric) Nash bargaining between firm and union is

$$(4) \qquad \max_{(W,N)} \quad \left[\frac{N}{M} U(W) + \frac{M-N}{M} U(\tilde{W}) - \bar{U} \right] [P\cdot F(N) - WN - \bar{\Pi}]$$

subject to

---

[1]The differences in specification relative to chapter 2 serve the purpose of simplifying the notation, and involve no loss in generality.

(5a) $\frac{N}{M}\,[U(W) - U(\tilde{W})] + U(\tilde{W}) \geq U^0$

(5b) $PF(N) - WN \geq \Pi^0$

In the light of (2), equation (5a) becomes simply

(5a') $W \geq \tilde{W}$

Let λ and μ be the non-negative Kuhn-Tucker multipliers pertaining to constraints (5a') and (5b) respectively. The first-order conditions are

(6a) $NU'(W)[PF(N)-WN-\bar{\Pi}] - [NU(W)+(M-N)U(\tilde{W})-M\bar{U}]N + \lambda - \mu N = 0$

(6b) $[U(W)-U(\tilde{W})][PF(N)-WN-\bar{\Pi}] + [NU(W)+(M-N)U(\tilde{W})-M\bar{U}][PF'(N)-W]$
$+ \mu\cdot[PF'(N)-W] = 0$

(6c) $\lambda\cdot[W-\tilde{W}] = 0$

(6d) $\mu\cdot[PF(N)-WN-\Pi^0] = 0$

As in chapter 1, three cases may arise according as to whether the parties are at an interior solution ($\lambda=\mu=0$) or whether either constraint is binding ($\lambda>0$ or $\mu>0$). These cases are now considered in turn.

(i) <u>Interior solution</u> ($\lambda=\mu=0$)

The first-order conditions are

$$\text{(7a)}\qquad \frac{U'(W)}{N[U(W)-U(\tilde{W})]+M[U(\tilde{W})-\bar{U}]} - \frac{1}{PF(N)-WN-\bar{\Pi}} = 0$$

$$\text{(7b)}\qquad \frac{U'(W)}{U(W)-U(\tilde{W})} + \frac{1}{PF'(N)-W} = 0$$

Equation (7a) is the *bargaining locus*, whereas equation (7b) is the *contract curve*. From inspection of (7b) one can notice that an interior solution requires $PF'(N)-W<0$. Furthermore, from (7b) one has

$$N = h\left\{ \frac{W}{P}\left[1 - \frac{U(W)-U(\tilde{W})}{WU'(W)} \right] \right\}$$

where $h(\cdot) \equiv (F')^{-1}(\cdot)$. Given the Inada properties of $F(\cdot)$, this implies that necessary condition for the existence of an interior solution is

$$\frac{W\,U'(W)}{U(W)-U(\tilde{W})} > 1$$

i.e. the wage elasticity of the utility gain from employment must be greater than unity. By taking total differentials one obtains

(8a) $\{U''[PF-WN-\bar{\Pi}]-2NU'\}\ dW + 2U'[PF'-W]\ dN =$

$= [(M-N)U'(\tilde{W})]\ d\tilde{W} + U'\ d\bar{\Pi} - M\ d\bar{U} - U'F\ dP + (\tilde{U}-\bar{U})\ dM$

(8b) $U''[PF'-W]\ dW + U'PF''\ dN = U'(\tilde{W})\ d\tilde{W} - U'F'\ dP$

In matrix notation,

$$(9)\quad \begin{bmatrix} \underset{(-)}{a_{11}} & \underset{(-)}{a_{12}} \\ \underset{(+)}{a_{21}} & \underset{(-)}{a_{22}} \end{bmatrix} \begin{bmatrix} dW \\ dN \end{bmatrix} = \begin{bmatrix} \underset{(+)}{b_{11}} & \underset{(+)}{b_{12}} & \underset{(-)}{b_{13}} & \underset{(-)}{b_{14}} & \underset{(+)}{b_{15}} \\ \underset{(+)}{b_{21}} & 0 & 0 & \underset{(-)}{b_{24}} & 0 \end{bmatrix} \begin{bmatrix} d\tilde{W} \\ d\bar{\Pi} \\ d\bar{U} \\ dP \\ dM \end{bmatrix}$$

The bargaining locus BL is thus negatively sloped on the (N,W) plane, whilst the contract curve CC has a positive slope (Fig. 1). The comparative statics results are

$$\frac{dW}{d\tilde{W}} \gtreqless 0\ ,\quad \frac{dW}{d\bar{\Pi}} < 0\ ,\quad \frac{dW}{d\bar{U}} > 0\ ,\quad \frac{dW}{dP} \gtreqless 0\ ,\quad \frac{dW}{dM} < 0$$

$$\frac{dN}{d\tilde{W}} < 0\ ,\quad \frac{dN}{d\bar{\Pi}} < 0\ ,\quad \frac{dN}{d\bar{U}} > 0\ ,\quad \frac{dN}{dP} > 0\ ,\quad \frac{dN}{dM} < 0$$

Increases in the alternative wage $\tilde{W}$ have an unclear effect on wages, whilst unambiguously depressing the level of employment.

Formally, this is due to the fact that both the BL and the CC curves are shifted to the left. Increases in the *status quo* of the firm and the union respectively exert opposite effects, the former reducing, and the latter increasing, both W and N. Increases in the firm's output price P (which can be interpreted as a firm-specific shift factor) increase N, while their effect on the bargained wage is unclear[2].

The most intriguing, and apparently paradoxical, result is that an increase in union membership should *decrease* both wages and employment. This is an unambiguous prediction of the model. It necessarily follows from the fact that an increase in union size shifts the BL curve to the left whilst leaving the position of the CC schedule unaffected (see Fig. 1). From the rent sharing equation (7a) one can see that, given the alternative wage, an increase in membership plays a similar role as a worsening in the union's *status quo*. As M rises, the *level* of utility gains to the union increases. The *marginal* increase in utility from reaching a settlement must therefore increase as well, and this is accomplished through a decrease in wage for any level of employment. Conversely, for any given wage, the increase in

---

[2]It is possible to show that $dW/dP>0$ iff

$$W < PF'(N)\left[1 - \frac{1}{2}\,\frac{F(N)}{NF'(N)}\,\frac{NF''(N)}{F'(N)} \right] \equiv PF'(N)\ [\ 1 - \varepsilon_{F',N}\ /2\varepsilon_{F,N}\ ]$$

The response of wages to changes in the output price is thus a function of the degree of concavity of the production technology.

utility following a rise in membership must be offset by a *decrease* in employment.

(ii) <u>Outside option binding for the union</u>: $U=U^0$ ($\lambda>0$, $\mu=0$)

The first-order conditions are:

(10a) $[U(W)-\bar{U}]\cdot[PF'(N)-W] = 0$

(10b) $W = \tilde{W}$

Substituting (10b) into (10a), and since $U(\tilde{W})>\bar{U}$ by assumption, one obtains

(11) $F'(N) = \frac{\tilde{W}}{P}$

Employment thus lies on the labour demand schedule. It should be noticed that equation (11) does not characterize the competitive outcome, since $\tilde{W}$ is not the competitive wage but the certainty equivalent wage for an unemployed worker. The union size is irrelevant to the bargained outcome.

(iii) <u>Outside option binding for the firm</u>: $\Pi=\Pi^0$ ($\lambda=0$, $\mu=0$)

The first-order conditions give

(12a) $[U(W)-U(\tilde{W})] + U'(W)[PF'(N)-W] = 0$

(12b) $\quad PF(N) - WN = \Pi^0$

Equation (12a) is the contract curve and equation (12b) is the outside option for the firm. It is immediately seen that the union size has no effect upon wages and employment when workers have to concede the firm its outside option. Comparative statics gives

$$\frac{dW}{d\Pi^0} < 0, \qquad \frac{dW}{d\tilde{W}} > 0, \qquad \frac{dW}{dP} < 0$$

$$\frac{dN}{d\Pi^0} < 0, \qquad \frac{dN}{d\tilde{W}} < 0, \qquad \frac{dN}{dP} > 0$$

An improvement in the firm's outside option worsens the wage-employment combinations which the union can attain. An increase in the alternative wage raises the equilibrium wage and lowers employment, whilst the opposite happens if the firm's output price increases[3].

One of the main results of the analysis of this section is that, under an expected utility objective function for the union, increases in the size of the latter must bring about a reduction of both wages and employment. The reason for this is that

---

[3]If one writes $\Pi^0 = \Pi^0(\tilde{W})$, $\Pi^{0\prime}(\cdot) < 0$, then the comparative statics results become $dW/d\tilde{W} > 0$, $dN/d\tilde{W} \gtrless 0$.

membership affects the *average* surplus of the union to a smaller extent than its *marginal* surplus. Rearranging (7a) one obtains

$$\text{(7a')} \qquad \frac{U'(W)/M}{\frac{N}{M}\,[U(W)-U(\tilde{W})] + [U(\tilde{W})-\bar{U}]} = \frac{1}{PF(N)-WN-\bar{\Pi}}$$

From (7a') it is apparent that a *ceteris paribus* increase in membership by itself brings about a reduction of the marginal gains from a wage increase that is larger than the overall dilution of the utility surplus. In fact, the decrease in total surplus only involves the fraction of the labour force which is employed. Hence, the rent-sharing condition requires that increases in membership be compensated for by a decrease in wage. A similar argument would apply to the level of employment.

A utilitarian union would have its payoff *increased* by a rise in membership, for given employment and wages. The rent sharing equilibrium condition at the margin again requires a fall in wages and employment. Hence, both an expected utility and a utilitarian objective function lead to the disturbing prediction that larger unions should bring about lower wages *and* employment.

These implications about the effects of membership necessarily follow from assuming an expected utility, or a utilitarian, objective function for the union. Hence, it seems one can be justified in assuming utility rents maximization, as in the previous chapter.

3. Efficiency wages and bargaining

In the analysis of chapter 1 and in the previous section it has been assumed throughout that workers were all identical. In particular, they are endowed with the same productive characteristics and have the same market opportunities available to them. This may seem to be a very restrictive assumption. It is certainly realistic to acknowledge that workers have unequal ability and face different outside market alternatives. At the limit, there might exist a *continuum* of outside options for workers according to their productive potential.

In the present section, I extend the bargaining model previously developed in order to allow for the possibility that workers face different outside options. I follow Weiss (1980) in postulating that wage remuneration cannot be made contingent upon individual performance. Each worker's ability is however positively correlated with his/her reservation wage. Following a decrease in the wage paid by the firm, the best workers would quit and labour productivity would be adversely affected. This decrease in average productivity might offset the positive effects on the firm' s profits of a reduction in the wage bill. In a bargaining framework, these quality composition effects on labour productivity must be taken into account by rational agents when negotiating over wages and employment.

Labour heterogeneity can be formalized as in Weiss (1980). Let $G(W)$ be the cumulative distribution of workers by their reservation wage, and let $q(W)$ be individual productivity (where

$q(\cdot)$ satisfies the Inada conditions). The average productivity of the workforce as a function of the wage, $Z(W)$, is then given by[4]

$$(13) \qquad Z(W) = \frac{\int_0^W q(v)dG(v)}{G(W)}$$

where $Z'(\cdot)>0$ and where $Z''(\cdot)$ is assumed to be negative over the relevant range (see Appendix A for a discussion of the necessary and sufficient condition for $Z''(\cdot)<0$).

The technology is described by the production function

$$(14) \qquad Y = F[Z(W)\cdot N]$$

Hence expected profits are given by[5]

$$(15) \qquad \Pi(W,N) = P\cdot F[Z(W)N] - WN$$

In the formal characterization of the bargaining structure, workers have a continuum of outside options. Since the analysis

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[4]One could easily modify equation (13) in order to allow the firm to control the lower bound of workers' ability, e.g. *via* a pass-fail test.

[5]Due to Jensen's inequality, expression (15) in the text is only valid as an approximation.

is mainly concerned with the behaviour of the parties at an interior solution, the outside option of the firm is neglected. Also, for notational simplicity the *status quo* positions of the firm and the union are both normalized to zero: $\bar{\Pi}=\bar{U}=0$.

An important assumption concerns the union objective function. For consistency with the analysis developed in the previous section, an expected utility function is adopted[6]. In what follows, the union size is independent of W. Workers who choose not to be hired by the firm because of low wages remain nevertheless members of the union. A possible justification for this is that membership is here properly identified with the labour pool from which the firm can randomly hire its employees, rather than with the formal group of fee-paying members. A different value of W, whilst effectively truncating the distribution of *actual* workers, does not alter the distribution of *potential* job applicants.

The Nash bargaining problem is

$$(16) \qquad \max_{(W,N)} \left[\frac{N}{M} U(W) + \frac{M-N}{M} U(\tilde{W}) \right] \{P \cdot F[Z(W)N] - WN\}$$

where $\tilde{W}$ is a measure of the alternative wage for laid off

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[6]The implications of considering an objective function of the form $N \cdot [V(W) - V(\tilde{W})]$, as in the previous chapter, are presented in Appendix D.

workers[7]. The first-order conditions for an interior solution can be written as:

$$(17a) \quad U'(W)\{PF[Z(W)N]-WN\} + [NU(W)+(M-N)U(\tilde{W})]\{PZ'(W)F'[Z(W)N]-1\} = 0$$

$$(17b) \quad [U(W)-U(\tilde{W})]\{PZ'(W)F'[Z(W)N]-1\} - U'(W)\{PZ(W)F'[Z(W)N]-W\} = 0$$

It is easy to verify that (17a) and (17b) would collapse to the corresponding equations (7a) and (7b) for the case of homogeneous workers if one sets $Z'(W)=0$ and $Z(W)=1$, i.e. if one rules out the efficiency wage effect upon productivity and normalizes the efficiency parameter to unity. The first-order conditions imply

$$(18) \quad PF' < \min\left(\frac{W}{Z}, \frac{1}{Z'}\right)$$

Equation (17b) can be rewritten as

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[7]It should be noticed that this measure is taken to be independent of the bargained outcome. This assumption requires that the opportunity set of the unemployed members of the union is different from that of workers who voluntarily quit.

$$N = \frac{1}{Z(W)} \quad h\left\{ \frac{W}{PZ} \left[1 + \frac{U(W)-U(\tilde{W})}{WU'(W)} (PZ'F'-1) \right] \right\}$$

where $h(\cdot) \equiv (F')^{-1}(\cdot)$. Existence of an interior solution therefore requires

$$\frac{WU'}{U-\tilde{U}} > 1 - PZ'F'$$

Since $Z'>0$, this condition is less stringent than the corresponding inequality for identical workers (obtained by setting $Z'=0$).

The absolute value of the marginal rate of substitution between wages and employment for the firm is

$$- \left. \frac{dW}{dN} \right|_{d\Pi=0} = \frac{PZF'-W}{(PZ'F'-1)N}$$

which implies that, for a given wage and employment combination, the slope of the indifference schedules tends to be smaller the larger is the strength of the efficiency wage effect, as expressed by the marginal increase in expected average productivity Z. The isoprofit lines tend thus to be more wage elastic than in the absence of labour heterogeneity.

By taking total differentials of (17a) and (17b) one has

(19a) $\{U''(PF-WN)+2NU'(PZ'F'-1)+[N(U-\tilde{U})+M\tilde{U}][PZ''F'+P(Z')^2NF'']\}dW$

$$+ \{2U'(PZF'-W)+[N(U-\tilde{U})+M\tilde{U}]PZZ'F''\}\ dN$$

$$= -\ (M-N)\tilde{U}'(PZ'F'-1)\ d\tilde{W} - \{U'F+[N(U-\tilde{U})+M\tilde{U}]Z'F'\}\ dP$$

$$- \tilde{U}(PZ'F'-1)\ dM$$

(19b) $$\{U''(PZF'-W)-(U-\tilde{U})[PZ''F'+PN(Z')^2F'']+U'PZZ'NF''\}\ dW$$

$$+ \{U'PZ^2F''-(U-\tilde{U})PZZ'F''\}\ dN$$

$$= -\ (PZ'F'-1)\tilde{U}'\ d\tilde{W} + [(U-\tilde{U})Z'F'-U'ZF']\ dP$$

More compactly,

(20) $$\begin{bmatrix} \underset{(-)}{a_{11}} & \underset{(-)}{a_{12}} \\ & \\ \underset{(+/-)}{a_{21}} & \underset{(+/-)}{a_{22}} \end{bmatrix} \begin{bmatrix} dW \\ \\ dN \end{bmatrix} = \begin{bmatrix} \underset{(+)}{\delta_{11}} & \underset{(-)}{\delta_{12}} & \underset{(+)}{\delta_{13}} \\ & & \\ \underset{(+)}{\delta_{21}} & \underset{(+/-)}{\delta_{22}} & 0 \end{bmatrix} \begin{bmatrix} d\tilde{W} \\ dP \\ dM \end{bmatrix}$$

where $a_{11}<0$ since $Z''<0$. It is immediate to show that $\text{sign}(a_{22})$ $[=\text{sign}(\delta_{22})] < 0$ iff

$$\frac{WZ'(W)}{Z(W)} < \frac{W\ U'(W)}{U(W)-U(\tilde{W})}$$

that is, iff

(21) $$\varepsilon_{Z,W} < \varepsilon_{U,W}$$

Thus, a_{22} and δ_{22} are negative - as with a homogeneous labour force - if and only if the wage elasticity of average productivity is lower than the wage elasticity of the utility from being employed. Clearly, inequality (21) is always satisfied if $Z'(W)=0$.

The coefficient a_{21} is positive (again, as in the case of homogeneous labour) if the following necessary and sufficient condition is satisfied[8]:

$$(22) \qquad \underset{(+)}{\varepsilon_{\pi_W, N}} < 1 + \frac{\overset{(+)}{\varepsilon_{\pi_W, W}}}{\underset{(+)}{\varepsilon_{U, W}}} - \underset{(-)}{\varepsilon_{U', W}} \frac{\overset{(-)}{\varepsilon_{\pi, N}}}{\underset{(-)}{\varepsilon_{\pi, W}}}$$

Inequality (22) is not met if $\varepsilon_{\pi_W, N}$ is large. Since $\varepsilon_{\pi_W, N} \equiv N\Pi_{NW}/\Pi_W$ and $\Pi_{NW}=PZ'(F'+ZNF'')-1$, provided $F(\cdot)$ is sufficiently concave condition (22) is violated if the efficiency wage effect is sufficiently important (i.e. if Z' is large).

Conditions (21) and (22) do not imply each other. There are no restrictions, therefore, that the sign of a_{21} places upon the sign of a_{22} and conversely.

Equation (19b) describes the contract curve. It is steeper than the corresponding relationship for the case of homogeneous labour if the following sufficient condition is met[9]:

$$(23) \qquad \varepsilon_{\pi_W, N} > 1 + \frac{\varepsilon_{\pi_W, W}}{\varepsilon_{U, W}}$$

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[8]See Appendix B.

[9]See Appendix C.

By comparison of (22) and (23), it follows that $a_{21}<0$ implies that the CC curve must be steeper than if Z'=0.

Four different configurations of signs of parameter values can arise.

Case I:	$a_{21} > 0,$	$a_{22} < 0,$	$\delta_{22} < 0$
Case II:	$a_{21} > 0,$	$a_{22} > 0,$	$\delta_{22} > 0$
Case III:	$a_{21} < 0,$	$a_{22} > 0,$	$\delta_{22} > 0$
Case IV:	$a_{21} < 0,$	$a_{22} < 0,$	$\delta_{22} < 0$

The comparative statics implications for each one of these cases are now considered in turn.

Case I

The system of total differentials is

$$\begin{bmatrix} \underset{(-)}{a_{11}} & \underset{(-)}{a_{12}} \\ \\ \underset{(+)}{a_{21}} & \underset{(-)}{a_{22}} \end{bmatrix} \begin{bmatrix} dW \\ \\ dN \end{bmatrix} = \begin{bmatrix} \underset{(+)}{\delta_{11}} & \underset{(-)}{\delta_{12}} & \underset{(+)}{\delta_{13}} \\ \\ \underset{(+)}{\delta_{21}} & \underset{(-)}{\delta_{22}} & 0 \end{bmatrix} \begin{bmatrix} d\tilde{W} \\ dP \\ dM \end{bmatrix}$$

Efficiency wage considerations are not powerful enough to modify the sign of any coefficient relative to a situation of homogeneous labour. The comparative statics results obtained for the interior regime of section 2 apply here as well:

$$\frac{dW}{d\tilde{W}} \gtrless 0, \qquad \frac{dW}{dP} \gtrless 0, \qquad \frac{dW}{dM} < 0$$

$$\frac{dN}{d\tilde{W}} < 0, \qquad \frac{dN}{dP} > 0, \qquad \frac{dN}{dM} < 0$$

Case II

The value of the wage elasticity of average productivity $\varepsilon_{Z,W}$ is large relative to the elasticity of the utility gains from being employed. Condition (21) is therefore not satisfied. The value of the employment elasticity of marginal profits with respect to wages, $\varepsilon_{\pi_W,N}$ is however not large enough to violate condition (22). Both the BL and CC curves are negatively sloped. The sign of the determinant is however ambiguous. Hence, one ought to distinguish between two sub-cases.

Sub-case II(a): $\Delta<0$

The CC schedule is steeper than the BL curve, since $a_{22}/a_{21}>a_{12}/a_{11}$ (Fig. 2). Comparative statics give

$$\frac{dW}{d\tilde{W}} < 0, \qquad \frac{dW}{dP} \gtrless 0, \qquad \frac{dW}{dM} < 0$$

$$\frac{dN}{d\tilde{W}} > 0, \qquad \frac{dN}{dP} \gtrless 0, \qquad \frac{dN}{dM} > 0$$

The most interesting result is that now a larger union does not lead to fewer members being employed. The responses to an increase in $\tilde{W}$ are a rise in N (consistent with the empirical findings of chapter 1) and a fall in W (which is not inconsistent with the observed behaviour in the interior regime).

Sub-case II(b): $\Delta>0$

The BL curve is steeper than the CC (Fig. 3). The responses of wages and employment are now opposite relative to sub-case II(a):

$$\frac{dW}{d\tilde{W}} > 0, \qquad \frac{dW}{dP} \gtrless 0, \qquad \frac{dW}{dM} > 0$$

$$\frac{dN}{d\tilde{W}} < 0, \qquad \frac{dN}{dP} \gtrless 0, \qquad \frac{dN}{dM} < 0$$

Case III

Both $\varepsilon_{Z,W}$ and $\varepsilon_{\pi_W,N}$ are large, and thus neither condition (21) nor (22) are satisfied. The determinant Δ is negative. The BL curve is negatively sloped, whilst the CC schedule has a positive slope and is steeper than in the absence of efficiency wage effects (see conditions (22) and (23)). Comparative statics gives (Fig. 4):

$$\frac{dW}{d\tilde{W}} < 0, \qquad \frac{dW}{dP} \gtrless 0, \qquad \frac{dW}{dM} < 0$$

$$\frac{dN}{d\tilde{W}} \gtrless 0, \qquad \frac{dN}{dP} > 0, \qquad \frac{dN}{dM} < 0$$

The only difference relative to case I lies in the responses to the external wage $\tilde{W}$: the wage W should now *decrease*, whereas the effect on N is indeterminate. An increase in $\tilde{W}$ lowers the *status quo* of the union, and the CC shifts downwards to the right. By contrast, in case I and in the presence of homogeneous labour the CC curve moves to the left.

Case IV

The elasticity $\varepsilon_{Z,W}$ is small, while $\varepsilon_{\pi_W,N}$ is large enough to violate condition (22). Both BL and CC schedule are negatively sloped. The sign of the determinant is unclear, and thus it is again necessary to distinguish between two sub-cases.

Sub-case IV(a): $\Delta<0$

The BL curve is steeper than the CC (Fig. 5). The comparative statics is

$$\frac{dW}{d\tilde{W}} \gtrless 0, \qquad \frac{dW}{dP} \gtrless 0, \qquad \frac{dW}{dM} > 0$$

$$\frac{dN}{d\tilde{W}} \gtrless 0, \qquad \frac{dN}{dP} \gtrless 0, \qquad \frac{dN}{dM} < 0$$

Sub-case IV(b): $\Delta>0$

The BL schedule is flatter than the CC (Fig. 6). The comparative statics results are reversed relative to the previous sub-case:

$$\frac{dW}{d\tilde{W}} \gtrless 0, \qquad \frac{dW}{dP} \gtrless 0, \qquad \frac{dW}{dM} < 0$$

$$\frac{dN}{d\tilde{W}} \gtrless 0, \qquad \frac{dN}{dP} \gtrless 0, \qquad \frac{dN}{dM} > 0$$

A remarkable result which emerges from the foregoing analysis is that, in a number of circumstances, the CC schedule presents a negative slope. This is due to the fact that, when efficiency wage effects are important, the isoprofit lines for the firm become highly wage elastic relative to the union indifference curves.

The comparative statics properties of equilibrium are altered in important ways relative to a situation of homogeneous labour force. The direction of the changes depends on the size of the efficiency wage effect, as measured by the marginal increase in the expected average productivity of labour. If this effect is large enough, the firm's concern with the potential adverse selection of its labour force may offset the positive implications on profits of decreases in wages.

The introduction of efficiency wage considerations into a bargaining framework is able to account for some empirical findings of the previous chapter, such as a negative relationship between the alternative wage and the level of employment. However, it does not seem to be generally feasible to assess which one of the possible different cases might be the relevant one in the actual bargaining situations. Conditions (21) and

(22), which identify the regimes, depend on unobservable elasticities. A direct verification of whether they are satisfied does not seem to be feasible.

4. Bargaining outcome and membership

In the previous sections the implications of union size on the bargained wages and employment have been analyzed. With homogeneous labour, increased membership unambiguously leads to lower wages and employment with both a utilitarian and an expected utility union. Since the bargained outcome is affected by membership, there might exist a union size level which maximizes the value of the union objective function. The present section aims to explore this issue, for both functional forms (1) and (1')[10].

The case of homogeneous labour is considered first. It is known from section 2 that at an interior solution one has

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[10]The analysis developed in the text is similar in spirit to the account of union membership which has been provided by Grossman (1983) and Booth (1984). It differs from those models since there labour heterogeneity and a median voter rule are assumed. It also differs from Booth and Ulph (1988) since in the present analysis the direct effects of the union on the firm's outside option are not explicitly considered.

$dW/dM<0$, $dN/dM<0$[11]. With an expected utility objective function (equation (1)) the optimization programme is:

$$(24) \qquad \max \quad U(W,N;M) = \frac{N}{M}U(W) + \frac{M-N}{M}U(\tilde{W})$$

subject to

$$(25a) \qquad W = W(M)$$

$$(25b) \qquad N = N(M)$$

$$(25c) \qquad W \geq \tilde{W}$$

$$(25d) \qquad \Pi(W,N) \geq \Pi^0$$

$$(25e) \qquad N \leq M$$

with $\tilde{W}$, Π^0 exogenously determined. Let ν_1, ν_2, ν_3 be the Kuhn-Tucker multipliers pertaining to constraints (25c), (25d) and (25e) respectively. First-order condition for M is:

$$(26) \quad \left(\underset{(+)(-)}{\frac{\partial U}{\partial W}\frac{dW}{dM}} + \underset{(+)(-)}{\frac{\partial U}{\partial N}\frac{dN}{dM}} + \underset{(-)}{\frac{\partial U}{\partial M}} \right) + \nu_1 \underset{(-)}{\frac{dW}{dM}} + \nu_2 \left(\underset{(-)(-)}{\frac{\partial \Pi}{\partial W}\frac{dW}{dM}} + \underset{(-)(-)}{\frac{\partial \Pi}{\partial N}\frac{dN}{dM}} \right) + \nu_3 \underset{(+)}{\left(1 - \frac{dN}{dM} \right)} = 0$$

The first bracketed term in (26) is negative: hence it must be either $\nu_2>0$, that is

$$(27) \qquad \Pi[W(M),N(M)] = \Pi^0$$

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[11]At the outside options the outcome is unaffected by union size.

or $\nu_3>0$, which would imply N=M. Hence, since Π is a positive function of M *via* W and N, the optimal membership is the largest value consistent with both conditions that profits be no smaller than Π^0 and employment N be no greater than union size.

Let us now consider equation (1'). The maximization problem is

$$(28) \qquad \max_{(M)} \quad V(W,N;M) = NU(W) + (M-N)U(\tilde{W})$$

subject to (25a)-(25e). The only qualitative difference between programmes (24) and (28) lies in the sign of the partial derivative of the objective function with respect to M. This is however sufficient to make the maximand in (28) a positive function of total membership[12]. The constraints on profits, (25d), or on size, (25e), are therefore no longer always binding.

First-order condition for M is now

$$(29)\left(\frac{\partial V}{\partial W}\frac{dW}{dM}+\underset{(+)}{\frac{\partial V}{\partial N}\frac{dN}{dM}}+\frac{\partial V}{\partial M}\right)+\phi_1\underset{(-)}{\frac{dW}{dM}}+\phi_2\left(\underset{(+)}{\frac{\partial \Pi}{\partial W}\frac{dW}{dM}}+\frac{\partial \Pi}{\partial N}\frac{dN}{dM}\right)+\phi_3\left(1-\underset{(+)}{\frac{dN}{dM}}\right)=0$$

The multiplier ϕ_1 on (25c) must be positive, which implies $W=\tilde{W}$. Then $\phi_2=0$ (provided the outside options for the firm and the union do not happen to be simultaneously verified), and if in addition $\phi_3=0$ (i.e. N<M) then equation (29) becomes

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[12]See Appendix E.

$$(29') \qquad -\left[\left(\frac{\partial V}{\partial W}+\phi_1\right)\frac{dW}{dM}+\frac{\partial V}{\partial N}\frac{dN}{dM}\right]=\frac{\partial V}{\partial M}$$

that is, the marginal cost from an increase in membership (LHS of (29')) must equal the marginal benefit.

With homogeneous workers, therefore, assuming either an expected utility or a utilitarian union yields sharply different results, the former leading to lower membership and higher wages and employment than the latter.

With heterogeneous workers this prediction carries through to Cases I and III of Section 3[13], for which $dW/dM<0$ and $dN/dM<0$ still hold true. No general results are available, however, in cases II and IV, in each of which dW/dM and dN/dM have opposite sign. The answer in general depends on the degree of curvature of the utility function relative to the production function and the relative strength of the efficiency wage effect.

5. Conclusions

This chapter has extended the bargaining framework developed in chapter 1. Alternative union objective functions and labour heterogeneity have been allowed for. Some implications of the analysis for union size have also been drawn.

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[13]See Appendix E.

When the union has an expected utility, or a utilitarian, objective function the predicted responses of wages and employment to changes in the exogenous variables are largely the same as for the case of utility rents maximization considered in the previous chapter. A notable exception is represented by the responses to changes in union membership, which are seen to exert a negative effect upon wages and employment.

The presence of labour heterogeneity is modelled by assuming that workers have a continuous variety of outside options. When efficient bargains considerations are combined with efficiency wages, a number of interesting results arise. The isoprofit loci for the firm are shown to be more wage elastic than if labour were homogeneous, and the contract curve is vertical in a number of circumstances. Depending on the relative strength of the efficiency wage effect, the comparative statics properties of the equilibrium will differ from the case of absence of heterogeneity.

Finally, the dependence of union size upon the bargaining outcome has been considered. The results crucially depend on the objective function of the union. In particular, an expected utility union is shown to lead to a lower membership than a utilitarian one.

Appendix A - Efficiency wages and expected productivity

The expected average productivity of the workforce is given by equation (13) in the text. Let $g(W)=G'(W)$: then one has

$$\text{(A1)} \qquad Z'(W) = \frac{g(W)}{[G(W)]^2} \int_0^W [q(W)-q(v)]dG(v)$$

which is positive since $q'(\cdot)>0$. Equation (A1) can alternatively be written as

$$\text{(A2)} \qquad Z'(W) = \frac{g(W)}{G(W)} [q(W)-Z(W)]$$

By comparison of (A1) and (A2) it follows that $q(W)>Z(W)$ for $W>0$, i.e. the marginal productivity must be greater than the average productivity.

The second derivative of $Z(W)$ is

$$\text{(A3)} \qquad Z''(W) = \frac{1}{[G(W)]^2} \Big\{ g'(W)[q(W)-Z(W)]G(W) +$$

$$+ \; g(W)[q'(W)-Z'(W)]G(W) + [g(W)]^2[q(W)-Z(W)] \Big\}$$

$$\propto (g'G-g)^2(q-Z) + gG(q'-Z')$$

$$\propto \frac{W(g'G-g^2)}{gG} + \frac{W(q'-Z')}{q-Z}$$

$$= \frac{Wg'}{g} - \frac{Wg}{G} - \frac{W(q'-Z')}{q-Z}$$

which is negative if and only if

$$\text{(A4)} \qquad \frac{W(q'-Z')}{q-Z} < \frac{Wg}{G} - \frac{Wg'}{g}$$

The LHS of condition (A4) is the wage elasticity of the excess surplus of the marginal over average productivity. The RHS is the difference between the wage elasticities of the distribution function and of the density function. A high positive wage response of the marginal relative to the average productivity would make it less likely that $Z''(W)$ might be negative. On the other hand, a 'steep' (highly wage elastic) distribution function relative to the density, or a negatively sloped density, would lead to a negative value of $Z''(W)$.

The assumption $Z''(W)<0$ made in the text can thus be justified on the grounds that large increases in productivity can only be observed over a range of values for wages characterized by a decreasing density function.

Appendix B - Employment elasticity of Π_W

By making use of equation (15) in the text for profits, the coefficient a_{21} in (20) can be written as

$$a_{21} = U''(PZF'-W)-(U-\tilde{U})[PZ''F'+PN(Z')^2F'']+U'PZZ'NF''$$

$$= U''\Pi_N - (U-\tilde{U})(\Pi_{WW}/N) + U'\Pi_{NW} - U'(\Pi_W/N)$$

where

$$\Pi_W = (PZ'F'-1)N$$

$$\Pi_N = PZF'-W$$

$$\Pi_{WW} = PZ''NF' + P(Z')^2N^2F''$$

$$\Pi_{NW} = PZ'F' + PZZ'NF'' - 1$$

Hence,

$$a_{21} \propto U'(N\Pi_{NW}-\Pi_W) - (U-\tilde{U})\Pi_{WW} + U''N\Pi_N$$

and $a_{21}>0$ iff

$$1 + \frac{\varepsilon_{\pi_W, N}}{\varepsilon_{U, N}} - \varepsilon_{U', N} \; \frac{\varepsilon_{\pi, N}}{\varepsilon_{\pi, W}} - \varepsilon_{\pi_W, N} > 0$$

which coincides with condition (22) in the text.

Appendix C - Contract curve and labour heterogeneity

The equation of the contract curve is given by (19b) in the text. Its slope is given by

$$\frac{dW}{dN} = -\frac{U'PZ^2F''-(U-\tilde{U})PZZ'F''}{U''(PZF'-W)-(U-\tilde{U})[PZ''F'+PN(Z')^2F'']+U'PZZ'NF''}$$

which is steeper than in the absence of heterogeneity (that is, if $Z'=0$) if the following sufficient condition is met:

$$ZZ'NF'' - \frac{(U-\tilde{U})}{U'}[Z''F'+N(Z')^2F''] < 0$$

which can be expressed as

$$N\Pi_{NW} - \Pi_W - \frac{U-\tilde{U}}{U'}\Pi_{WW} < 0$$

After some algebraic manipulations, and remembering that $\Pi_W<0$, one obtains condition (23) in the text.

Appendix D - Union rents maximization and efficiency wages

Let us assume that the union's utility is as in chapter 1, that is

$$(D1) \qquad U(W,N) = N\cdot[V(W) - V(\tilde{W})]$$

The first-order conditions for an efficient bargain are

$$(D2a) \qquad V'(W)\,\{PF[Z(W)N] - WN\} + \\ + N\cdot[V(W) - V(\tilde{W})]\,\{PZ'(W)F'[Z(W)N] - 1\} = 0$$

$$(D2b) \qquad [V(W) - V(\tilde{W})]\,\{PZ'(W)F'[Z(W)N] - 1\} + \\ - V'(W)\,\{PZ(W)F'[Z(W)N] - W\} = 0$$

By totally differentiating (D2a) and (D2b) one obtains

$$(D3a) \qquad \{V''(PF-WN) + 2V'(PZ'NF'-W) + N(V-\tilde{V})(PZ''F'+PZ'^{2}NF'')\}\,dW \\ + \{V'(PZF'-W) + (V-\tilde{V})(PZ'F'-1) + N(V-\tilde{V})(PZZ'F''\}\,dN \\ = -\{V'F + N(V-\tilde{V})Z'F'\}\,dP + N\tilde{V}'(PZ'F'-1)\,d\tilde{W}$$

$$(D3b) \qquad \{U''(PZF'-W)-(U-\tilde{U})[PZ''F'+PN(Z')^{2}F'']+U'PZZ'NF''\}\,dW \\ + \{U'PZ^{2}F''-(U-\tilde{U})PZZ'F''\}\,dN \\ = -(PZ'F'-1)\tilde{U}'\,d\tilde{W} + [(U-\tilde{U})Z'F'-U'ZF']\,dP$$

It is apparent that the comparative statics results with respect to the price level P are unchanged relative to the expected utility function. The properties related to the alternative wage $\tilde{W}$ are instead modified as follows.

Case I.	$\frac{dW}{d\tilde{W}} > 0$	$\frac{dN}{d\tilde{W}} \gtrless 0$
Case II.	$\frac{dW}{d\tilde{W}} \gtrless 0$	$\frac{dN}{d\tilde{W}} \gtrless 0$
Case III.	$\frac{dW}{d\tilde{W}} \gtrless 0$	$\frac{dN}{d\tilde{W}} > 0$
Case IV.		
Sub-case (a)	$\frac{dW}{d\tilde{W}} < 0$	$\frac{dN}{d\tilde{W}} > 0$
Sub-case (b)	$\frac{dW}{d\tilde{W}} > 0$	$\frac{dN}{d\tilde{W}} < 0$

Appendix E - Utilitarian union and membership

Let us consider the maximization programme (28) subject to (25a)-(25d).

(a) Homogeneous labour

$$\text{(E1)}\qquad \frac{dV}{dM} \propto PNF''(U')^2\tilde{U} - (PF'-W)U''\tilde{U}(U-\tilde{U}) + \{[(PF'-W)u''-2NU']PF''U'$$

$$- (PF-WN)U''[U'(PF'-W)-(U-\tilde{U})]\}\ \tilde{U}$$

Upon making use of the first-order conditions and simplifying, one has

$$\text{(E2)}\qquad \frac{dV}{dM} \propto PF''(PF-WN)U'U'' - PNF''(U')^2 - (PF'-W)^2U'U'' > 0$$

(b) Heterogeneous labour

$$\text{(E3)}\qquad \Delta\,\frac{1}{\tilde{U}}\,\frac{dV}{dM} = (1-PZ'F')NU'[-PZZ'F''(U-\tilde{U})+PZ^2F''U'] - (1-PZ'F')\cdot$$

$$(U-\tilde{U})\cdot\{-[PZ''F'+PN(Z')^2F''(U-\tilde{U})+(PZF'-W)U''+PNZZ'F''U'\} + \Delta$$

where $\Delta \equiv a_{11}a_{22}-a_{12}a_{21}$. After substituting out and simplifying, one obtains

$$\text{(E4)} \quad \Delta = (PF-WN)PZ^2F''U'U'' - 4(PZF'-W)PNZZ'F''(U')^2$$
$$+ 2(PZ'F'-1)PNZ^2F''(U')^2 + P^2Z^2Z''F'F''U'[NU+(M-N)\tilde{U}]$$
$$+ 2(PZF'-W)[PZ''F'+PN(Z')^2F'']U'(U-\tilde{U}) - 2(PZF'-W)^2U'U''$$

By combining (D3) and (D4) and further simplifying, one has

$$\Delta \frac{1}{\tilde{U}} \frac{dV}{dM} = (PF-WN)PZ^2F''U'U'' - 2(PZF'-W)PNZZ'G''(U')^2$$
$$+ (PZ'F'-1)PNZ^2F''(U')^2 + [NU+(M-N)\tilde{U}]P^2Z^2Z''F'F''U'$$
$$+ (PZF'-W)P[Z''F'+N(Z')^2F'']U'(U-\tilde{U}) - PZF'-W)^2U'U''$$
$$= PZ^2Z''F'F''U'[NU+(M-N)\tilde{U}] \qquad \text{(a)}$$
$$+ (1-PZ'F')PZF''NU'[Z'(U-\tilde{U})-ZU'] \qquad \text{(b)}$$
$$+ (1-PZ'F')P(U-\tilde{U})\{ZZ'NF''U'-(U-\tilde{U})Z''F'\} \qquad \text{(c)}$$
$$+ (1-PZ'F')(U-\tilde{U})^2PNZ'^2F'' \qquad \text{(d)}$$
$$+ (1-PZ'F')U''(U-\tilde{U})(PZF'-W) \qquad \text{(e)}$$
$$+ PZ^2F''U'U''(PF-WN) \qquad \text{(f)}$$

The expressions (d), (e) and (f) are always positive, (a) is positive since $Z''(w)<0$, (b) is positive iff $WZ'/Z<WU'/U$, and (c) is positive iff

$$\frac{WZ''}{Z'} \frac{1}{Z} < \frac{WU'}{U-\tilde{U}} \frac{NF''}{F'}$$

Figure 1 - Homogeneous labour: interior solution

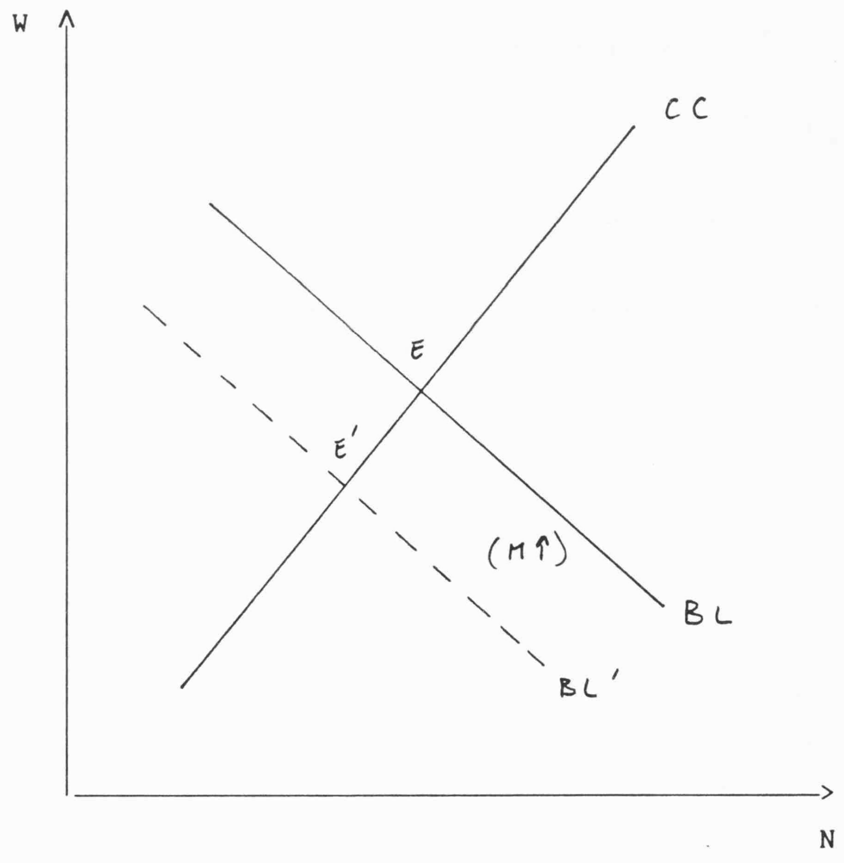


Figure 2 - Heterogeneous labour: Case II(a)

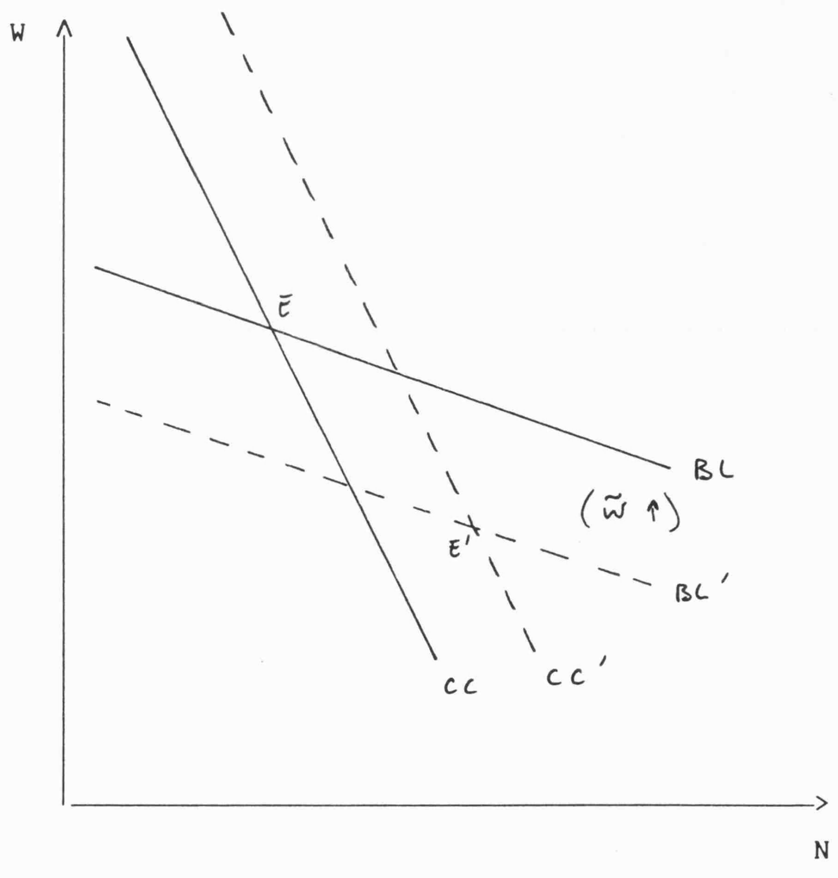


Figure 3 - Heterogeneous labour: Case II(b)

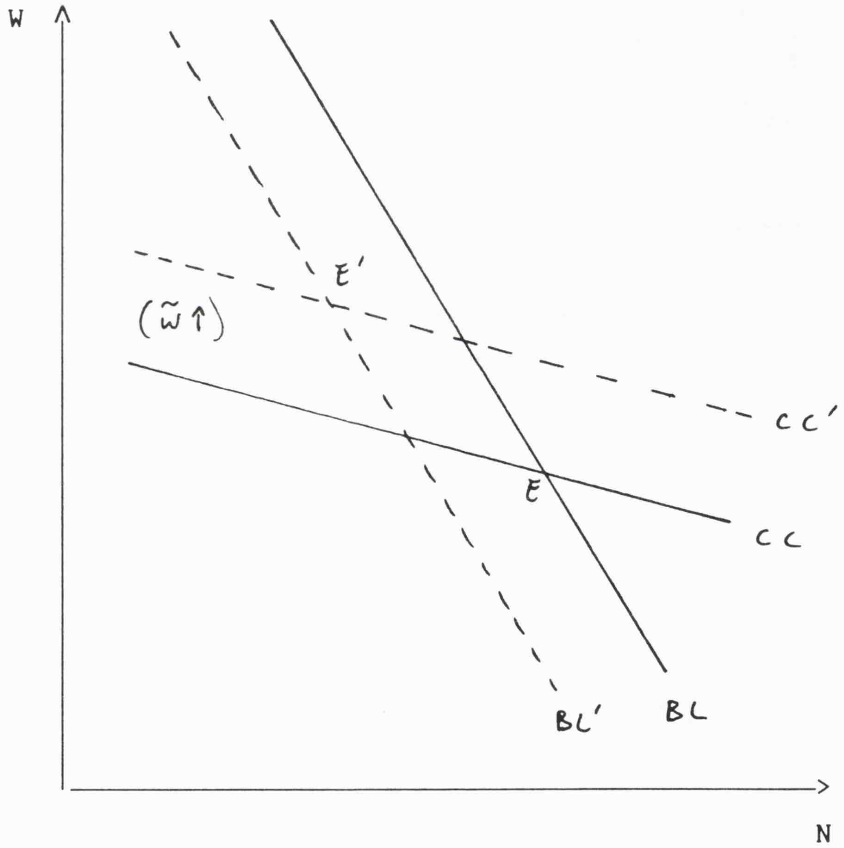


Figure 4 - Heterogeneous labour: Case III

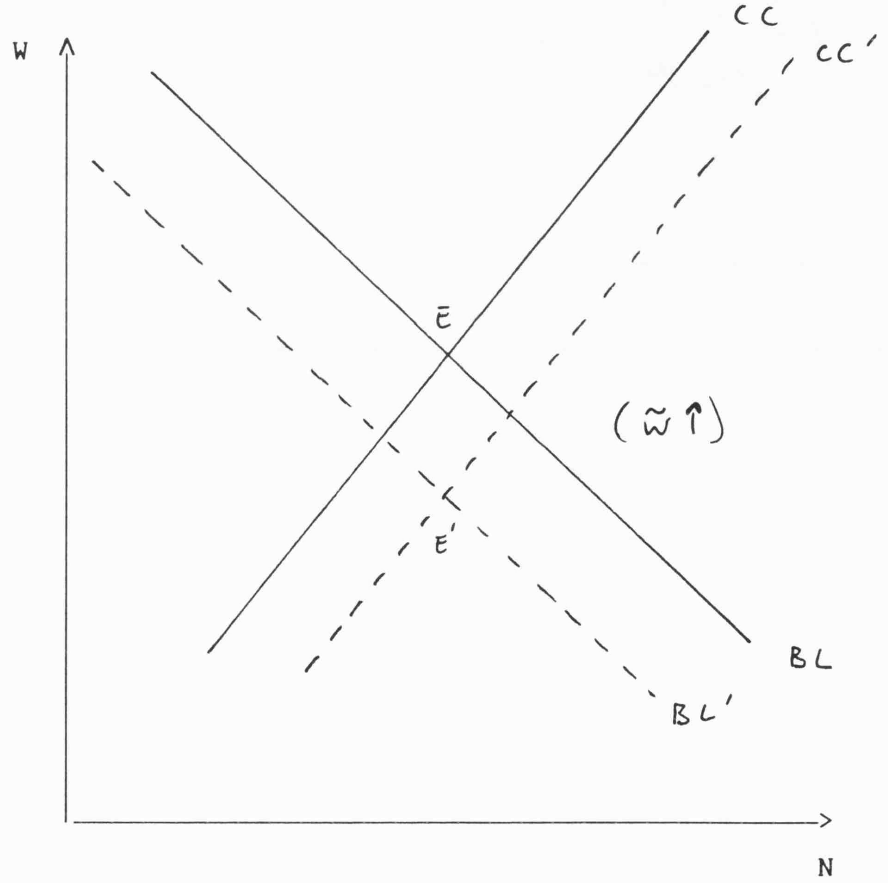
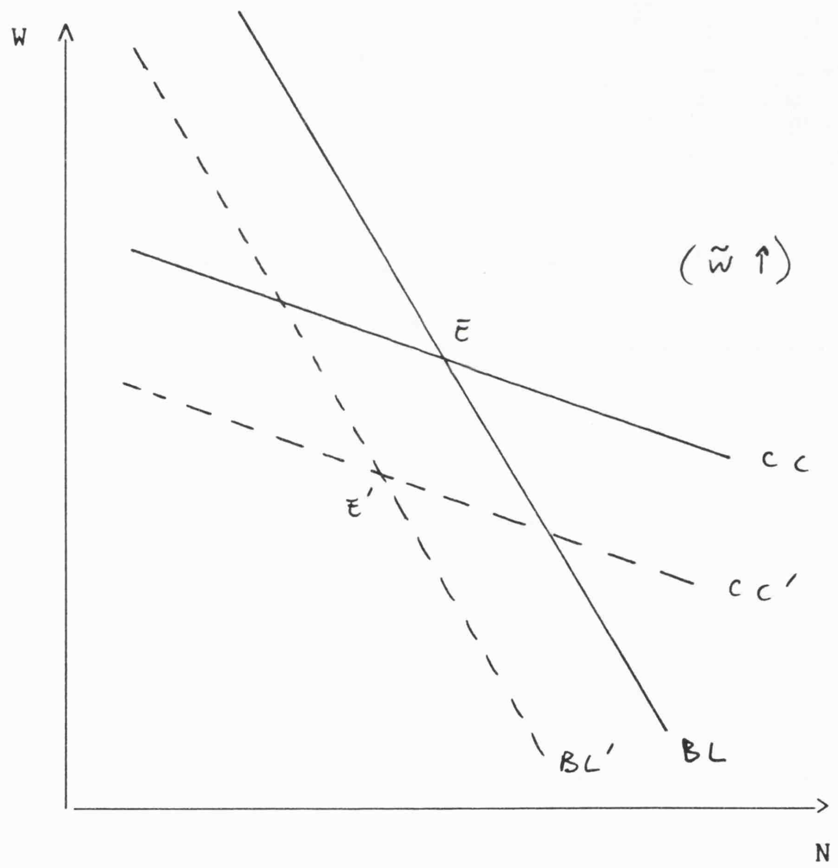
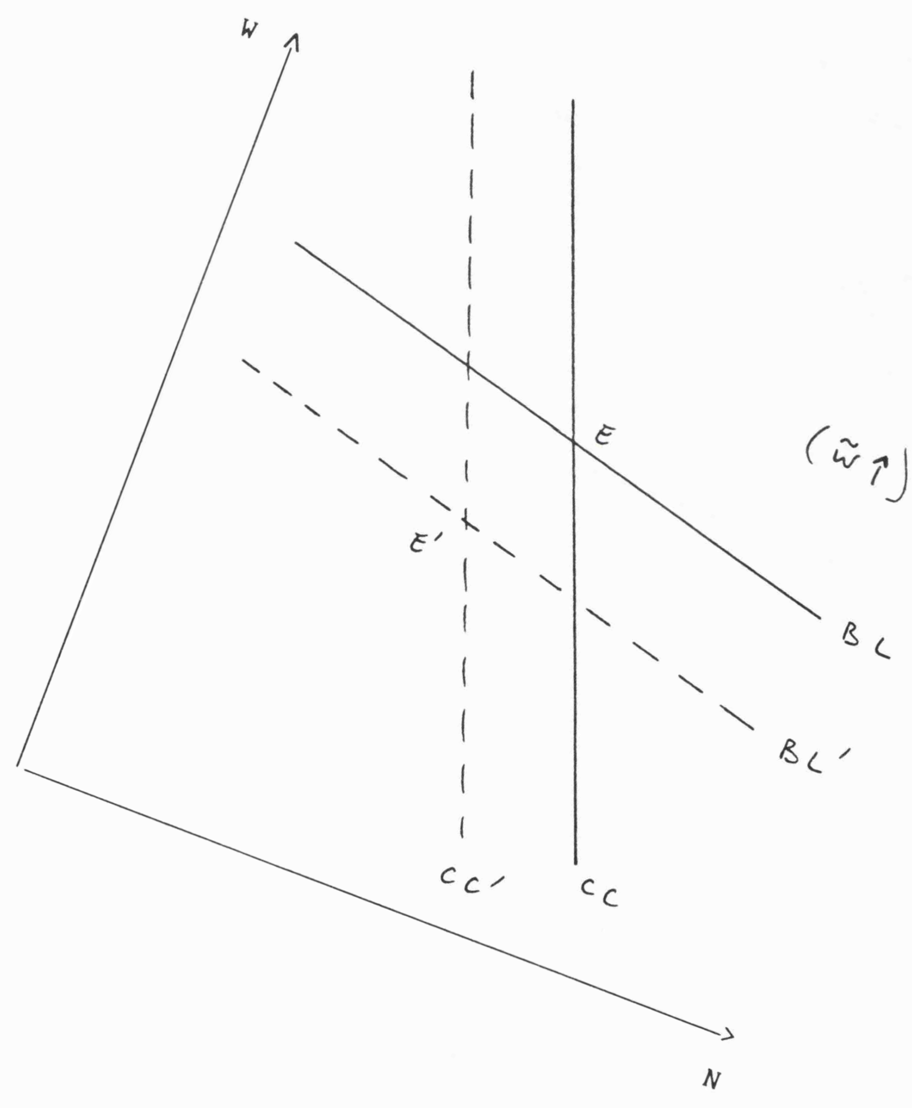


Figure 5 - Heterogeneous labour: Case IV(a)



<u>Figure 6</u> - Heterogeneous labour: Case IV(b)



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PART II

CHAPTER 3

WAGE AND PRICE FLEXIBILITY, INFLATION EXPECTATIONS AND VARIABILITY OF OUTPUT

1. Introduction

The previous chapters have addressed the issue of the determination of wages and employment at the level of individual firms. Empirical observations are seen to be consistent with the presence of bargaining between firms and workers. Important non-competitive elements are thus present in the labour market.

In the present and the following chapters I explore some macroeconomic implications of the existence of microeconomic rigidities[1]. Specifically, I investigate the issue of whether the existence of predetermined wages and prices can lead to an increased variability of activity and employment levels. The channel through which such a destabilization might occur is represented by expectations of the future price level. If wages and prices are set in advance of the realization of stochastic shocks, uncertainty in the economy about future variables is reduced. On the other hand, rigid wages and prices may cause expectations to react in a destabilizing fashion to such shocks.

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[1]The literature on the relationship between nominal/real rigidities and business cycle theory is surveyed and critically assessed by Blanchard and Fischer (1989).

The net outcome could in principle be ambiguous: output and employment can be either more or less variable as a result of increased wage and price flexibility, according as to how exactly wages and prices are determined, to the nature of the shocks, and to the process by which expectations of future prices are formed.

Some recent literature has looked at this problem from a modern perspective (important contributions were put forward by, amongst others, DeLong and Summers (1986a, 1986b, 1988), Driskill and Sheffrin (1986), Hahn and Solow (1986), and Taylor (1986a); for critical assessments one can see Fischer (1988), Blanchard and Fischer (1989), Blanchard (1990)). The issue is however not a new one: the awareness of its relevance dates back at least since the Keynes-Pigou controversy about whether increased price flexibility is always capable of restoring a market clearing equilibrium, starting from a condition of underemployment[2]. Pigou was able to establish that the real wealth effect on consumption following a price deflation must lead to a recovery of employment and activity levels.

A different perspective had been taken up by Fisher (1923, 1925, 1933) who focusses on the disruption to financial markets and institutions occurring whilst a deflation is taking place. The starting point of Fisher's analysis was the observed positive correlation between (a distributed lag of) price changes and an indicator of trade volume. The argument for a deflation-based

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[2]See Keynes (1936) and Pigou (1943, 1947).

theory of business cycles relies on debt liquidation and distress selling when borrowers are over-exposed. The resulting fall in prices reduces net profits, with the initial fall in output and employment being further aggravated by the ensuing pessimism and loss of confidence. Mundell (1963) shows that anticipated inflation can have real effects in a Meltzer-type framework where wealth can be held in the form of either money or shares[3].

In the present and the following chapters the relationship between wage and price flexibility and output variability is analyzed in a framework in which the possible channel for destabilization is the expected inflation effect on aggregate demand. The emphasis is placed upon labour contracts and imperfections in the labour and product markets. Following a demand shock, the movement in the aggregate price level acts as an automatic stabilizer due to a real balance effect. Current expectations of future inflation, however, may play a destabilizing role *via* changes in the *ex ante* real rate of interest if expected inflation moves procyclically. Whether expected inflation exacerbates output and employment fluctuations depends on the characteristics of the shocks from which the

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[3]Theories of depressions based on similar arguments have been proposed again recently by Bernanke (1983), Bernanke and Gertler (1989), and Calomiris and Hubbard (1989) amongst others. This research programme relates macroeconomic fluctuations to agency costs in firms and credit institutions.

economy is affected, on the mechanism whereby expectations are formed, and on the precise nature of the rigidities in the labour and product markets.

The net effect of an increase in wage and price flexibility is in general ambiguous due to second-best considerations. As a consequence of the existence of imperfections in the economy, an increased response of wages and prices to labour and product market imbalances might in principle have perverse effects. A countercyclical demand management policy can be more effective in dampening output fluctuations than a policy aimed at reducing rigidities in the labour market. The present chapter aims to provide a critical assessment of this issue and to furnish a selected survey of the related literature. The review is by no means exhaustive, its main purpose being to introduce the analyses of chapters 4 and 5 and relate them to previous contributions.

The structure of this chapter is as follows. The next section analyses the dynamic stability of a system with expected inflation, under both adaptive and rational expectations. Section 3 looks at Taylor-type models with staggering of wages and prices. In section 4 alternative supply-side specifications are proposed and wage flexibility is seen to decrease output variability in a model with synchronized wage contracts and uncorrelated demand shocks. Section 5 summarizes the results and provides a description of the following chapters.

2. Dynamic stability of equilibrium

The question of whether a market economy might ever be unable to remedy to a protracted disequilibrium in the goods market has been elegantly addressed by Tobin (1975) in an explicitly dynamic framework (see also Tobin (1980)). Effective demand, e, depends positively on real output, y, negatively on the price level, p (due to both a Keynes effect on real balances and a Pigou effect on wealth), and positively on expected inflation, $\pi^e \equiv \dot{p}^e/p$, *via* changes in the *ex ante* real rate of interest[4]: $e=e(y,p,\pi^e)$, where $0<e_y<1$, $e_p<0$, $e_{\pi^e}>0$. The supply side of the economy is characterized by adjustment of output to effective demand (equation (1)), by an expectations-augmented Phillips curve (equation (2)), and by an adaptive rule of expectations formation (equation (3))[5]:

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[4]The assumption is made that the expansionary effect of expected inflation outweighs the capital losses incurred by holders of money balances.

[5]Tobin contrasts this model (which he defines as the Walras-Keynes-Phillips adjustment system) to a Marshallian model, in which *prices* - rather than quantities - respond to an excess of demand over output, and where the level of activity reacts to deviations from full employment *via* changes in factor prices. The Marshallian system is shown to be always dynamically stable.

(1) $\dot{y} = a_y(e-y)$

(2) $\pi = a_p(y-y^*) + \pi^e$

(3) $\dot{\pi}^e = a_{\pi^e}(\pi-\pi^e)$

Equations (1)-(3) describe a dynamical system in the variables (y, p, π^e). Necessary condition for local stability is

(4) $$\underset{(-)}{p^* e_p} + \underset{(+)}{a_{\pi^e}} \cdot \underset{(+)}{e_{\pi^e}} < 0$$

where p^* is the equilibrium value of prices. It is easily seen that, for a given expectations formation parameter a_{π^e}, the condition (4) is not satisfied if the stabilizing role of e_p is small vis-à-vis the "speculative" effect of inflation expectations upon aggregate demand as measured by e_{π^e}.

An intuitive account for this result can be as follows. When output is lower than its full employment level, current prices increase by less than expected, thereby stimulating aggregate demand through a real balance effect. By contrast, a negative inflationary surprise implies a downward revision of current expectations of future inflation, due to the adaptive rule of expectations formation. This will increase the expected *ex ante* real interest rate and depress aggregate demand. The latter effect may well outweigh the former, thus violating condition (4).

The assumption of adaptive expectations is crucial in driving the results. It implies that, in the presence of an inflationary surprise, expectations are always revised *in the same direction* as the shock. On the other hand, if agents are entirely backward-looking, they only gradually adjust their inflation expectations to a permanent shock to the level of activity. Hence, they will be systematically surprised by the realized inflation level in each period.

By contrast to Tobin's analysis, McCallum (1983b) shows that, if rational expectations are introduced, the system is stable even in the presence of a "liquidity trap" in money demand - and hence without a stabilizing Keynes effect on aggregate demand for output - provided a Pigou effect on consumption is in operation. The discrete-time specification of the model is very similar to Tobin's continuous-time analytical framework. Aggregate demand is given by

$$(5) \qquad e_t = b_0 + b_1 y_t + b_2 r_t + b_3(E_t p_{t+1} - p_t) + b_4(m_t - p_t) + v_t$$

where $b_4>0$ reflects the Pigou effect and where v_t is a white noise aggregate demand disturbance. The monetary rule consists of pegging the nominal interest rate: $r_t=r$. The adjustment equation for output is

$$(6) \qquad y_t - y_{t-1} = \lambda(e_t - y_{t-1}) \qquad 0<\lambda<1$$

The model is closed by a Lucas-Sargent-Wallace surprise supply function, augmented to allow for adjustment costs to the level of activity:

(7) $$y_t-\bar{y} = \alpha_1(p_t-E_{t-1}p_t) + \alpha_2(y_{t-1}-\bar{y}) + u_t$$

The minimal state solution, which by construction rules out bubbles or explosive paths, can be found by the method of undetermined coefficients and has the form

(8) $$y_t-\bar{y} = \alpha_2(y_{t-1}-\bar{y}) + \xi_t$$

where α_2 is the coefficient on lagged output in (7). Thus, the dynamic stability of the system directly follows from the stability of aggregate supply (7). Hence, McCallum argues that there is "no support for Tobin's suggestion that the system lacks self-correcting mechanisms - i.e., is dynamically unstable - in the presence of a Pigou effect" (1983b, p. 400). Clearly, the assumption of rational expectations is critical to this conclusion. Lower than expected *current* inflation does not imply lower current expectations of *future* inflation. Hence, the destabilizing mechanism envisaged by Tobin is no longer at work[6].

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[6]In Chapter 4 it is shown that, in a flexible price model similar to McCallum's, inflation expectations increase output variability if demand shocks display a sufficiently high degree of serial correlation. McCallum's results seem thus to depend critically

3. Staggered wages and prices

Several attempts have been recently put forward in order to justify a destabilizing role for wages and price flexibility in a rational expectations framework. DeLong and Summers (1986a) maintain that the lower output variability in the post-World-War-II US economy relative to the pre-War period is largely due to a greater degree of predetermination of wages and prices. They do not however explicitly control for the counter-cyclical stance of monetary and fiscal policy in the more recent period[7]. Moreover, as Taylor (1986a, 1986b) points out, they do not allow for the fact that the variance of the shocks from which the US economy was affected after WW-II is lower than before the war.

The DeLong-Summers explanation is also criticized by Driskill and Sheffrin (1986), who consider a staggered wage model à-la Taylor modified to incorporate an expected inflation effect on aggregate demand. Driskill and Sheffrin consider the responses of the economy to wage-push shocks of the type considered by Taylor (1979, 1980). They conclude that the expected inflation effect is always stabilizing in the presence of such supply shocks.

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upon assuming white noise aggregate demand disturbances.

[7]Barro (1989), for instance, argues that there is evidence that the FED has engaged in countercyclical monetary policy since World War II.

Positive wage or price surprises are in fact always accompanied by a decrease in the *ex ante* real interest rate. The contractionary effects of the shock are thus offset by an increase in aggregate demand. The expected inflation effect acts as an automatic stabilizer in the face of cost-push shocks.

DeLong and Summers (1986b) however contend that one should be concerned with the responses of the level of activity to *demand* disturbances. If one shares the Keynesian tenet that the business cycle is largely induced by fluctuations to the level of aggregate demand, the critical issue becomes whether expected inflation is stabilizing in the presence of such shocks. Furthermore, DeLong and Summers argue that, for the effects of the demand disturbances to persist over the cycle, it is necessary to assume that the shocks are serially correlated. The model which they consider has the following structure:

$$(9) \qquad y_t = -a\ [i_t-(E_t p_{t+1}-p_t)] + \eta_t$$

$$(10) \qquad \eta_t = \rho\eta_{t-1} + \varepsilon_t$$

$$(11) \qquad m_t = p_t + y_t - vi_t$$

$$(12) \qquad m_t = \beta i_t$$

$$(13) \qquad w_t = \frac{1}{2}\ (w_{t-1}+E_{t-1}w_{t+1}) + \frac{1}{2}\ g(E_{t-1}y_t+E_{t-1}y_{t+1})$$

$$(14) \qquad p_t = \frac{1}{2}\ (w_t+w_{t-1})$$

Equations (9)-(12) characterize the demand side, whereas equations (13)-(14) describe the supply side of the economy. The IS schedule is given by (9), with stationary AR(1) demand shocks as in (10). Equation (11) is the LM curve, with velocity being a positive function of the nominal interest rate. The monetary authorities follow the policy rule (12), thereby making money supply an endogenous variable. Equation (13) is a standard Taylor-type wage setting rule, with equal weights being put on the backward- and the forward-looking components. Prices are finally given in (14) under uniform staggering as a constant mark-up on wages.

Aggregate demand is obtained by combining (9)-(12):

$$(15) \qquad y_t = k\cdot\{a[(E_t p_{t+1}-p_t)-(\beta+v)^{-1}p_t]+\eta_t\}$$

Prices exert a role on aggregate demand through both a level and an expected inflation effect. The former is always stabilizing, whereas the latter could be destabilizing. No clear-cut analytical results are available. However, DeLong and Summers' numerical simulations show that, as g increases, the steady state variance of output typically increases, provided demand shocks are not close to following a random walk. Similar results are obtained if the contract length increases for a given period unit, or alternatively if the period unit is shortened. From this, DeLong and Summers infer that increases in wage and price flexibility would be destabilizing, for empirically plausible parameter values.

Some remarks are in order on these results. First, it should be noticed that DeLong and Summers interpret destabilization of the activity level in the sense of an increase in the asymptotic variance of output, and not as dynamic instability of the system. Second, by admission of the authors, a steep AD (i.e., a flat LM and/or a steep IS) is required in order to generate the destabilizing outcome. Third, the parameter measuring the response of wages to excess demand conditions, g, is only allowed to vary in the interval [0,1]. This implies that the AS schedule is constrained to be relatively flat on the output-price plane. With a steep AS, increased wage flexibility might again be stabilizing.

The analytical set-up of DeLong and Summers has been criticized by King (1988) on the grounds that it does not allow for any contemporaneous response of wages and prices to demand shocks. If a fraction of wages is set in a spot market, and is thus able to immediately react to current shocks, then the asymptotic variance of output is always a decreasing function of g, provided the proportion of wages determined in the spot sector is not too small. In their reply, DeLong and Summers (1988) argue that King's results are crucially driven by his assumption that wages are a jump variable. This assumption is not realistic, in their opinion: in a contracting framework, nominal wages should properly be modelled as being predetermined. If numerical simulations are carried out with predetermined wages in the spot sector then again wage flexibility is destabilizing.

In a recent paper, Ambler and Phaneuf (1989) look at a further modification to Taylor's model. Wage setters are assumed to be endowed with the same information set as the investors. They are therefore able to observe the current value of shocks *before* wages are determined. With positively correlated demand shocks, the steady-state variance of output often decreases as the flexibility of wages increases. Price flexibility is stabilizing the more, the greater is the weight being placed upon the forward-looking component in wage setting. However, a criticism similar to the one addressed to King's (1988) procedure can be applied to this case as well. Nominal wages effectively behave as a jump variable, and this assumption is questionable in a contracting set-up. If individual wage setting is staggered over time and the realization of current demand shocks is not known at the time when wages are set, then increased flexibility may well exacerbate output fluctuations.

4. Some alternative supply-side specifications

In the previous section it was shown that, when wages are staggered over time in a Taylor-type fashion, aggregate demand depends on expected inflation and demand shocks are autocorrelated, then increased flexibility may be destabilizing in the sense of involving a larger asymptotic variance of output. It could be argued that this outcome crucially depends on specific features of Taylor's model. In the present section I look at alternative ways to characterize the supply side of the economy. I start with Hahn and Solow's (1986) overlapping generations model, and then I furnish some comments on Flemming's (1987) analysis which assumes a gradual adjustment of wages towards their equilibrium level. Finally, an example with rational expectations is presented in which increased price flexibility has the effect of reducing the asymptotic (steady-state) variance of output. The expected inflation effect on aggregate demand is seen to unambiguously decrease output variability, provided the system is stable. However, this result relies on assuming white noise demand shocks. Furthermore, the presence of the expected inflation effect makes it *less* likely that the condition for dynamic stability is satisfied.

Hahn and Solow (1986) make use of an OLG model to contrast an economy with wage flexibility to another with a fixed wage but in which an active monetary policy is pursued. Agents are assumed to live for three periods. They invest when they are young, produce when they are middle-aged, and consume when they are old. By considering a three-period overlapping generations framework, Hahn and Solow are able to include capital as a state variable in a monetary economy. Production, investment and prices evolve according to a non-linear third-order difference equation, which, as expected, turns out to be very sensitive to the arbitrary initial conditions. Few analytical results are therefore available. It seems however that active monetary policy dominates increased wage flexibility as far as the stability properties of the system are concerned. This conclusion is perfectly consistent with the results reported in the chapter 5, where it is shown that active policy can be effective in reducing the negative externalities from decentralized price setting in a monopolistically competitive set-up.

Flemming (1987) looks at the stability properties of the equilibrium of an economy in which wages are sluggish and only gradually adjust to their equilibrium values, whereas prices instantaneously clear the goods market given the nominal wage. In this fashion, real wages effectively behave as a jump variable. Demand disturbances follow a random walk, and agents' expectations are rationally formed. For a certain range of parameter values, increases in the response of wages to the wage gap might be destabilizing. This is attributed to the fact that "greater wage flexibility implies a reduced responsiveness of prices to wages and thus greater sensitivity of both real wages and employment to disturbances" (Flemming (1987), p. 162). These results are consistent with our findings of chapter 4, where a variant of Fischer's overlapping wage contracts model is analyzed. In Flemming's original article, however, it does not seem to be fully appreciated that the destabilizing outcome critically depends on assuming random walk aggregate demand shocks. As shown in chapter 4, it is the presence of highly correlated demand disturbances that makes expected inflation move procyclically, and this widens output fluctuations.

The final model considered in the present section has been proposed by McCallum (1983b). It is a variant of the specification already discussed in section 2. In modelling the supply side of the economy, use is made of a discrete-time version of Mussa's (1981) continuous-time price adjustment rule[8]. Here, demand shocks are assumed to follow a white noise pattern. Positive costs of changing prices, and uniform staggering of individual price setting decisions, lead to an equation for the aggregate price level characterized by gradual adjustment to the equilibrium (market-clearing) level. McCallum looks at the dynamic stability properties of the model to infer that, even under sluggishness of prices, rational expectations imply that the system does not exhibit asymptotic instability. In the present section, I analyze the specific relationship between price flexibility, inflation expectations, and variability of output. It is shown that an increased response of prices to excess output demand decreases the asymptotic variability of the activity level. provided the model is stable. Also, the expected inflation effect is always seen to dampen output variability. However, the dynamic stability requirements are *less* likely to be met in the presence of the expected inflation effect and of a high degree of price flexibility.

Aggregate prices obey the following rule:

$$(16) \qquad p_t - p_{t-1} = \gamma(y_{t-1} - \bar{y}) + E_{t-1}(p^*_t - p^*_{t-1})$$

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[8]A rationale for the postulated price rule can be found in McCallum (1980). A forthright criticism of McCallum's formulation has been expressed by Buiter (1980).

where p_t^* is the market-clearing price level. Equation (16) is very similar to an expectations-augmented Phillips curve. The only difference lies in the fact that the expectations term does not refer to actual inflation, but to changes in the *equilibrium value* of the price level. One can combine (5) and (6) from Section 2 to obtain

$$(17) \qquad y_t = \beta_0 + \beta_1(E_t p_{t+1} - p_t) + \beta_2(m - p_t) + \beta_3 y_{t-1} + u_t$$

where u_t is serially uncorrelated. Use has been made of the assumption that the LM schedule is horizontal, and that therefore one can set $m_t = m$. Due to the liquidity trap, no stabilizing Keynes effect is present in equation (17), so that one is left with the expected inflation effect operating in isolation. After setting $\psi_t \equiv y_t - \bar{y}$, the reduced form for the deviations of output from its natural level is

$$(18) \qquad \psi_t = \phi\psi_{t-1} + \varepsilon_t$$

where

$$(19) \qquad \phi \equiv 1 - \frac{\gamma\lambda(b_3+b_4)}{1-\lambda b_1}$$

It is easily seen that $\phi<1$ is always satisfied, while it cannot be ruled out on *a priori* grounds that $\phi<-1$. McCallum however argues that this inequality is unlikely to be met, for plausible values of the parameters. The system is then stationary, and the asymptotic variance of the deviations of output from its market clearing level is given by

$$(20) \qquad \sigma_{\psi}^{2} = \theta\sigma_{\varepsilon}^{2}$$

where $\theta \equiv 1/(1-\phi^{2})$. One can show that

$$\frac{\partial\sigma_{\psi}^{2}}{\partial\gamma} = - \quad 2\phi\theta^{2} \quad \frac{\lambda(b_{3}+b_{4})}{1-\lambda b_{1}} \quad \sigma_{\varepsilon}^{2} < 0$$

$$\frac{\partial\sigma_{\psi}^{2}}{\partial b_{3}} = - \quad 2\phi\theta^{2} \quad \frac{\gamma\lambda}{1-\lambda b_{1}} \quad \sigma_{\varepsilon}^{2} < 0$$

since $0<\lambda b_{1}<1$. Hence, increases in the wage flexibility parameter γ, or in the coefficient of expected inflation b_{3}, have the effect of *reducing* the asymptotic variability of output around its equilibrium level. On the other hand, it is apparent from (19) that an increase in wage flexibility or in the coefficient pertaining to expected inflation would make it less likely that the stationarity condition $\phi>-1$ be met. The system could thus exhibit dynamic instability.

It should be noticed that the aggregate price equation (16) is very close in spirit to a Lucas-Sargent-Wallace specification of a "surprise" aggregate supply function[9]. As shown in the next chapter, the reduction of output variability critically hinges upon assuming uncorrelated demand shocks. In this case, expected inflation moves countercyclically and dampens output fluctuations. If demand shocks were to be highly serially correlated, a destabilizing outcome would ensue.

5. Conclusions and outline of the next chapters

The present chapter has assessed some recent literature on the relationship between wage/price flexibility and output variability, in the presence of an expected inflation effect on aggregate demand. The process of expectations formation is clearly crucial. Under an adaptive rule expected inflation moves in a procyclical fashion, thus exacerbating the effects of shocks. Under rational expectations, one should consider both the exact form of wage/price stickiness and the degree of autocorrelation of the demand shocks in order to determine the possible destabilizing effect of increased wage and price flexibility.

This chapter has looked at models with wage staggering à-la Taylor or *ad hoc* price adjustment rules. Chapter 4 investigates the possibility of destabilizing inflation expectations in a variant of Fischer's (1977) overlapping wage contract model, and

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[9]See Buiter (1980).

derives analytical conditions for output destabilization to occur. It also shows that price stickiness is neither a necessary nor a sufficient condition for destabilization. By making use of a Sargent-Wallace surprise supply function and of a Lucas equilibrium model with signal extraction, it demonstrates that the crucial condition is the degree of serial correlation of the demand shocks. Destabilization of output is thus perfectly consistent with price flexibility of a new classical variety.

Chapter 5 looks at a monopolistic competition model with synchronized wage contracts. Under decentralized price setting, individual firms do not internalize the effects that their price decision exerts upon the aggregate price level. It is shown that, in such a monopolistically competitive framework, the consideration of the expected inflation effect always makes it more likely that increases in wage and price flexibility reduce employment variability. This result is driven by the presence of externalities in the price setting process. It is also shown that wage and price flexibility, although *ceteris paribus* desirable, is an inferior substitute for optimally designed demand management.

CHAPTER 4

EXPECTED INFLATION AND OUTPUT VARIABILITY IN CONTRACTING AND FLEXIBLE PRICE MODELS

1. Introduction

Increased wage flexibility is not necessarily stabilizing even when private agents form expectations rationally. This influential proposition, initially put forward by DeLong and Summers (1986b), seems to have survived several criticisms. Whether a destabilizing outcome is more likely to occur is however still an unsettled issue. Ambiguity arises since there are no clear-cut analytical results when Taylor's model is augmented to consider explicitly the effect of expected inflation on aggregate demand and persistence in demand shocks[1].

The literature has focussed on this particular class of contracting models ignoring, to our knowledge, the wage structure presented in the seminal paper by Fischer (1977) as well as

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[1]The expected inflation effect is the channel through which destabilizing increased wage flexibility may occur (DeLong and Summers(1986b)). Persistence in aggregate demand disturbances is also necessary. A white noise demand shock would not, in fact, alter the analytical stabilizing results obtained by Driskill and Sheffrin (1986) in a model containing only wage push shocks.

rational expectations models with flexible prices. Of course, in the latter case the only relevant issue is whether or not the expected inflation (or Keynes-Tobin-Mundell) effect, presented in the previous chapter, dampens output variability.

Probably, such a lack of attention to new classical models can be explained on the grounds that inflationary expectations were generally regarded as playing a stabilizing role[2].

The aim of the present chapter is twofold. We first investigate the effects of increased wage flexibility on the variability of real output in a variant of Fischer's overlapping wage contract model. The original framework is duly modified to incorporate both the necessary requirements for a potential destabilizing effect, namely expected inflation and autoregressive aggregate demand shocks. Our theoretical findings provide analytical support to some of the propositions presented by DeLong and Summers.

Secondly, we analyze the stabilizing properties of the expected inflation effect in two standard new classical models, where output supply is respectively of the Sargent and Wallace (1975) and Lucas (1973) variety. We are able to demonstrate that price stickiness is not a critical requirement for destabilizing inflation expectations. In other words, the source of instability emphasized by Keynes (1936, chap. 19), Fisher (1933) and Tobin

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[2]See e.g. DeLong and Summers (1988).

(1975) in models with market imperfections and static or adaptive expectations carries through to models with both rational expectations *and* flexible prices.

The scheme of this chapter is as follows. Section 2 presents our variant of Fischer's model. The main analytical findings are discussed in section 3. Section 4 examines the effects of inflation expectations in a standard new classical model. The concluding section 5 summarizes the results.

2. Output variability in an overlapping wage contract model

The theoretical set-up we consider is a variant of Fischer's (1977) overlapping contracts model. Nominal wages are predetermined for either one or two periods with the aim of maintaining *ex ante* constancy of the real wage each period. Output is a negative function of real wages. Aggregate demand depends positively on real balances and on expected inflation *via* the real *ex ante* interest rate. For simplicity, a serially correlated real demand shock is the only source of uncertainty considered.

The model has the following structure (all variables are in logs):

$$(1) \qquad y_t = \alpha k(p_t - E_{t-1}p_t) + (1-\alpha)k(p_t - E_{t-2}p_t) \qquad 0<\alpha<1$$

(2) $$y_t = \gamma(m-p_t) + \beta(E_t p_{t+1}-p_t) + \varepsilon_t$$

(3) $$\varepsilon_t = \rho\varepsilon_{t-1} + u_t \qquad 0<\rho<1$$

where y_t is real output, p_t output price, m nominal money balances, ε_t a real demand shock, and E_{t-s} denotes mathematical expectation conditional on the information set available in period t-s.

Equation (1) is aggregate supply. The coefficient α describes the proportion of one-period contracts in the economy, and is our suggested measure of wage and price flexibility. This choice can be justified by assuming the existence of different costs of adjustment across firms in the economy. The absolute value of the real wage elasticity of output supply is given by the parameter k. Equation (2) is aggregate demand. The coefficient $\gamma>0$ is the reciprocal of the income elasticity of the demand for real balances. Since we abstract from the role of monetary policy and from nominal shocks, money balances are held constant. The coefficient β measures the semi-elasticity of aggregate demand with respect to the expected inflation rate. It is positive since the expansionary effects of expected inflation are assumed to outweigh the capital losses incurred by holders of money balances. Equation (3) describes the stationary AR(1) process followed by the real aggregate demand shock.

By equating (1) and (2) one has

$$(4) \qquad (k+\beta+\gamma)p_t = \alpha k E_{t-1}p_t + (1-\alpha)kE_{t-2}p_t + \beta E_t p_{t+1} + \gamma m + \varepsilon_t$$

A minimal state solution can be postulated as (see e.g. McCallum (1983a)):

$$(5) \qquad p_t = \pi_0 m + \pi_1 \varepsilon_{t-2} + \pi_2 u_{t-1} + \pi_3 u_t$$

Using (5) to evaluate conditional expectations, substituting into (4) and equating coefficients with (5) one obtains the following reduced form solution for the equilibrium price level:

$$(6) \qquad p_t = m + \frac{\rho^2}{\beta(1-\rho)+\gamma} \varepsilon_{t-2} + \frac{(\beta+\gamma)\rho}{[k(1-\alpha)+\beta+\gamma][\beta(1-\rho)+\gamma]} u_{t-1}$$

$$+ \frac{k(1-\alpha)[\beta(1-\rho)+\gamma]+(\beta+\gamma)^2}{(k+\beta+\gamma)[k(1-\alpha)+\beta+\gamma][\beta(1-\rho)+\gamma]} u_t$$

Upon substitution of (6) into the aggregate supply (1) one obtains the solution for the level of output:

$$(7) \qquad y_t = \Phi u_{t-1} + \Psi u_t$$

where

$$\Phi \equiv \frac{k(1-\alpha)(\beta+\gamma)\rho}{[k(1-\alpha)+\beta+\gamma][\beta(1-\rho)+\gamma]} \tag{7a}$$

$$\Psi \equiv \frac{k^2(1-\alpha)[\beta(1-\rho)+\gamma]+k(\beta+\gamma)^2}{[k(1-\alpha)+\beta+\gamma](k+\beta+\gamma)[\beta(1-\rho)+\gamma]} \tag{7b}$$

The asymptotic variance of output is given by

$$\sigma_y^2 = (\Phi^2 + \Psi^2)\sigma_u^2 \tag{8}$$

where σ_u^2 is the variance of the innovation component of the aggregate demand shock.

From (7a) and (7b),

$$\frac{\partial\Phi^2}{\partial\alpha} = - \frac{2k^2(1-\alpha)(\beta+\gamma)^3\rho^2}{[k(1-\alpha)+\beta+\gamma]^3[\beta(1-\rho)+\gamma]^2} < 0 \tag{9a}$$

$$\frac{\partial\Psi^2}{\partial\alpha} = 2\,\frac{\{k^2(1-\alpha)[\beta(1-\rho)+\gamma]+k(\beta+\gamma)^2\}(\beta+\gamma)\beta\rho}{[k(1-\alpha)+\beta+\gamma]^3(k+\beta+\gamma)^2[\beta(1-\rho)+\gamma]^2} > 0 \tag{9b}$$

It can immediately be seen that both (9a) and (9b) would vanish if ρ were to be equal to zero. Hence, the asymptotic variance of output would be invariant to changes in the degree of wage flexibility.

The effect of increases in α, for $\rho>0$, can be shown to be

$$(10)\ \frac{\partial\sigma_y^2}{\partial\alpha} = \Theta\cdot\{k(1-\alpha)\beta[\beta(1-\rho)+\gamma]+(\beta+\gamma)^2\beta-k(k+\beta+\gamma)^2(1-\alpha)(\beta+\gamma)^2\rho\}\ \sigma_u^2$$

where

$$\Theta \equiv \frac{2}{(k+\beta+\gamma)^2[k(1-\alpha)+\beta+\gamma]^3[\beta(1-\rho)+\gamma]^2}$$

The sign of the RHS of (10) critically depends upon parameter values. In particular, it is positive if demand shocks exhibit a low degree of serial correlation or if contracts in the economy are mostly short-term.

3. Interpretation of the results

Out of the several analytical considerations that can be made, we elect to stress the following.

From equation (10), it immediately emerges that when the expected inflation effect is absent (that is, $\beta=0$) increases in wage flexibility are always stabilizing, confirming thus the intuition of DeLong and Summers (1986b).

There is, however, no analogous counterpart to the stabilizing outcome in Taylor-type models in presence of white noise aggregate demand shock. From equations (9a) and (9b) one can see that, when ρ is set to zero, the degree of wage flexibility is totally irrelevant.

In the general case of autoregressive demand shock (ρ>0) and presence of the expected inflation effect (β>0) increases in wage flexibility may reduce or exacerbate output fluctuations, depending on parameter values. In particular, for low values of ρ increased flexibility is destabilizing and conversely, exactly confirming the prediction of DeLong and Summers.

4. The expected inflation effect in standard new classical models

There seems to be consensus in the literature towards the view that there is no room for destabilizing inflation expectations in new classical models (see e.g. McCallum (1983b), DeLong and Summers (1988)). Formal analysis of the expected inflation effect has typically been carried out in disequilibrium frameworks in which price adjustment is not immediate. However, price stickiness is *not* a necessary requirement for destabilizing inflation, even when expectations are rational. Destabilization of output may indeed occur even with flexible prices.

In the present section we consider two prototypical equilibrium models, as set forth by Sargent and Wallace (1975) and Lucas (1973) respectively. In the first case, output supply is of the standard form

$$(11) \qquad y_t = k(p_t - E_{t-1}p_t)$$

The demand side of the economy is modelled as in section 2 (equations (2) and (3)). The semi-reduced form solution for the price level is obtained by combining (2), (3) and (11):

$$(12) \qquad (k+\beta+\gamma)p_t = kE_{t-1}p_t + \beta E_t p_{t+1} + \gamma m + \rho\varepsilon_{t-1} + u_t$$

The guess solution takes the form

$$(13) \qquad p_t = \pi_0 m + \pi_1 \varepsilon_{t-1} + \pi_2 u_t$$

Using (13) to evaluate expectations, substituting into (12) and equating coefficients with (13) we obtain the final reduced form solution for the price level:

$$(14) \qquad p_t = m + \frac{\rho}{\beta(1-\rho)+\gamma}\,\varepsilon_{t-1} + \frac{\beta+\gamma}{[\beta(1-\rho)+\gamma](k+\beta+\gamma)}\,u_t$$

Output is therefore given by

$$(15) \qquad y_t = \Xi \cdot u_t$$

where

$$\Xi \equiv \frac{k(\beta+\gamma)}{[\beta(1-\rho)+\gamma](k+\beta+\gamma)}$$

One can see that whether or not the expected inflation effect is destabilizing crucially depends upon the degree of serial correlation of the aggregate demand shock.

From (15) one can derive

$$\text{(16)} \qquad \frac{\partial\Xi}{\partial\beta} = \Lambda\cdot\{k\gamma\rho-(\beta+\gamma)^2(1-\rho)\}$$

where

$$\Lambda \equiv \frac{k}{(k+\beta+\gamma)[\beta(1-\rho)+\gamma]^2}$$

It is immediately apparent that (16) is positive for values of ρ close to unity and negative for ρ close to zero. Hence, the expected inflation effect is destabilizing when aggregate demand disturbances exhibit a high degree of serial correlation.

Price stickiness is thus neither a necessary nor a sufficient condition for destabilizing inflation expectations. The intuition for our result is best explained for the cases of white noise (ρ=0) and random walk (ρ=1) demand shocks. Expected inflation can be expressed respectively as

$$(16a) \quad E_t p_{t+1} - p_t = -\frac{1}{k+\beta+\gamma} u_t \qquad (\rho=0)$$

$$(16b) \quad E_t p_{t+1} - p_t = \frac{k}{\gamma(k+\beta+\gamma)} u_t \qquad (\rho=1)$$

When demand disturbances are serially uncorrelated (equation (16a)) the innovation in the shock is purely transitory, so that expectations of future prices are not affected. Expected inflation moves countercyclically and acts as an automatic stabilizer[3].

When the shock is permanent (equation (16b)) the expectation of the next period price level fully reflects the current shock. By contrast, the response of the present price level is dampened by the contemporaneous increase in output supply. Hence expected inflation will move procyclically.

We now investigate the robustness of our result in the "island" equilibrium model presented by Lucas (1973), modified to incorporate the expected inflation effect. The supply and demand schedules in each market are assumed to be as follows:

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[3]The stabilizing results obtained by McCallum (1983b) and presented in chapter 4 are due to the white noise nature of the demand disturbances.

$$(17) \qquad y_t(z) = k\ [p_t(z) - E_z p_t]$$

$$(18) \qquad y_t(z) = \gamma\ [m_t(z) - E_z p_t] + \beta\ [E_z p_{t+1} - E_z p_t] + \nu_t(z) + \varepsilon_t$$

where z is a market index and E_z denotes the mathematical expectation conditional on the available information set, containing the model, all the past history of the economy and the observation of the current local equilibrium price. Nominal money is assumed constant, say $m_t(z)=m$, and the idiosyncratic demand shock $\nu_t(z)$ is assumed to be white noise. The economy-wide demand shock ε_t is, as usual, assumed to follow the stationary autoregressive process described in (3).

The semi-reduced form for $p_t(z)$ is

$$(19) \qquad p_t(z) = k^{-1}\ [\gamma m + (k-\beta-\gamma)E_z p_t + \beta E_z p_{t+1} + \nu_t(z) + \varepsilon_t]$$

The proposed guess solution is

$$(20) \qquad p_t(z) = \pi_0 m + \pi_1 \varepsilon_{t-1} + \pi_2 u_t + \pi_3 \nu_t(z)$$

Using (20),

$$(21) \qquad E_z p_t = \pi_0 m + \pi_1 \varepsilon_{t-1} + \pi_2 E_z u_t$$

and

(22) $E_z p_{t+1} = \pi_0 m + \pi_1 E_z \varepsilon_t$

The signal extraction problem is solved, using (19), as

(23) $E_z u_t = \theta\ [\nu_t(z) + u_t]$

where

(24) $$\theta \equiv \frac{\sigma_u^2}{\sigma_\nu^2 + \sigma_u^2}$$

The solutions for the undetermined coefficients are easily seen to be

(25a) $\pi_0 = 1$

(25b) $$\pi_1 = \frac{\rho}{\beta(1-\rho)+\gamma}$$

(25c) $$\pi_2 = \frac{\beta\theta\rho+\beta(1-\rho)+\gamma}{[k(1-\theta)+(\beta+\gamma)\theta][\beta(1-\rho)+\gamma]}$$

(25d) $\pi_3 = k^{-1}\ [1 + \beta\theta\pi_1 + (k-\beta-\gamma)\theta\pi_2]$

Averaging (17), (20) and (21) across markets, the economy wide equilibrium output can be written as

$$(26) \qquad y_t \equiv N^{-1} \sum_{z=1}^{N} y_t(z) = k \; (p_t - \sum_{z=1}^{N} E_z p_t) = k \; (1-\theta)\pi_2 u_t$$

where $p_t \equiv N^{-1}\Sigma_{z=1}^{N} p_t(z)$ and N is the total number of markets. Hence, the expected inflation effect is destabilizing iff $\partial\pi_2/\partial\beta>0$. From (25c), the necessary and sufficient condition for this to happen when $\rho=1$ is

$$(27) \qquad k > \gamma$$

This result can be explained along lines analogous to the Sargent-Wallace model previously analyzed. From (21), (22) and (25a)-(25c), expected inflation for the cases of white noise and random walk demand disturbances is respectively given by

$$(28) \qquad E_z p_{t+1} - E_z p_t = - \frac{\theta}{k(1-\theta)+(\beta+\gamma)\theta} \qquad (\rho=0)$$

$$(29) \qquad E_z p_{t+1} - E_z p_t = \frac{(1-\theta)(k-\gamma)}{\gamma[k(1-\theta)+(\beta+\gamma)\theta]} \qquad (\rho=1)$$

Expected inflation is always an automatic stabilizer if $\rho=0$, whereas when $\rho=1$ it moves procyclically, and is thus destabilizing, if and only if $k>\gamma$. This clearly coincides with the condition for $\partial\pi_2/\partial\beta>0$. If the price elasticity of aggregate supply is large vis-à-vis the real balance effect, then there will be a relatively small response of current prices to the demand innovation. On the other hand, future prices fully respond to current shocks, given their random walk dynamics.

The source of instability associated to the expected inflation effect, dating back to the work of Keynes, Fisher and Tobin and recently recast by DeLong and Summers in a staggered wage setting framework, generalizes to a larger variety of macroeconomic models. The standard new classical approach by no means constitutes an exception.

5. Conclusions

Increases in wage flexibility may exacerbate the variability of real output in presence of persistent aggregate demand shocks, when the expected inflation effect is explicitly modelled. Our findings, derived in a variant of Fischer's overlapping wage contract set-up, lend analytical support to this proposition, originally advocated by DeLong and Summers (1986b) in a Taylor-type framework.

The destabilizing influence of inflation expectations has also been proved in a standard new classical model. The latter finding demonstrates that the source of instability described by Keynes, Fisher and Tobin can also be present when prices are flexible and expectations are rationally formed.

CHAPTER 5

MONOPOLISTIC COMPETITION, EXPECTED INFLATION AND CONTRACT LENGTH

1. Introduction

In chapters 3 and 4 the issue of the possible destabilizing effect of increased wage and price flexibility in presence of the Keynes-Mundell-Tobin effect has been addressed in models with imperfections in the labour market. Nominal wages were predetermined, and labour markets were prevented from clearing. Imperfections in product markets, however, were not explicitly modelled.

An important area of research in modern macroeconomics has been directed at providing rigorous microeconomic underpinnings for the rigidity of wages and prices. Substantial progress towards explaining economic fluctuations has been achieved by developing models based on monopolistic competition and near-rational behaviour (see, for example, Akerlof and Yellen (1985), Ball (1987), Blanchard and Kiyotaki (1987), and the reviews by McCallum (1986), Fischer (1988), and Blanchard (1990)). Price and wage rigidity can be compatible with optimizing behaviour of individual agents, although undesirable fluctuations inevitably emerge in the aggregate.

The present chapter explores the issue of the (de)stabilizing effects of increased price flexibility in a variant of a model first presented by Ball (1987). This model is particularly interesting, since it is explicitly based on monopolistic competition and therefore offers a satisfactory framework for the analysis of the externalities associated with the existence of contracts. Furthermore, Ball's (1987) claim that wages are too rigid can be interpreted as basically replicating the results emerging from the original Taylor's (1979) model, that is increased wage flexibility, now in the form of reduced contract length, would be stabilizing. It is of interest, therefore, to verify whether explicitly modelling anticipated inflation could produce possible destabilizing effects along the lines described by DeLong and Summers (1986b). Our analytical results show that the expected inflation effect unambiguously strengthens the case for reducing contract length, irrespective of the nature and degree of persistence of demand and supply shocks. It is formally demonstrated that the negative externalities associated with long contracts actually increase. It is also shown that leaning against the wind policies can be extremely powerful if and only if the expected inflation effect is present.

The main reason for these results lies in the monopolistically competitive features of the product market. Under longer contracting regimes, inflation expectations are more volatile. If firms face a downward sloping demand for output, their level of employment directly depends on inflation expectations. The presence of this factor in the labour demand schedule is bound to increase the variability of employment and output.

The scheme of the chapter is as follows. Section 2 presents a version of Ball's (1987) model modified to explicitly incorporate the expected inflation effect and demonstrates that increased wage flexibility is likely to be stabilizing. Section 3 considers the case of autoregressive demand shocks and relates the results to earlier findings in the literature. Section 4 illustrates how lagged feedback monetary rules can be effective only in presence of the expected inflation effect and compares their relative desirability versus increasing wage flexibility. A summary of the main results is provided in the concluding section 5.

2. Expected inflation and wage flexibility

We now provide an appraisal of the expected inflation effect upon aggregate demand, in a rational expectations model with predetermined labour contracts[1]. The specific framework chosen is a variant of the discrete time version of Ball's (1987) model of long-term contracts under monopolistic competition, modified to incorporate inflation expectations. The aim of the analysis is to evaluate the implications for employment variability of a shift in the economy from short to longer term contracts.

In a standard monopolistically competitive environment, an individual firm's labour demand depends on the firm's real wage and on aggregate demand (see e.g. Blanchard and Kiyotaki (1987)).

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[1]This set-up can be justified on the grounds that transaction costs prevent agents from signing contracts which are contingent upon the realization of current economic variables (as e.g. in Fischer (1977)).

An increase in the average contract length in the economy makes nominal wages and prices less responsive to aggregate demand shocks: this dampens the variability of the real wage over the cycle, but exacerbates the variability of aggregate demand. The net effect of longer contracts on the variance of the demand for labour and hence of output will therefore depend on the relative weight of real wages and demand for goods in the firm's labour demand. Any individual firm decides on the length of the contract with its workers, neglecting the consequences that its decision will have on the aggregate wage and price levels. In so doing, it creates externalities upon the other firms. Ball (1987) shows that shorter contracts than the market equilibrium ones would be socially optimal if and only if an increase in contract length creates *negative* externalities to the single firms, in the sense of increasing the variability of the responses of employment and output to nominal shocks[2].

We now show that a negative dependence of aggregate demand on the *ex ante* real interest rate makes it more likely, in the present context, that increases in contract length generate negative externalities compared to a situation in which this

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[2]Following the literature (see e.g. Barro (1977)), the *ad hoc* policy criterion chosen is minimizing the fluctuations of actual employment about its market clearing level. A rigorous analysis of welfare in this kind of models is rather difficult, as shown by Ball and Romer (1987).

effect is absent; in other words, increased wage and price flexibility is more likely to be desirable[3]. The intuition behind this result is fairly simple: under a long-term contract regime the current price level does not respond to current innovations which are instead always incorporated in the current expectations of the next period price level. Hence, the presence of expected inflation in the labour demand increases the volatility of employment and output over the cycle as labour contracts become longer.

The structure of the model is as follows. The technology of the economy is represented by the following constant returns to scale production function

$$(1) \qquad y_{it} = \ell_{it}$$

where "i" is a firm specific index, uniformly distributed over [0,1], and where y_{it} and ℓ_{it} are the logarithms of output and

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[3]Ball (1987) compares the length of the contracts chosen by firms in a decentralized economy (*Nash equilibrium*) in the presence of fixed (exogenously given) contracting costs to the Pareto-optimal contract length. In equilibrium, firms equate the marginal gains from a shorter length to the marginal increase in contracting costs. The presence of negative externalities implies that shorter contracts would bring about net welfare gains and therefore would be socially desirable.

labour input respectively. The logarithm of money supply follows the random walk process

$$(2) \qquad m_t = m_{t-1} + \xi_t$$

where ξ_t is a white noise with variance σ_ξ^2. The disturbance ξ_t is an exogenous nominal shock, not controllable by the monetary authorities. Aggregate demand is given by[4]

$$(3) \qquad y_t = \alpha(m_t - p_t) + \beta(E_t p_{t+1} - p_t) + \eta_t$$

where y_t and p_t are aggregate output and price level, respectively:

$$y_t = \int_0^1 y_{it} di \qquad\qquad p_t = \int_0^1 p_{it} di$$

and where η_t is a white noise with variance σ_η^2. The symbol $E_t x_{t+s}$ denotes the expectation of the variable x_{t+s} conditional on the information set at time t, which contains the structure of the model and all past and current values of the relevant variables: in particular, agents can directly observe the two different demand shocks ξ_t and η_t. The real aggregate demand shock, η_t, is assumed to be serially uncorrelated; this assumption will be relaxed in the next Section, where the results will be compared

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[4]Equation (3) can be seen as the reduced form of a standard IS-LM model (see e.g. DeLong and Summers (1986b) and Blanchard (1987)).

with other findings in the literature. In (3), the coefficient $\beta>0$ represents the negative effect on aggregate demand of expectations of decreasing inflation.

The firms operate under conditions of monopolistic competition. The share of firm "i" 's demand is

$$(4) \qquad y_{it}-y_t = -\gamma(p_{it}-p_t)$$

where $\gamma>1$. Substituting (3) into (4) we obtain

$$(5) \qquad y_{it} = \alpha(m_t-p_t) + \beta(E_t p_{t+1}-p_t) - \gamma(p_{it}-p_t) + \eta_t$$

Using (1) and (5), the profit maximizing demand for labour of firm "i" is[5]

$$(6) \qquad \ell_{it} = \alpha(m_t-p_t) + \beta(E_t p_{t+1}-p_t) - \gamma(w_{it}-p_t) + \eta_t$$

where w_{it} is the nominal wage. The size of the labour pool of firm "i" is assumed to be wage inelastic and is normalized to zero for analytical convenience. The market clearing level of employment is thus $\ell^*_{it}=0$. The losses from the discrepancy between actual labour demand and its market clearing level are given by the following quadratic function:

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[5]See Appendix A.

$$(7) \qquad z_{it} = E[(\ell_{it}-\ell^{*}_{it})^2] \\ = E(\ell_{it}^{2})$$

We can now examine the behaviour of wages, prices and employment under different contracting regimes. Formally, we consider contracts spanning either one or two periods and analyze how the loss function and the value of the externalities are affected in each case when $\beta>0$, that is when the expected inflation effect upon aggregate demand is present, compared to a situation in which such an effect is absent, that is $\beta=0$. Using (1), (5) and (6) and aggregating, one obtains

$$(8) \qquad p_t = w_t$$

where w_t is the aggregate nominal wage.

When all firms sign contracts which last one period only, they are virtually executing spot contracts and can therefore fix employment at the market clearing level: $\ell_{it}=\ell^{*}_{it}=0$, which obviously implies $z_{it}=0$. From (6) and $\ell_{it}=0$ we have

$$(9) \qquad w_{it} = \frac{\alpha}{\gamma} m_t + \left(1-\frac{\alpha+\beta}{\gamma}\right) p_t + \frac{\beta}{\gamma} E_t p_{t+1} + \frac{1}{\gamma} \eta_t$$

Aggregating and using (8) one obtains

(10) $$p_t = \frac{\alpha}{\alpha+\beta} m_t + \frac{\beta}{\alpha+\beta} E_t p_{t+1} + \frac{1}{\alpha+\beta} \eta_t$$

Equation (10) can be solved by the method of undetermined coefficients (see e.g. McCallum (1983a)) to obtain[6]

(11) $$p_t = m_t + \frac{1}{\alpha+\beta} \eta_t$$

Consider now the case in which all firms predetermine wages for two periods. There is no staggering: all contracts are perfectly synchronized. In the first period, wages are set at the market clearing level and thus equations (9) and (11) still hold true. In the second period wages are set at the level for which $E_{t-1}(\ell_{it})=0$. Taking conditional expectations of the labour demand (6) and rearranging we obtain

(12) $$w_{it} = \frac{\alpha}{\gamma} E_{t-1} m_t + \left(1 - \frac{\alpha+\beta}{\gamma}\right) E_{t-1} p_t + \frac{\beta}{\gamma} E_{t-1} p_{t+1} + \frac{1}{\gamma} E_{t-1} \eta_t$$

After aggregating and using (8) the solution for the price level turns out to be

(13) $$p_t = m_{t-1}$$

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[6]Details of this and later proofs can be found in Appendix A.

We can now address the issue of the value of the externalities in each regime. Since each firm has zero measure, the externalities are defined as 'the effects on firm "i" of a change in the contract length of *other* firms' (Ball (1987), p. 619). If the net externalities from an increase in contract length are negative, then it would be optimal for a social planner to reduce, if possible, the length of the contracts, thereby increasing the degree of flexibility of wages and prices. We show that the presence of the expected inflation effect makes it indeed *more* likely that negative externalities might arise.

Let all firms, with the exception of firm "i", move from one to two-period labour contracts. If firm "i" is in a one-period contract, or in the first period of a two-period contract, then the condition $\ell_{it}=0$ implies that there cannot be any externalities from the behaviour of other firms, since any increase in their contract length will be exactly offset by firm "i". Hence, externalities can only occur in the second period of a two-period contract.

Suppose now that all other firms are in a one-period contract, and firm "i" is in the second period of a two-period contract. Equation (11) for the aggregate price level still holds true, since firm "i" 's behaviour cannot affect aggregate magnitudes. Together with the wage setting equation (12), this implies

$$(14) \qquad w_{it} = m_{t-1}$$

By substitution of (2), (11) and (14) into the labour demand equation (6), we obtain

$$(15) \qquad \ell_{it} = \gamma\, \xi_t + \frac{\gamma}{\alpha+\beta}\, \eta_t$$

whence, using (7):

$$(16) \qquad z_{it}^{(1)} = \gamma^2 \sigma_\xi^2 + \frac{\gamma^2}{(\alpha+\beta)^2}\, \sigma_\eta^2$$

The loss function $z_{it}^{(1)}$ is a *decreasing* function of the parameter β: the variability of employment and output is lower the more responsive aggregate demand is to changes in expected inflation.

The intuition of this result is straightforward. All other firms observe the current realizations of the stochastic shocks and can thus replicate the competitive solution. Wages and prices fully reflect changed demand conditions. The only externality for firm "i" is due to the variability of its real wage. Since its nominal wage is predetermined, the welfare loss is monotonically related to the variance of the aggregate, non-predetermined, price level. Following exogenous demand shocks, the price level will change less since expected inflation varies anticyclically and exerts thus a built-in stabilizing effect on aggregate demand.

Let us now assume that all other firms are in a two-period contract. Equations (12) and (13) imply

$$(17) \qquad w_{it} = m_{t-1}$$

By substitution into (6), we obtain

$$(18) \qquad \ell_{it} = (\alpha+\beta)\ \xi_t + \eta_t$$

and therefore

$$(19) \qquad z_{it}^{(2)} = (\alpha+\beta)^2\sigma_\xi^2 + \sigma_\eta^2$$

The loss $z_{it}^{(2)}$ is now an *increasing* function of the expected inflation effect (as measured by β). In this case externalities arise only from variability in real aggregate demand, since the price level is predetermined. Expected inflation now varies procyclically (following demand shocks) and thus amplifies the destabilizing effects of the exogenous disturbances. The expected inflation effect acts now as an automatic destabilizer.

It follows from (16) and (19) that the necessary and sufficient condition for negative externalities from an increase in contract length (i.e., the condition for $z_{it}^{(1)}<z_{it}^{(2)}$) is

$$(20) \qquad \gamma < \alpha + \beta$$

Condition (20) has an immediate interpretation in terms of the parameters of equations (3) and (4). Long-term contracts have a negative net externality if the real wage elasticity of the demand for labour, γ, is lower than the sum of the elasticities of aggregate demand with respect to real money balances, α, and expected inflation, β. The presence of the last term reduces the externalities from long-run contracts, thereby making it more likely that the latter are not socially desirable.

The reason why a greater wage and price variability might be preferable is that long contracts, whilst reducing the variability of real wages over the cycle, also enhance the volatility of real money balances and expected inflation: nominal prices are predetermined and do not respond to current shocks, which are instead reflected in the nominal money level and in inflation expectations. The monopolistically competitive structure of product markets is obviously crucial. Expected inflation is a determinant of labour demand: when it moves counter-cyclically, the variability of employment and output is reduced and *vice versa*.

Our analysis could be criticized on the grounds that the one-period contracting regime is observationally equivalent to the Walrasian case. As noted by DeLong and Summers (1986b, 1988), it is hardly surprising that the expected inflation effect is stabilizing in a situation of perfect markets. However, our results do not depend on the particular specification employed, as shown in Appendix B where both contracting regimes are lagged one period. It is demonstrated that the necessary and sufficient condition for negative externalities when the contract length increases is unchanged. Without loss of generality we can thus retain the much simpler framework adopted so far for the following discussion.

3. Persistent demand shocks and externalities

In the previous section we have considered white noise disturbances to aggregate demand. It has been shown in chapters 3 and 4, however, that the expected inflation effect may have a destabilizing influence on the level of output if demand shocks are autoregressive. In DeLong and Summers' (1986b) Taylor-type framework, for instance, the variance of output is shown to increase, over a certain range of parameter values, as wages become more responsive to excess demand in the goods market or as the length of contracts decreases. In the case of serially uncorrelated disturbances, however, wage flexibility is still stabilizing as in the original Taylor's (1980) model. Hence, some elements of persistence in the demand shocks appear to be necessary in order to generate a destabilization outcome.

In order to investigate this issue in a framework as similar as possible to that of DeLong and Summers (1986b), but which retains monopolistically competitive features, we assume that the aggregate demand shock η_t in equation (3) follows a stationary AR(1) process:

$$(21) \qquad \eta_t = \rho\eta_{t-1} + \varepsilon_t$$

where $0<\rho<1$ and ε_t is white noise with variance σ_ε^2. Our model is now given by equations (1)-(7) and (21), and can also be interpreted as a particular case of a policy rule reacting to the contemporaneous nominal interest rate.

Using the same solution procedure as before, one can find that in one-period contracts the aggregate price level is given by

$$(22) \qquad p_t = m_t + \frac{1}{\alpha+\beta(1-\rho)}\, \eta_t$$

while in two-period contracts it is given by

$$(23) \qquad p_t = m_{t-1} + \frac{\rho}{\alpha+\beta(1-\rho)}\, \eta_{t-1}$$

If all firms, with the exception of firm "i", are in a one-period contract while firm "i" is in the second period of a two-period contract, the wage set by the latter is equal to

$$(24) \qquad w_{it} = m_{t-1} + \frac{\rho}{\alpha+\beta(1-\rho)}\, \eta_{t-1}$$

from which

$$(25) \qquad \ell_{it} = \gamma\xi_t + \frac{\gamma}{\alpha+\beta(1-\rho)}\, \varepsilon_t$$

and

$$(26) \qquad z_{it}^{(1)} = \gamma^2\sigma_\xi^2 + \frac{\gamma^2}{[\alpha+\beta(1-\rho)]^2}\, \sigma_\varepsilon^2$$

If instead all other firms are in a two-period contract, then

$$(27) \qquad w_{it} = p_t = m_{t-1} + \frac{\rho}{\alpha+\beta(1-\rho)}\, \eta_{t-1}$$

whence

$$(28) \qquad \ell_{it} = (\alpha+\beta)\, \xi_t + \frac{\alpha+\beta}{\alpha+\beta(1-\rho)}\, \varepsilon_t$$

and

$$(29) \qquad z_{it}^{(2)} = (\alpha+\beta)^2\sigma_\xi^2 + \left[\frac{\alpha+\beta}{\alpha+\beta(1-\rho)}\right]^2 \sigma_\varepsilon^2$$

From (26) and (29) it is apparent that the value of the externalities in either regime is an increasing function of the autoregressive parameter ρ, provided $\beta \neq 0$.

The persistence of the demand shocks can thus actually increase the volatility of employment and output in presence of the expected inflation effect. When demand shocks are autoregressive, expected inflation varies less in the short contract case (when it is stabilizing) and varies more when the price level is predetermined (that is, when it is destabilizing).

This does not imply, of course, that increased wage flexibility in the form of shorter contracts may now be destabilizing. Inspection of (26) and (29) immediately reveals that the necessary and sufficient condition for negative externalities from an increase in contract length is

$$(30) \qquad \gamma < \alpha + \beta$$

which exactly coincides with the condition (20) obtained in the case of serially uncorrelated demand disturbances, that is when $\rho=0$.

The condition is unchanged because the lower stabilizing influence of the expected inflation effect in the short contracts regime is exactly compensated by the greater destabilizing effects in the longer contracts case[7]. The persistence of demand shocks, therefore, does not affect the relative desirability of short versus long-term contracts from a welfare point of view. In particular, the presence of the expected inflation effect still makes it more likely that shorter contracts might be preferred to longer ones, in the sense that they minimize the externalities arising from the existence of contracts in the economy.

4. Active policy and welfare

As demonstrated in the previous sections, increased wage flexibility, in the form of reduced contract length, is more likely to be stabilizing in presence of the expected inflation effect under a passive monetary policy of the kind presented by Driskill and Sheffrin (1986) and DeLong and Summers (1986b). The conclusion emerging from our analysis is that either institutional reforms or policies aimed at penalizing longer contracts, if feasible, ought to improve welfare.

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[7]See equations (A22b) and (A25b) in Appendix A.

We now turn to the issue of what active demand management can do in such a framework. We investigate the effectiveness of a leaning against the wind policy, that is a rule designed to alter the rate of growth of money around a fixed trend (here normalized to zero, for simplicity) in response to lagged demand conditions. Specifically, we assume that the monetary authorities relate the rate of growth of the money supply to the lagged values of the random shocks, which are here assumed to be white noise processes[8]:

$$(31) \qquad m_t = m_{t-1} + \xi_t - \delta_1 \xi_{t-1} - \delta_2 \eta_{t-1}$$

If all firms follow one-period contracts, the aggregate price level is given by

$$(32) \qquad p_t = m_t - \frac{\beta\delta_1}{\alpha+\beta} \xi_t + \frac{1-\beta\delta_2}{\alpha+\beta} \eta_t$$

which clearly collapses to equation (11) when $\delta_1=\delta_2=0$. If by contrast all firms sign two-period contracts, the price level becomes a predetermined variable:

$$(33) \qquad p_t = m_{t-1} - \delta_1 \xi_{t-1} - \delta_2 \eta_{t-1}$$

which again reduces to (13) for $\delta_1=\delta_2=0$. If now all firms are in

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[8]The relevant model is thus the one presented in section 2.

a one-period contract while firm "i" is in the second period of a two-period contract, we have

$$w_{it} = m_{t-1} - \delta_1 \xi_{t-1} - \delta_2 \eta_{t-1} \tag{34}$$

and

$$\ell_{it} = \frac{\gamma}{\alpha+\beta} \{[\alpha+\beta(1-\delta_1)]\xi_t + (1-\beta\delta_2)\eta_t\} \tag{35}$$

and thus

$$z_{it}^{(1)} = \frac{\gamma^2}{(\alpha+\beta)^2} \{[\alpha+\beta(1-\delta_1)]^2\sigma_\xi^2 + (1-\beta\delta_2)^2\sigma_\eta^2\} \tag{36}$$

It is apparent from (35) and (36) that the monetary authority can reduce to zero the externalities by setting

$$\delta_1^* = \frac{\alpha+\beta}{\beta} \tag{37a}$$

$$\delta_2^* = \frac{1}{\beta} \tag{37b}$$

For the countercyclical policy to be at all viable it must be $\beta>0$: the presence of the expected inflation effect in the aggregate demand is a necessary condition for the effectiveness of (lagged feedback) active demand management.

If all firms are in the second period of a two period contract, then

$$(38) \qquad w_{1t} = p_t = m_{t-1} - \delta_1 \xi_{t-1} - \delta_2 \eta_{t-1}$$

from which

$$(39) \qquad \ell_{1t} = [\alpha+\beta(1-\delta_1)]\ \xi_t + (1-\beta\delta_2)\ \eta_t$$

and

$$(40) \qquad z_{1t}^{(2)} = [\alpha+\beta(1-\delta_1)]^2\sigma_\xi^2 + (1-\beta\delta_2)^2\sigma_\eta^2$$

The optimal policy rule is again given by (37a) and (37b). Under this rule, the policy authority makes the choice of contract length completely irrelevant. This can be seen by substituting (31), (37a) and (37b) into the one-period price (32):

$$(41) \qquad p_t = m_{t-1} - \delta_1^*\ \xi_{t-1} - \delta_2^*\ \eta_{t-1}$$

Under the optimal countercyclical policy, the one-period price will be identical to the two-period price (33)[9].

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[9]By comparing (36) with (40) one could immediately see that whenever $(\delta_1, \delta_2) \neq (\delta_1^*, \delta_2^*)$ the necessary and sufficient condition for negative externalities from an increase in contract length is still $\gamma<\alpha+\beta$. If the monetary authorities follow a different

The intuition for the result is the following. Under a passive monetary growth rule, expected inflation is unaffected by the systematic component of monetary policy[10]. A countercyclical rule, on the other hand, affects expected inflation[11]: it thus follows that externalities can be eliminated by optimally choosing the values of the feedback parameters. The channel for policy effectiveness is the existence of a non-predetermined[12] intertemporal substitution term[13], that is the expected inflation effect.

The policy objective is to stabilize aggregate demand in the

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policy than the optimal one, the relative losses associated with the externalities in the short and the long-term regimes are unchanged.

[10]See equations (A12b) and (A13b) in Appendix A.

[11]See equations (A36b) and (A39b).

[12]Following Buiter's (1982) classification, a variable is non-predetermined if and only if "its *current* value is a function of *current* anticipations of future values of endogenous and/or exogenous variables".

[13]The same condition would ensure policy effectiveness even for "contract-free" new classical macroeconomic models, as shown in Marini (1985, 1986, 1988) and Buiter (1989).

choke off the effects of random disturbances on real aggregate demand. In other words, the *ex post* price in the short-term contracts regime is forced to be the same as in the case of longer contracts. Perfect stabilization of aggregate demand thus makes the price level a predetermined variable in either case. Active policy can so replicate the first best of the economy irrespective of the actual length of contracts. In this sense we can reaffirm the validity of the Keynesian prediction that increased wage flexibility is an imperfect substitute for active policy[14] [15].

5. Conclusions

In a monopolistically competitive framework with synchronized wage setting, the explicit consideration of the expected inflation effect makes employment variability more likely to

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[14]Perfect stabilization is of course not achievable when current shocks are not contemporaneously observable. However the result that active policy dominates increased wage flexibility still holds, as demonstrated in Appendix B.3.

[15]It should be noticed that, under the optimal monetary rule (31), (37a) and (37b), the Lucas critique does not apply. The parameters α, β and γ are in fact policy invariant, and the private sector's choice of contract length is a matter of irrelevance under the optimal rule.

wage setting, the explicit consideration of the expected inflation effect makes employment variability more likely to increase with contract length. A greater wage flexibility, in the form of reduced contract length, would appear to be desirable for a given conduct of demand management.

However, we have shown that leaning against the wind monetary rules can reduce the externalities arising from the existence of contracts, irrespective of their length. The Keynesian prediction that increased wage flexibility may not be a good substitute for active policy is thus exactly replicated.

Appendix A

1. Demand for labour

The output demand for firm "i" is assumed to be

$$\text{(A1)} \quad Y_{it} = \left(\frac{M_t}{P_t}\right)^{\alpha} \left(1 + \pi_t^e\right)^{\beta} \left(\frac{P_{it}}{P_t}\right)^{-\gamma} H_t$$

where $\pi_t^e \equiv (E_t P_{t+1} - P_t)/P_t$ and where capital letters denote variables in their natural units. Profits are then given by

$$\text{(A2)} \quad \Pi_{it} = P_t \, L_{it}^{(\gamma-1)/\gamma} \left(\frac{M_t}{P_t}\right)^{\alpha/\gamma} \left(\frac{E_t P_{t+1}}{P_t}\right)^{\beta/\gamma} H_t^{1/\gamma} - W_{it} L_{it}$$

The first-order condition for employment is

$$\text{(A3)} \quad \frac{\gamma-1}{\gamma} P_t \, L_{it}^{-1/\gamma} \left(\frac{M_t}{P_t}\right)^{\alpha/\gamma} \left(\frac{E_t P_{t+1}}{P_t}\right)^{\beta/\gamma} H_t^{1/\gamma} = W_{it}$$

or

$$\text{(A3')} \quad L_{it} = \left(\frac{\gamma}{\gamma-1}\right)^{-\gamma} \left(\frac{M_t}{P_t}\right)^{\alpha} \left(\frac{E_t P_{t+1}}{P_t}\right)^{\beta} \left(\frac{W_{it}}{P_t}\right)^{-\gamma} H_t$$

which coincides with equation (6) in the text, apart from a constant factor.

2. Uncorrelated shocks

2.(i) One-period contracts

The 'guess' solution is

(A4) $$p_t = \pi_0 m_t + \pi_1 \eta_t$$

Upon taking expectations,

(A5) $$E_t p_{t+1} = \pi_0 E_t m_{t+1} + \pi_1 \eta_{t+1}$$

$$= \pi_0 m_t$$

using (2) and the assumption that η_t is a white noise. Substituting (A5) into (10) we obtain

(A6) $$p_t = \frac{\alpha+\beta\pi_0}{\alpha+\beta} m_t + \frac{1}{\alpha+\beta} \eta_t$$

Equating (A4) to (A6) one has

(A7) $$\pi_0 = 1, \qquad \pi_1 = \frac{1}{\alpha+\beta}$$

which yield equation (11) in the text.

(ii) Two-period contracts

Aggregate equation (12) and use (8) to obtain

$$\text{(A8)} \quad p_t = \frac{\alpha}{\gamma} m_{t-1} + \left(1 - \frac{\alpha+\beta}{\gamma}\right) E_{t-1}p_t + \frac{\beta}{\gamma} E_{t-1}p_{t+1}$$

The guess solution is

$$\text{(A9)} \quad p_t = \pi_0 m_{t-1}$$

Substituting (A9) into (A8) we obtain

$$\text{(A10)} \quad p_t = \left[\frac{\alpha}{\gamma}(1-\pi_0) + \pi_0\right] m_{t-1}$$

and equating coefficients in (A9) and (A10) we obtain $\pi_0=1$, i.e. equation (13).

(iii) Externalities

If all other firms sign one-period contracts, then the wage for firm "i" is given by (12) while the aggregate price level is given by (11). Since $E_{t-1}p_t = E_{t-1}p_{t+1} = m_{t-1}$, we obtain

$$\text{(A11)} \quad w_{it} = m_{t-1}$$

The components of labour demand (6) are

(A12a) $m_t - p_t = -\frac{1}{\alpha+\beta}\eta_t$

(A12b) $E_t p_{t+1} - p_t = -\frac{1}{\alpha+\beta}\eta_t$

(A12c) $w_{1t} - p_{1t} = -\xi_t - \frac{1}{\alpha+\beta}\eta_t$

from which we obtain equation (15).

If instead the other firms are in the second period of a two-period contract the price level is (13). The components of labour demand are

(A13a) $m_t - p_t = \xi_t$

(A13b) $E_t p_{t+1} - p_t = \xi_t$

(A13c) $w_{1t} - p_t = 0$

and by substitution into (6) we obtain equation (18).

3. Autocorrelated shocks

(i) One-period contracts

The price equation is (10), which is here reported for convenience:

(10) $$p_t = \frac{\alpha}{\alpha+\beta} m_t + \frac{\beta}{\alpha+\beta} E_t p_{t+1} + \frac{1}{\alpha+\beta} \eta_t$$

The guess solution is

(A14) $$p_t = \pi_0 m_t + \pi_1 \eta_t$$

Take expectations of (A14) using (21):

(A14') $$E_t p_{t+1} = \pi_0 m_t + \pi_1 \rho \eta_t$$

After substituting into (10), one has

(A15) $$p_t = \frac{\alpha+\beta\pi_0}{\alpha+\beta} m_t + \frac{1+\beta\rho\pi_1}{\alpha+\beta} \eta_t$$

Equate (A14) and (A15) to obtain

(A16) $$\pi_0 = 1 \qquad\qquad \pi_1 = \frac{1}{\alpha+\beta(1-\rho)}$$

which yield the price equation (22) in the text.

(ii) <u>Two-period contracts</u>

Aggregate equation (12) to obtain

(A17) $$p_t = \frac{\alpha}{\gamma} m_{t-1} + \left(1 + \frac{\alpha+\beta}{\gamma} \right) E_{t-1} p_t + \frac{\beta}{\gamma} E_{t-1} p_{t+1} + \frac{1}{\gamma} \rho \eta_{t-1}$$

The guess solution is

(A18) $$p_t = \pi_0\, m_{t-1} + \pi_1\, \eta_{t-1}$$

Taking expectations,

(A18') $$E_{t-1}p_t = \pi_0\, m_{t-1} + \pi_1\, \eta_{t-1}$$

(A18") $$E_{t-1}p_{t+1} = \pi_0\, m_{t-1} + \pi_1 \rho \eta_{t-1}$$

and hence (A17) becomes

(A19) $$p_t = \left(\frac{\alpha}{\gamma} + \pi_0 - \frac{\alpha}{\gamma}\, \pi_0 \right) m_{t-1} +$$

$$+ \left(\pi_1 - \frac{\alpha+\beta}{\gamma}\, \pi_1 + \frac{\beta}{\gamma}\, \rho\pi_1 + \frac{1}{\gamma}\, \rho \right) \eta_{t-1}$$

By comparison of (A18) with (A19) one obtains the coefficients of equation (24):

(A20) $$\pi_0 = 1 \qquad\qquad \pi_1 = \frac{\rho}{\alpha+\beta(1-\rho)}$$

(iii) Externalities

All other firms are in a one-period contract. Using the price equation (22), the wage for firm "i" is given by

$$\text{(A21)} \quad w_{1t} = \frac{\alpha}{\gamma} E_{t-1}m_t + \left(1 - \frac{\alpha+\beta}{\gamma} \right) E_{t-1}p_t + \frac{\beta}{\gamma} E_{t-1}p_{t+1}$$

$$+ \frac{1}{\gamma} E_{t-1}\eta_t$$

$$= m_{t-1} + \frac{\rho}{\alpha+\beta(1-\rho)} \eta_{t-1}$$

The components of labour demand are thus

$$\text{(A22a)} \qquad m_t - p_t = - \frac{1}{\alpha+\beta(1-\rho)} \eta_t$$

$$\text{(A22b)} \qquad E_tp_{t+1} - p_t = - \frac{1-\rho}{\alpha+\beta(1-\rho)} \eta_t$$

$$\text{(A22c)} \qquad w_{1t} - p_t = - \xi_t - \frac{1}{\alpha+\beta(1-\rho)} \xi_t$$

Hence,

$$\text{(A23)} \qquad \ell_{1t} = - \frac{\alpha}{\alpha+\beta(1-\rho)} \eta_t - \frac{\beta(1-\rho)}{\alpha+\beta(1-\rho)} \eta_t + \gamma \xi_t +$$

$$+ \frac{\gamma}{\alpha+\beta(1-\rho)} \xi_t + \eta_t$$

$$= \gamma \xi_t + \frac{\gamma}{\alpha+\beta(1-\rho)} \xi_t$$

which coincides with equation (25).

Let all other firms be in a two-period contract. The price is given by equation (23), which immediately implies

$$w_{it} = m_{t-1} + \frac{\rho}{\alpha+\beta(1-\rho)} \eta_{t-1} \tag{A24}$$

Then one has

$$m_t - p_t = \xi_t - \frac{\rho}{\alpha+\beta(1-\rho)} \eta_{t-1} \tag{A25a}$$

$$E_t p_{t+1} - p_t = \xi_t + \frac{\rho(\rho-1)}{\alpha+\beta(1-\rho)} \eta_{t-1} + \frac{\rho}{\alpha+\beta(1-\rho)} \xi_t \tag{A25b}$$

$$w_{it} - p_t = 0 \tag{A25c}$$

and by substitution into (6) we obtain

$$\begin{aligned} \ell_{it} &= \alpha\, \xi_t - \frac{\alpha\rho}{\alpha+\beta(1-\rho)} \eta_{t-1} + \beta\, \xi_t + \frac{\beta\rho(\rho-1)}{\alpha+\beta(1-\rho)} \eta_{t-1} \\ &\quad + \frac{\beta\rho}{\alpha+\beta(1-\rho)} \xi_t + \rho\, \eta_{t-1} + \xi_t \\ &= (\alpha+\beta)\, \xi_t + \frac{\alpha+\beta}{\alpha+\beta(1-\rho)} \xi_t \end{aligned} \tag{A26}$$

which is equation (28) in the text.

4. Countercyclical money rule

(i) One-period contracts

The aggregate price is given by equation (10). Given the money rule (31), the guess solution is

$$(A27) \qquad p_t = \pi_0\, m_t + \pi_1\, \xi_t + \pi_2\, \eta_t$$

and implies

$$(A28) \qquad E_t p_{t-1} = \pi_0\, (m_t - \delta_1 \xi_t - \delta_2 \eta_t)$$

By substitution into (10) one obtains

$$(A29) \qquad p_t = \frac{\alpha+\beta\pi_0}{\alpha+\beta}\, m_t - \frac{\beta\delta_1\pi_0}{\alpha+\beta}\, \xi_t + \frac{1-\beta\delta_2\pi_0}{\alpha+\beta}\, \eta_t$$

and by comparison of (A27) with (A29) we get

$$\pi_0 = 1$$

$$(A30) \qquad \pi_1 = -\frac{\beta\delta_1}{\alpha+\beta}$$

$$\pi_2 = \frac{1-\beta\delta_2}{\alpha+\beta}$$

(ii) Two-period contracts

Aggregating the wage equation (12) we obtain

(A31) $$p_t = \frac{\alpha}{\gamma} E_{t-1}m_t + \left(1 - \frac{\alpha+\beta}{\gamma} \right) E_{t-1}p_t + \frac{\beta}{\gamma} E_{t-1}p_{t+1} + \frac{1}{\gamma} E_{t-1}\eta_t$$

The guess solution is

(A32) $$p_t = \pi_0 m_{t-1} + \pi_1 \xi_{t-1} + \pi_2 \eta_{t-1}$$

Take expectations of (A32) and substitute into (A31) to get

(A33) $$p_t = \left(\frac{\alpha}{\gamma} + \pi_0 - \frac{\alpha}{\gamma} \pi_0 \right) m_{t-1} + \left(\frac{\alpha}{\gamma} \delta_1 + \pi_1 - \frac{\alpha+\beta}{\gamma} \pi_1 - \frac{\beta}{\gamma} \delta_1\pi_0 \right) \xi_{t-1} + \left(- \frac{\alpha}{\gamma} \delta_2 + \pi_2 - \frac{\alpha+\beta}{\gamma} \pi_2 - \frac{\beta}{\gamma} \delta_2\pi_0 \right) \eta_{t-1}$$

from which

(A34) $$\pi_0 = 1 \qquad \pi_1 = - \delta_1 \qquad \pi_2 = - \delta_2$$

which give equation (33).

(iii) Externalities

Let us assume that all firms with the exception of firm "i" sign one-period contracts. The wage equation (12) together with the price equation (32) imply

(A35) $$w_{it} = m_{t-1} - \delta_1 \xi_{t-1} - \delta_2 \eta_{t-1}$$

The components of labour demand are

(A36a) $$m_t - p_t = \frac{\beta\delta_1}{\alpha+\beta} \xi_t - \frac{1-\beta\delta_2}{\alpha+\beta} \eta_t$$

(A36b) $$E_t p_{t-1} - p_t = -\frac{\alpha\delta_1}{\alpha+\beta} \xi_t - \frac{\alpha\delta_2 + 1}{\alpha+\beta} \eta_t$$

(A36c) $$w_{it} - p_t = -\frac{\alpha+\beta(1-\delta_1)}{\alpha+\beta} \xi_t - \frac{1-\beta\delta_2}{\alpha+\beta} \eta_t$$

and hence

(A37) $$\ell_{it} = \frac{\gamma}{\alpha+\beta} (\alpha+\beta-\beta\delta_1) \xi_t + \frac{\gamma}{\alpha+\beta} (1-\beta\delta_2) \eta_t$$

which coincides with equation (35).

If instead all other firms are in a two-period contract, combine equations (12) and (33) to obtain

(A38) $$w_{it} = m_{t-1} - \delta_1 \xi_{t-1} - \delta_2 \eta_{t-1} = p_t$$

and

(A39a) $$m_t - p_t = \xi_t$$

(A39b) $$E_t p_{t+1} - p_t = (1-\delta_1)\ \xi_t - \delta_2 \eta_t$$

(A39c) $$w_{1t} - p_t = 0$$

By substitution of (A39a)-(A39c) into the labour demand (6) we can thus obtain equation (39).

Appendix B

In the present Appendix we derive the critical conditions for negative externalities in contract length, under the assumption that current shocks are not observed when contracts are signed. Our previous results are not affected in any substantial way by this change in the informational assumptions of the model: the necessary and sufficient condition for negative externalities is still shown to be given by

$$\gamma < \alpha + \beta$$

(equation (20) in the text) for each of the cases that we consider.

We retain the assumption that the firms have the option of signing either one- or two-period contracts. These are however redifined as follows. In the one-period contracts, firms set wages for time t at the end of period t-1, before the realization of the shocks ξ_t, η_t. Employment is instead set after the uncertainty about current shocks is resolved. In the two-period contracts, wages are set at the end of period t-2.

Formally, the one-period contracts in the present context are comparable to the two-period contracts of the analysis developed in the text and in Appendix A. We can thus use for the former the analytical results already obtained for the latter. The model is then given by the money supply (2), the labour demand equation (6), and the wage setting rules which are derived below.

1. Uncorrelated shocks

(i) One-period contracts

Let the shock η_t be a white noise process with variance σ^2_η. Firm "i" sets w_{it} at the end of period t-1 by solving the equation $E_{t-1}(\ell_{it})=0$. Therefore the analysis can proceed as in Section A.2.(ii), and the solution for the price level is

(B1) $$p_t = m_{t-1}$$

(ii) Two-period contracts

If all firms are in the first period of a two-period contract, prices are given by equation (B1) above. Let firms at time t be in the period of a two-period contract. Then

(B2) $$w_{it} = \frac{\alpha}{\gamma} E_{t-2}m_t + \left(1 - \frac{\alpha+\beta}{\gamma} \right) E_{t-2}p_t + \frac{\beta}{\gamma} E_{t-2}p_{t+1} + \frac{1}{\gamma} E_{t-2}\eta_t$$

Aggregating,

(B3) $$p_t = \frac{\alpha}{\gamma} m_{t-2} + \left(1 - \frac{\alpha+\beta}{\gamma} \right) E_{t-2}p_t + \frac{\beta}{\gamma} E_{t-2}p_{t+1}$$

The guess solution for the level of prices has the form

(B4) $$p_t = \pi_0 m_{t-2}$$

which of course also implies

(B5) $$E_{t-2}p_t = \pi_0 m_{t-2}$$

By contrast, since there is no staggering, prices at t+1 must be given according to (B1) by

(B6) $$p_{t+1} = m_t$$

and hence

(B7) $$E_{t-2}p_{t+1} = m_{t-2}$$

By substitution of (B5) and (B7) into (B3) and solving we obtain

(B8) $$p_t = m_{t-2}$$

(iii) Externalities

When firm "i" is in the last period of a two-period contract and all other firms are in a one-period contracts, we have $p_t = m_{t-1}$, $E_tp_{t+1} = m_t$, and $w_{it} = m_{t-2}$, which imply

(B9a) $$m_t - p_t = \xi_t$$

(B9b) $$E_tp_{t+1} - p_t = \xi_t$$

(B9c) $$w_{it} - p_t = - \xi_{t-1}$$

The value of the externalities is thus

(B10) $$z_{it}^{(1)} = [(\alpha+\beta)^2 + \gamma^2]\ \sigma_{\xi}^2 + \sigma_{\eta}^2$$

Suppose now that all firms are in the last period of a two-period contract. Then $p_t = m_{t-2}$, $E_t p_{t+1} = m_t$ (since price setting is synchronized), and $w_{it} = m_{t-2}$, and therefore

(B11a) $$m_t - p_t = \xi_t + \xi_{t-1}$$

(B11b) $$E_t p_{t+1} - p_t = \xi_t + \xi_{t-1}$$

(B11c) $$w_{it} - p_t = 0$$

The externalities are given by

(B12) $$z_{it}^{(2)} = 2(\alpha+\beta)^2\ \sigma_{\xi}^2 + \sigma_{\eta}^2$$

By comparing (B10) with (B12), the critical condition for negative externalities from an increase in contract length is seen to be

$$\gamma < \alpha + \beta$$

By contrast, if firm "i" is in the first period of a two-period contract, its losses are easily shown to be independent of other firms' contract length. Formally, if all firms are in one-period contracts then the components of firm "i" 's labour demand are given by

(B13a) $$m_t - p_t = \xi_t$$

(B13b) $$E_t p_{t+1} - p_t = \xi_t$$

(B13c) $$w_{it} - p_t = 0$$

and its losses are

(B14) $$z_{it}^{(1')} = (\alpha+\beta)^2 \sigma_\xi^2 + \sigma_\eta^2$$

If instead all firms, with the exception of firm "i", are in the second period of two-period contracts then

(B15a) $$m_t - p_t = \xi_t + \xi_{t-1}$$

(B15b) $$E_t p_{t+1} - p_t = \xi_t + \xi_{t-1}$$

(B15c) $$w_{it} - p_t = \frac{\alpha+\beta}{\gamma} \xi_{t-1}$$

whence

(B16) $$z_{it}^{(2')} = (\alpha+\beta)^2 \sigma_\xi^2 + \sigma_\eta^2$$

which coincides with (B14). Therefore, if firm "i" signs short-term contracts its losses do not depend on whether the other firms are in short or long-term contracts. The intuition behind this result is clear: in the above framework, externalities arise due to the inability of firms to adjust wages in the face of changes of the aggregate price level. When firm "i" signs one-period contracts, it is at least as fast in adjusting to aggregate shocks as the other firms. It is therefore always able to react to any changes in aggregate prices. The losses (B14) (or (B16)) are indeed always strictly lower than the corresponding expressions (B10) or (B12): they are thus reduced to a level which cannot be further decreased given the information lag in the wage setting process.

This finding is a general result, which does not depend on the absence of serial correlation between the shocks nor on the assumed properties of the money supply process. Hence, in the next sections of the present Appendix we shall only compute the losses for the case in which firm "i" is in the second period of a two-period contract.

2. <u>Autocorrelated shocks</u>

The demand shock η_t evolves now according to equation (21) in the text:

$$\eta_t = \rho\, \eta_{t-1} + \varepsilon_t$$

If all firms sign one-period contracts, the price level is given by

(B17) $$p_t = m_{t-1} + \frac{\rho}{\alpha+\beta(1-\rho)} \eta_{t-1}$$

In the second period of a two-period contract, prices are

(B18) $$p_t = m_{t-2} + \frac{\rho^2}{\alpha+\beta(1-\rho)} \eta_{t-2}$$

Let us now assume that firm "i" is in the second period of a two-period contract. If all other firms shift from one to two-period contracts, firm "i" 's losses are respectively given by

(B19) $$z_{it}^{(1)} = [(\alpha+\beta)^2 + \gamma^2] \sigma_\xi^2 + \frac{[(\alpha+\beta)^2 + \gamma^2\rho^2]}{[\alpha+\beta(1-\rho)]^2} \sigma_\varepsilon^2$$

(B20) $$z_{it}^{(2)} = 2(\alpha+\beta)^2 \sigma_\xi^2 + \frac{(1+\rho^2)\ (\alpha+\beta)^2}{[\alpha+\beta(1-\rho)]^2} \sigma_\varepsilon^2$$

in the usual notation. Condition (20) still applies.

3. Countercyclical money rule

The monetary authorities follow the lagged feedback policy rule (31), which is here reported for convenience:

$$m_t = m_{t-1} + \xi_t - \delta_1\xi_{t-1} - \delta_2\eta_{t-1}$$

Under one period contracts, the aggregate price level is

(B21) $$p_t = m_{t-1} - \delta_1\xi_{t-1} - \delta_2\eta_{t-1}$$

whilst in the second period of two-period contracts prices are

(B22) $$p_t = m_{t-2} - \delta_1\xi_{t-2} - \delta_2\eta_{t-2}$$

If firm "i" is in the second period of a two-period contract while all other firms are in a one-period contract, then

(B23) $$z_{it}^{(1)} = \{ [\alpha+\beta(1-\delta_1)]^2 + \gamma^2(1-\delta_1)^2 \} \sigma_\xi^2$$

$$+ [(1-\beta\delta_2)^2 + \gamma^2\delta_2^2] \sigma_\eta^2$$

If all firms are in two-period contracts,

(B24) $$z_{it}^{(2)} = \{ [\alpha+\beta(1-\delta_1)]^2 + (\alpha+\beta)^2(1-\delta_1)^2 \} \sigma_\xi^2$$

$$+ [(1-\beta\delta_2)^2 + (\alpha+\beta)^2\delta_2^2] \sigma_\eta^2$$

and $z_{it}^{(2)} > z_{it}^{(1)}$ iff $\alpha+\beta > \gamma$.

It is interesting to notice that in this case the monetary authorities can no longer eliminate the losses by means of a suitable choice of the policy parameters δ_1 and δ_2. They can however still exert a stabilizing influence, and indeed it would be easy to show that employment variability would now be minimized by setting

$$\text{(B25a)} \qquad \delta_1^* = 1 + \frac{\alpha\beta}{\beta^2+\phi^2}$$

$$\text{(B25a)} \qquad \delta_2^* = \frac{\beta}{\beta^2+\phi^2}$$

where

$$\phi = \begin{cases} \gamma & \text{under one-period contracts} \\ \alpha+\beta & \text{under two-period contracts} \end{cases}$$

It is apparent that δ_1^*, δ_2^* as defined in (B25a), (B25b) do not reduce the losses to zero. There exist externalities which cannot be removed by a lagged-feedback policy rule. The reason for this is that, in the framework considered here, wages and prices are entirely predetermined, whilst employment is free to react to contemporaneous disturbances.

Perfect stabilization is therefore no longer a feasible target. Active policy is however always capable of reducing the variability of the level of employment relative to a situation of no intervention (i.e. $\delta_1=\delta_2=0$).

Moreover, when short contracts prevail, the value of the externalities in the absence of a feedback policy is given by

$$\text{(B26)} \qquad z_{it}^{(1)}\bigg|_{\delta_1=\delta_2=0} = [(\alpha+\beta)^2 + \gamma^2]\ \sigma_\xi^2 + \sigma_\eta^2$$

On the other hand, the optimal policy reduces the losses to

$$\text{(B27)} \qquad z_{it}^{(2)}\bigg|_{\delta_1=\delta_1^*,\,\delta_2=\delta_2^*} = \frac{\alpha^2(\alpha^2+2\alpha\beta)(\alpha+\beta)^2}{[\beta^2+(\alpha+\beta)^2]^2}\ \sigma_\xi^2$$

$$+ \frac{(\alpha+\beta)^2}{\beta^2+(\alpha+\beta)^2}\,\sigma_\eta^2$$

Since (B27) is always smaller than (B26), we can restate the superiority of active policy vis-à-vis wage flexibility.

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