Productivity, The Capital Stock and Profit Sharing in UK Firms 1974-86: A Micro-Data Study

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Chapters 2 to 6 of this thesis are revised versions of working papers and articles co-authored with my supervisor, Sushil Wadhwani. In addition Stephen Nickell was a co-author of the paper upon which chapter 6 is based. Chapter 2 is based on 'The UK Capital Stock: New Estimates of Premature Scrapping' in ***Oxford Review of Economic Policy*** August 1986. Chapter 3 is based upon 'The Effects of Profit Sharing on Employment, Wages, Stock Returns and Productivity: Evidence From UK Micro-Data', forthcoming in ***The Economic Journal***, March 1990. Chapter 4 is based on 'A Direct Test of the Efficiency Wage Model Using UK Micro-Data' CLE discussion paper no. 313. Chapter 5 is a version of 'Unions and Productivity Growth in Britain, 1974-86: Evidence From Company Accounts Data', CLE discussion paper no. 353. Chapter 6 is drawn from 'The Effects of Unions on Corporate Investment, Evidence From Accounts Data, 1972-86', CLE discussion paper no. 354.

Abstract.

The work described in this thesis is concerned with empirically testing four hypotheses about the observed behaviour of the labour market over the 1974-86 period. The data used for these tests is drawn from the published accounts of a panel of UK manufacturing firms. Specifically these four hypotheses are:-

1. That the oil shocks of 1973 and 1979 caused a great deal of 'economic' scrapping of capital equipment. Such a fall in the capital stock would not be picked up in the official figures, and could be a cause of the fall in measured TFP growth after 1973. Using data on 'current cost' valued assets to inflation adjust the 'historic cost' figures contained in accounts we conclude that the official measure of the capital stock does overstate the 'true' figure for most of this period, but that this overstatement is by much less than suggested by other authors and could not account for more than a fraction of the productivity 'slowdown.'

2. That the introduction of profit related pay will lead to desirable economic outcomes including higher productivity and perhaps a cure for stagflation. Specifically we test the models of firm and worker behaviour that are due to Martin Weitzman. We test a key proposition of Weitzman by exploring it's implications for empirical employment and stock returns equations. We find no support for Weitzman's proposition. We also find evidence that profit sharing will be wage inflationary. However there is some evidence that profit sharing causes higher productivity.

3. That payment of 'efficiency wages' enhances productivity. The efficiency wage hypothesis suggests that firms will pay high wages because they reap more in the way of higher productivity than they lose in terms of increased wage costs. This could explain why high wages persist with high unemployment. We test for a direct effect of relative wages on productivity. We find such an effect and carry out further experimentation to test whether this result points to an efficiency wages or some competititive explanation of wage setting. We also find that high unemployment leads to higher productivity. This finding provides some evidence for efficiency wage models. The finding that high unemployment boosts productivity could be an explanation of the high productivity growth of the 1980s.

4. That firms that recognise unions will have lower productivity growth then non-union firms. Unions are supposed to adversely affect the economic performance of the firm by defending restrictive practices and resisting technical change. Using a data set that includes firm level data on union status we find that there is no evidence to suggest the union firms have lower productivity over our sample period. We find that unionised firms grow at the same rate as non-union firms over the 1975-78 and 1985-86 periods, but grow faster over the 1980-84 period. We feel this effect is consistent with unions being unable to defend restrictive practices over the eighties, but that the probable cause of this is the 'shock' effect of the 1979-81 recession rather than the change in trade union legislation.

We also assess whether unions act as a deterrent to investment. This would be the case if investors expected unions to capture the quasi-rents from capital. We show that union density does not effect investment and that union firms do not invest less than non-union firms. By estimating a wage equation we also show that unionised workers are not more effective than non-unionised at capturing the quasi-rents from capital.

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List of Abbreviations

CSO : Central Statistical Office

DPD : Dynamic Panel Data (program)

EW : Efficiency Wages

MM : Mendis and Muellbauer (1984)

NGA : National Graphical Association

PRP : Profit Related Pay

R&D : Research and Development

TFP : Total Factor Productivity

WIRS : University of Warwick, Industrial Relations Department, Workplace Industrial Relations Survey. (WIRS I, 1980, WIRS II, 1984).

GMM : General Method of Moments.

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I have benefited enormously from the help of a large number of people who have made useful comments, suggested lines of approach or made data and software available. I have tried to indicate in the text and footnotes specific instances of where I feel special thanks are due.

Finally I would like to dedicate this to my parents, Kenneth Wall and Jean Wall.

Chapter 1: Introduction

1.1 Overview

The reports and accounts published annually by registered companies contain a vast amount of information that has been more or less left unexploited by economists. The motivation for the work in this thesis has been to rectify this by using accounts data to create a cohort of UK firms that are followed over the 1970s and 1980s. This dataset can then be used to assess interesting economic hypotheses ***at firm level***. This has the advantage, common to microeconometric studies, that it is easier to deal with problems of aggregation bias and measurement error. This particular study has an additional advantage in that, because of the large size of our firms, our sample covers over a quarter of all manufacturing capacity in the UK in 1980. Thus the behaviour of the sample might be considered important in it's own right, independent of whether we can use it to make inferences for the behaviour of the whole manufacturing sector.

The main empirical problems faced were concerned with turning the figures the companies present in their reports into meaningful economic quantities. This is discussed in the next section.

The economic problems and hypotheses we addressed were to some extent chosen by the availability of the data. Within the set of possible hypotheses that could be tested using this data set, we chose to concentrate on assessing the importance of theories that rely for their justification on 'non-standard' labour market behaviour. Specifically we look at; a) the effects of introducing profit sharing schemes, do they lead to desirable outcomes? b) do higher relative wages lead to higher productivity, and is this due to an 'efficiency wage' effect? c) does the degree of unionisation of the workforce effect the economic performance of the firm? We discuss these questions in section 1.3.

1.2 Empirical Problems

Our firm level databank was constructed using data from both company accounts and stock market databases (all details are to be found in the data appendix). The sample follows up to 250 firms for from 7 to 15 years (the sample size varies in both dimensions as our data requirements change). The maximum sample period is 1972-1986, covering both oil shocks, the recession of 1979-81 and the recovery that has taken place since that date.

The main problem we faced was that company accounts are not drawn up for the purpose of providing accurate data for economic analysis. This was a particularly acute problem when it came to calculating the capital stock. However an an accurate measure of each firm's productive capacity is vital for the subsequent empirical work. Chapter two is concerned with the methodology we adopted to obtain a suitable measure of capital.

The problem is caused by the fact that accountants value assets at 'historic' cost, each asset is valued at it's price when it was installed. We are interested in the 'current' or 'replacement' cost which should much more closely correspond to the physical capacity of capital. To obtain the latter value from the former, one needs information on the age profile of the firm's assets. No such information of this sort is available.

The measure of the firm specific capital stock that we obtain is used in later chapters as an variable in empirical work. However, the behaviour of the capital stock over the sample period is also interesting in it's own right. There has been a great deal of interest in the hypothesis that the periods following the oil shocks of the 1970s were characterised by a considerable amount of 'economic' scrapping of productive assets. When there is a large change in relative factor prices, so the story goes, a portion of the existing capital stock may be no longer economic to operate. This is called 'economic' scrapping. The machines involved have not reached the end of their physical lives but they no longer form part of the 'effective' capital stock. Scrapping for this reason would not be detected by the official Central Statistical Office (CSO) measure of capital (for reasons discussed in the text) and hence the official measure could overstate productive capacity. Some economists have argued that this 'unobserved' scrapping could be one of the reasons for the slowdown in the measured growth of total factor productivity (TFP) after 1973. We discuss what inference we can draw from the behaviour of our measure of the capital stock, calculated directly from firm's accounts, and what implications this has for the accuracy of the official measure.

We find that there has been 'unobserved' scrapping over our sample period. The official figure consistently overstates the 'true' figure over the period 1976 to 1982, which is where this particular study ends. That being said, this overstatement is much less than has been estimated by other studies and we estimate that only .31 of the 2 per cent slowdown in measured TFP growth after 1973 can be accounted for by this measurement error. The results of this study are important for two reasons.

i) It assesses the accuracy of the official CSO figures for the stock of capital. We find these figures are inaccurate but by a much smaller degree than has been suggested by other authors (see table 2.1).

ii) If the UK capital stock had fallen by as much as these authors had suggested than any attempt to reflate the economy would have quickly ran into capacity constraints causing inflation to increase without unemployment falling.

1.3 The Economic Problems

As stated above, the economically interesting problems that we felt able to investigate were to some extent dictated by the strengths and weaknesses of the data. We chose to concentrate on assessing explanations of labour market behaviour that do not fit into the market clearing model.

It is quite clear that the standard market clearing paradigm does not explain many aspects of observed labour market behaviour. Some of the key questions that labour economists ask cannot, therefore, be answered without moving away from this model. Do firms pay above the competitive rates for their labour and if so, why? Why have firms introduced profit sharing schemes; what advantages are such schemes thought to have over paying fixed wages? What is the role of a union within a firm? If unions act as obstacles to the operation of a free market, how can unionised firms survive?

The point is that a great deal of labour market behaviour only makes sense by appealing to notions of 'custom' or 'fairness', or to the idea that there is a workplace 'culture'. These are not notions that can be subsumed into the error term. Ommitting them from the model simply leads to false conclusions. We deal below with three areas of economic theory; to do with profit sharing, efficiency wages and the effects of unions, that all draw on theories of labour market behaviour that come less from the idea of market clearing and more from game theoretic and sociological models of the relationship between the firm and it's workers.

1.3.1 Profit Sharing

In chapter 3 we attempt to assess what beneficial effects (if any) result from linking part of employee remuneration to the surplus earnt by the firm. The 'traditional' argument in favour of profit sharing is that it directly leads to increased productivity through greater cooperation among workers and managers. More recently Martin Weitzman, in his book and articles, has made claims about the beneficial ***macroeconomic*** effects of introducing Profit related pay (PRP). We subject these claims to scrutiny using Weitzman's work as the basis for our own.

The empirical results for this chapter are based on a balanced panel of 101 firms for which we have both accounting data and detailed survey information on profit sharing. Of these firms, 21 operated a PRP scheme at some point over the sample period.

The beneficial ***macroeconomic*** effects of profit sharing depend crucially on the assumption that the base wage and *not* the total level of remuneration (i.e. the base wage plus the profit related bonus) is the relevant marginal cost of labour to the firm when deciding upon it's level of employment. If this is true then, in the Weitzman model, widespread introduction of PRP will lead to an increase in employment. Indeed the economy will be an equilibrium where there is excess demand for labour. Governments can then pursue anti-inflationary measures without worrying about the consequences for unemployment. This is nothing less than a cure for stagflation.

We test the effects of these schemes in four ways:-

i) We estimate an employment equation. Separate coefficients are given to the base wage and the bonus. If it is true that firms regard the base wage as the relevant variable for employment decisions then the coefficient on the bonus will be zero.

ii) We estimate a wage equation. Here we are testing Weitzman's contention that PRP schemes lead to a reduction in wage pressure. We also test the popular notion that the profit related bonus will simply be regarded as an add-on payment and hence will be inflationary.

iii) We also estimate a stock returns equation. If the PRP scheme is genuine, as opposed to a cosmetic scheme operated solely to obtain tax concessions, then the workers are sharing some of the risk previously bourne only by the equity holders. In a rational stock market, investors should accept a lower return on this equity since it's associated risk has fallen. Therfore the return on equity should fall when a PRP scheme is introduced.

iv) Finally a production function is estimated. This is to test for the 'traditional' effect of profit sharing on productivity.

The main conclusions of this section are that:-

1) Firms regard total remuneration and not the base wage as the relevant marginal cost of labour.

2) The profit related bonus does not enter the wage equation. This is consistent with the popular view that this bonus is simply regarded as an 'add-on' payment by wage negotiators.

3) There is evidence that profit sharing increases productivity.

These conclusions suggest that PRP is not the cure for stagflation that it's proponents believe.

1.3.2 Efficiency Wages

The main characteristic of efficiency wage models is that firms find it profitable to pay wages above the market clearing level. This is because the the payment of a high relative wage induces increases in productivity that outweigh the increased wage costs. Since the wage is no longer determined by market clearing, involuntary unemployment can persist.

This effect can operate through several channels. Basically the firm finds it difficult to monitor the effort level of it's workers. A higher relative wage will change the incentives facing a worker so he will work harder. Efficiency wage arguments are embedded in several types of models.

(i) Workers will either 'work or shirk' on the job. By raising the relative wages you increase the costs of job loss to each worker so he is less likely to shirk.

(ii) A higher relative wage will reduce the quit rate. This leads to lower training costs and higher firm specific human capital.

(iii) Workers regard a higher wage than necessary as a 'gift' and will reciprocate by working harder.

The main problem with testing such models is that a positive relationship between relative wages and productivity is perfectly consistent with the classical market clearing theory of wage determination.

(i) Firms could be paying more for workers of higher quality.

(ii) Firms could be paying more for greater bargained effort or compensating for a poor work enviroment.

(iii) The causality could run from higher productivity to higher wages, i.e. the firm could be sharing rents with it's workforce.

We attempt to discriminate between the former and latter group of theories by estimating a production function where both the relative wage and unemployment effect productivity. The presence of the latter variable is important to the discriminatory power of our empirical work. It is important because, in an efficiency wage model, the worker decides on his level of effort by comparing his current wage with his perceived 'outside opportunities'. These reflect how well he thinks he would do if he left, or was sacked from, his current job. Higher unemployment will reduce his 'outside opportunities' and hence will increase his effort in his current job. Such a role for unemployment would be more difficult to rationalise in the context of a market clearing model.

We find a positive productivity effect for both relative wages and the rate of unemployment. For the above reasons we feel that the latter effect provides some evidence that there is an efficiency wage effect in our firms. Both of these effects are robust to using a wide variety of different specifications. The effort-wage elasticity is about 0.35 and the effort-unemployment elasticity is about 0.05.

The results of this chapter are important because it may help to explain the 'breakthrough' in labour productivity growth that occurred in the '80s. The government has argued that this is due to an 'industrial relations' breakthrough in British industry. We would argue that at least part of this breakthrough involves workers deciding on higher effort levels to avoid losing or leaving their jobs at a time of very low outside opportunities.

1.3.3 Unions and Economic Performance

In Chapters 5 and 6 we examine the effects that trade unions have on economic performance. Specifically, chapter 5 is concerned with productivity and chapter 6 with investment. Our basic approach is to compare the productivity and investment records of firms where there is a recognised union with those of firms where no union is recognised.

(i) Productivity: For a long time the 'received wisdom' has been that unions adversely effect economic performance. Unionised workers will be less productive, on average, than non-unionised. This effect is supposed to work through two channels:-

1. Unions will be associated with inefficient working practices such as the overmanning of machines and the existence of demarcation lines between related tasks. This prevents the manager from directing and allocating labour resources in an efficient way.

2. Unions will resist technical change and will thus prevent firms from competing effectively with non-unionised rivals. This will also adversely effect the productivity growth of unionised firms.

We suggest that the above arguments represent the 'popular' view of the way unions operate. This view has been promulgated by both politicians and the press throughout our sample period. It was clearly shared by the, newly elected, Thatcher government in 1979. In October 1979, Sir Keith Joseph, then the Minister for Industry and a prime mover in the formulation of government policy in this area, stated in a speech to the NEDO:-

> "Trade Union attitudes make good management difficult. Many at Shopfloor level seem hostile to the need for industrial efficiency...Labour agreements are less dependable in the UK and restrictive practices - reflected in a reluctance by labour to agree to the elimination of unnecessary work rules - are too prevalent." (quoted in Taylor (1982)).

Academics have usually been more cautious about attributing the ills of UK industry to it's degree of unionisation. However, in a series of papers in recent years David Metcalf has argued that the empirical evidence points unequivocally to unions adversely effecting almost every aspect of economic performance (Metcalf 1988a, b). This work has received a good deal of attention and has influenced present government policy as expressed in ***Employment for the 1990s*** (White Paper (1988))[2]

Part of the motivation for the work reported in chapter 5 was to examine the strength of the empirical evidence for the effects reported by Metcalf. We also wished to evaluate the importance of theories of union behaviour that differ from the 'popular' view.

That this 'popular' view cannot be the whole truth is seen if we compare the UK with countries such as Sweden, Norway and Austria. These countries couple stable, low unemployment and high standards of living with the highest rates of unionism in the western world. This would suggest that it is not the existence of unions ***as such*** that leads to poor economic performance.

The most well known 'pro-union' theory is the 'union voice' model due to Freeman and Medoff (1984). In this model the union acts as a means whereby the workforce can express their grievances to the management in a constructive fashion. Without a union, if they are unhappy with some aspect of their work they have a limited number of actions (quitting, shirking, sabotaging etc.), all of which are negative. Thus the presence of a union can lead to higher productivity.

Another interesting hypothesis with regard to unions was whether the anti-union legislation of the 1980s had led to a diminuation of union power, the lessening of union's ability to defend restrictive work practices and hence higher productivity. This is clearly the opinion of the government (see ***Employment for the 1990s*** section 2.). We discuss the changes in legislation over the 1980s in 5.3.1.

We set up a model where unions bargain over both wages and effort. This model gives us an equation where the bargained level of effort (i.e. labour productivity) is inversely related to union power. Union power in it's turn, is effected by firm specific variables, such as recognition and the proportion of the workforce covered by collective agreements, and aggregate variables, such as the strength of anti-union legislation. We obtain the firm specific variables by merging the results of two surveys on unionisation, one carried out by ourselves and one by Steve Machin (see data appendix for full details). Our results show that, over the periods 1974-79 and 1985-86, union firms had similar productivity growth to non-union firms. Over the period 1980-84, union firms grew faster. These results are weakly consistent with the view that the anti-union legislation of the 1980s led to the abandonment of restrictive practices by unions and to a productivity 'catch-up' in unionised firms. However, for this to be convincing, we would expect unionised firms to be growing more slowly than non-unionised over the 1974-79 period, characterised by pro-union legislation (see 5.3.1), and also that this 'catch-up' should have occurred later in the sample period and not have fizzled out in 1985 when, in the aftermath of the miners strike, the legislation would be expected to be reaching it's full strength. A story we prefer is that it was the shock of the recession of 1979-81 that forced the changes in working practices. Something like 1 in 7 of industrial workers lost their jobs during this period and the fear of redundancy induced by this event meant that workers came to realise that productivity gains were necessary in order for the firm to survive. Since 1985 unionised firms have 'caught up ' and there would seem little benefit in continuing to weaken union's ability to defend their members interests.

(ii) Investment: If unionised firms invest less than non-union firms then their relative long term productivity growth will fall. In chapter 6 we investigate whether unionisation deters investment.

The original insights in this area are due to Simon (1944). He argued that:-

a) Unions will capture the quasi-rents of long term capital. This occurs because typically, once installed, capital is irreversible. The costs of investment are 'sunk' since there is no easy way of switching the capital out of the industry. Unions will realise this and demand a wage such that the firm only just covers variable cost and so remains in business. However, all the gains from the investment now go to the union.

b) Rational investors will foresee this possibility and hence will not invest in unionised firms.

These insights have been formalised in models by Baldwin (1983) and Grout (1984). A further channel through which unions could effect investment is by resisting technical change or insisting on maintaining old working practices for new machines. Thus unionised firms might face higher adjustment costs when investing (this is contained in a model due to Denny and Nickell (1989)). We might expect this latter effect to become weaker over the 1980s because of the anti-union legislation. We approach this problem by firstly deriving an investment equation from underlying theory and including the degree of unionisation as an explanatory variable. We found no evidence that union firms invested less on average. Our results indicated, if anything, that there was a ***positive*** relationship between unionisation and investment. We then went on to estimate a wage equation to examine whether unionisation actually does enable workers to capture a greater proportion of the rents from capital. We found no evidence to support this hypothesis either. Thus, even if the insights of Simon were correct, there is no evidence that unionised workforces are any better at capturing quasi-rents than non-unionised. Hence, unionisation, as such, will not effect investment behaviour.

The results of this section again illustrate that there is no strong evidence to indicate that unions are always an adverse effect on economic performance.

The results of the two chapters on unions point to the dangers of relying too heavily on anecdotal evidence to form a world view or as a basis for policy. However, the poor quality of published data in this area clearly indicate that further research is required.

Footnotes

1 'Unobserved' and 'economic' scrapping are here the same thing and hence these terms are used interchangebly.

2 "Recent research shows that trade unions have used their power in ways which have adversely affected labour costs, productivity and jobs. Managements who recognised and negotiated with trade unions were more likely to suffer job losses than managements which did not. In general trade unions tended to push up the earnings of people they represented whilst blocking the improvements in productivity which are neede to pay for these higher earnings." ***Employment for the 1990s*** Para. 2.4.

Chapter two

The U.K. Capital Stock: New Estimates of Premature Scrapping

2.1 Introduction

The purpose of this chapter is twofold:

i) To obtain a satisfactory measure of each firm's capital stock to use as an input in future empirical work.

ii) To use this measure to make inferences about the behaviour of the capital stock in the whole of the U.K. manufacturing sector. Specifically we wish to answer the question, "has there been a great deal of 'premature scrapping' of capital in the U.K. over the seventies and early eighties ?" The problem of measuring the capital stock has aroused considerable interest both from academics and the press in recent years. The common view seems to be that the official figures, compiled by the Central Statistical Office (CSO), grossly overestimate the actual physical capital stock of the U.K. If this is the case then it is important for two reasons.

i) A lower than estimated capital stock could be a cause of the measured productivity slowdown this country experienced after 1973 (this is a view argued in papers by Muellbauer (1984) and Baily (1981)).

ii) If there has been a decline in manufacturing capacity then this will limit the ability of the government to reduce unemployment by reflating. The capacity constraints mean that any increase in demand will simply fuel higher inflation (this is argued in Ball (1985) and is also a popular opinion among journalists and politicians).

The reason the official figures are widely believed to be misleading is that they are based on fixed assumptions about retirements. Machines of type A are assumed to operate for x years at full efficiency and are then scrapped. This 'perpetual inventory' method ignores the possibility of the 'economic' scrapping of machines. This occurs when a change in relative prices or a demand shock make continued operation of the machine uneconomic. The optimal action by the firm is then to scrap or retire the machine no matter how many years of it's assumed lifespan remains. Such large changes in relative prices occurred in 1973 with OPEC I and 1979 with OPEC II, and there was a massive fall in competitiveness in 1980. It seems highly likely that a significant amount of plant and machinery, economic to operate with cheap energy, could no longer cover variable costs after either 1973 or 1979. The approach we take to this problem is to use the data contained in company accounts as a direct measure of the capital stock. The main difficulty with this approach is that, in company accounts, fixed assets are valued at 'historic' cost and we need to make certain assumptions to adjust these figures to, the economically more meaningful, 'replacement' or 'current' cost value. When there is non-zero inflation these two concepts will differ. Fortunately, a sub-set of these firms have been valuing assets at current cost since 1980. We use these current cost figures in two ways. Firstly they are of interest in themselves, providing direct evidence of the behaviour of the capital stock over 1980-82. Secondly, they act as a valuable check as to the validity of our inflation adjustment of the historical cost series.

Using the current cost data as direct evidence of the behaviour of the capital stock over 1980-82 is, a priori, a more satisfying procedure than using indirect, econometric methods, such as the one used by Robinson and Wade (1985). These authors argue that 11-12 percent of the capital stock was scrapped between 1979 and 1981. Our evidence suggests that this is unlikely. The current cost assets of our firms do not change much over these years. Although we would admit that our sample could not be regarded as representative, there would have to be massive unobserved scrapping in the firms outside our sample for our results to be consistent with those of Robinson and Wade.

We then wished to obtain a series going back to 1973 in order to provide an answer as to whether an unobserved fall in the capital stock was a proximate cause of the productivity slowdown. To do this required inflation adjusting the historic cost figures for a sample of 333 firms. These firms, between them, employed almost 2 million people in 1979. To adjust these figures for inflation we must make some assumption about the length of life of disposed assets. There are several possible assumptions, none of which is a priori superior. We chose the adjustment which leads to our inflation adjusted series being closest to the current cost series. The results of this exercise suggest that the CSO has overestimated the growth in the capital stock over 1976-82 and that this is especially true for the period 1980-82. However the degree of economic or premature scrapping that we find is much less than that suggested by other authors (see table 2.1). Specifically our 1978-82 figure is a fall of 2.3 per cent compared with Robinson and Wade's figure of -11 per cent and the CSO figure of +2.25 per cent. On the question of productivity slowdown, our estimate of unrecorded scrapping can explain only .31 of the 2 per cent slowdown in productivity growth after 1973 (based on the figures of Mendis & Muellbauer (1984)).

Section 2.2 contains a review of existing work on this subject. Section 2.3 presents the current cost numbers. Section 2.4 contains details of our method of adjustment and the empirical results we obtain. Section 2.5 discusses the robustness of our estimates to alternative assumptions. In 2.6 we analyse the implications of this work for measuring U.K. productivity growth. This is done within the framework of papers by

Muellbauer (1984) and Mendis and Muellbauer (1984). Section 2.7 contains a summary and some conclusions.

2.2 A Review of Existing Estimates of the Capital Stock

The CSO estimates the stock of fixed capital by using the 'perpetual inventory' method (this is reviewed in Griffin (1976)). Investment expenditures are cumulated over time and an estimate of scrapping is subtracted. The amount of scrapping that is estimated depends on the length of life that the CSO allots to each particular type of asset in the capital stock. To show how this works consider the following example. A certain industry in 1971 has an unknown stock of capital and each year it invests in £10 million's worth of fixed assets all of which have an operating lifespan of two years. So, at the end of 1972 it has at least £10 million in capital goods. At the end of 1973 it has exactly £20 million because all the unknown capital in 1971 has now been scrapped. If, in 1974, it invests £15 million, then it's capital stock at the end of the year will be £25 million, £20 million plus £15 million minus the £10 million's worth of capital originally installed in 1972 and that has now been scrapped. In practice this is made considerably more complex by having to assume different service lives for different types of asset. This system will give a smooth series and probably mimics how firms plan capital accumulation to occur. In fact this system would be very satisfactory if the underlying incentives to invest in, or scrap, machines remained stable. Several authors[1] have argued that these underlying incentives have been altered by the relative price changes that occurred in the seventies (in particular OPEC I and OPEC II, 1973 and 1979 respectively), and the negative demand shock in 1980 (caused by a fall in competitiveness). To assume fixed service lives over such a turbulent period may be very misleading. For example, in our story, if £5 million's worth of capital was made obsolescent by OPEC I and scrapped at the end of 1973, then this would not be measured by the 'perpetual inventory' method and, in this case, the capital stock would be over estimated by 20 per cent. Most of the authors cited above have attempted to assess exactly how inaccurate the CSO's method has been over this period. However all the alternative ways used have to rely on some method of indirectly inferring the degree of inaccuracy. The main methods used are:

i) Production Functions. Mendis and Muellbauer (1985) are mainly concerned with obtaining an accurate measure of productivity growth over the period 1955 to 1983. They fit a production function to quarterly data and are very careful to control for changes in labour utilisation and for measurement biases in recorded output. They estimate that the trend rate of annual productivity growth fell by two percentage points after 1973 (3.4% p.a to 1.4% p.a.). In 1979 there was a further fall of 1.7 points and a large increase of 3.1 points after 1980 quarter 3. The estimated equation is essentially;

$$\text{Ln}\left[\frac{Q}{K}\right]_t = \alpha\ \text{Ln}\left[\frac{L}{K}\right]_t + \text{Utilisation} + \text{trend} + \text{trend}_{59.4} + \text{trend}_{73.1} + \text{trend}_{79.3} + \text{trend}_{80.3} \qquad 2.1$$

Total factor productivity is modelled using a linear time trend with discrete switching points. If all the trend fall in productivity after 1973 is attributed to unobserved scrapping then by 1980 II the measurement error is 35%[2]. The problems with this approach are;

a) 35 per cent is an upper bound obtained by assuming all the slowdown is attributable to unobserved scrapping. It is not an estimate of the amount of scrapping. It also depends on the precision of the estimates. If the coefficient on capital varies either way by one standard error the 35%

becomes 28% or 47%.

b) This bound is also dependent on the precision of the estimates of the linear splines of the time trend. The switching points of the trend are chosen before estimation by looking at the data. This might not effect the estimate of the slowdown overall, but it might have a great effect on the point estimates on which this 35% figure is based.

ii) Behaviour of Output and/or the Capital-Labour ratio. Robinson and Wade (1985) were specifically interested in 'unobserved scrapping'. They argue that the capital labour ratio depends only on a trend and relative prices. On this basis they conclude that over 1979-81, the combination of OPEC II and the demand shock caused firms to scrap 11-12 per cent of their capital stock. The point of this is that in 1985 there will be no spare capacity, at least in manufacturing, to re-employ the unemployed. The only evidence they have that firms have scrapped machines rather than 'mothballed' them, to await better times, is the CBI's capacity utilisation index. This indicates that despite the degree of unemployment there was not a great deal of spare capacity in the economy at this time. The main weakness of the Robinson-Wade approach is that there is every reason to believe that the capital-labour ratio ***was*** changing over this time. In chapter 5 we argue that, in the post 1980 period, workers found themselves unable to defend restrictive work practices such as overmanning and demarcation. Discussion of the causes of this change is deferred until chapter 5. However, if the labour productivity 'miracle' of the 1980s is attributable to the widespread abandonment of restrictive practices then we would not expect the capital-labour ratio to be stable.

iii) The CBI capacity utilisation index. Record (1985) uses this series by estimating a relationship between it and the capital output ratio up until 1979. Using data on output and utilisation after 1979 he infers the capital stock and estimates it to have fallen by 11 per cent over 1979-81.

Another approach to the problem of measuring the extent of scrapping, was that taken by Simon Wren-Lewis, Mark Minford and myself in a National Institute discussion paper (1988). This paper also uses data on capacity utilisation taken from the CBI industrial trends survey to obtain a series for the unobservable 'full capacity' output . We argue in that paper that movements in 'full capacity' output represent movements in the 'effective' capital stock. The methodology used by Minford et al. is entirely different to that contained in this chapter and it is interesting that we reach similar conclusions with regard to scrapping.

The CBI asks a sample of UK firms the same question every quarter. The question is, 'is your present level of output below capacity?'. The only information available to us was the proportion of firms answering 'yes' to this question at time t. We define this proportion as D_t. To obtain a series for 'full capacity' output from this single piece of information required several assumptions.

We firstly needed to make some assumption about what the firm's answer to this question actually meant. We assumed that each firm knew what it's full capacity output was in each period (we defined this as CAP_{it}). There will be an indifference interval of width 2a around CAP_{it}. That is, the firm will only answer 'yes' to the above question if actual output falls short of capacity output by more than 'a'. Typical values of 'a' would be .05 or .1. The interpretation of this is that if firms are within this indifference interval then they are 'near enough' to full capacity.

Secondly we had to make some assumption about how utilisation was distributed across firms. Each firm has a utilisation level, x_{it}, which is the ratio of it's actual output to it's notional full capacity output, CAP_{it}. We then define CAP_t as the aggregate full capacity output at time t and $\bar{x}_t$ as the average level of utilisation. We ***define*** this as:-

$$\bar{x}_t = \ln Y_t - \ln CAP_t \qquad 2.2$$

i.e average utilisation is the ratio of aggregate output to aggregate 'full capacity' output. We then assume that firm level utilisation x_{it} is $sech^2$ distributed around $\bar{x}_t$ with constant variance, v. The $sech^2$ distribution is similar to the normal (see fig. 2.1). The advantage of using this assumption is that it can be shown that it leads to there being a very simple relationship between D_t and $\bar{x}_t$.

$$\bar{x}_t = -v\ CUD_t - a \qquad 2.3$$

where

$$CUD_t = \ln (D_t/1-D_t)$$

(so, if the proportion answering 'yes' to the question goes up then CUD_t will increase and $\bar{x}_t$ will fall). So, (2.1) and (2.2) gave us two equations in $\bar{x}_t$, We wished to solve these for the unobservable CAP_t. To do this we had to estimate 'a' and 'v'. Ideally we would have done this by regressing some independent estimate of $\bar{x}_t$ on CUD_t in (2.3). This approach was rejected because there was no obvious alternative measure. What we did instead was to assume a simple stochastic process for CAP_t. Using equation (2.2) this gave us an independent (though unscaled) measure for $\bar{x}_t$. We then use ***this*** to estimate 'a' and 'v'. In effect what this does is to impose some prior structure on how CAP_t should move. We expect it to be a fairly smooth series but we did not want to restrict it too heavily because, after all, this is what we finally wanted to estimate. The actual stochastic specification of CAP_t was assumed to be a random walk with stochastic drift. Estimating this model required us to use a Kalman Filter program[3]. This program will produce minimum mean square estimates of the unobservable 'state' variable CAP_t. Note that more general stochastic specifications are very easy to implement using a Kalman Filter. Solving (2.2) and (2.3) for CUD_t gives:

$$CUD_t = -\frac{1}{v}\left[\ln Y_t - \ln CAP_t + a\right] \qquad 2.4$$

We can write this as a Kalman Filter measure equation

$$CUD_t = \alpha_t - w \ln Y_t + u_t \qquad 2.5$$

Where $w = 1/v$, u_t has been added to represent measurement error and α_t is ***defined*** as:-

$$\alpha_t = 1/v[\ \ln CAP_t - a] \qquad 2.6$$

such that,

$$\alpha_t = \alpha_{t-1} + \beta_t + \epsilon_t \qquad 2.7$$

$$\beta_t = \beta_{t-1} + \eta_t \qquad 2.8$$

where u_t, ϵ_t and η_t are normal, independently distributed variables with mean zero and constant variance over time.

The *Measure Equation* (2.5), is expressed in terms of observables (Y_t, CUD_t). The unobservable α_t is given a stochastic specification by the *Transition Equations* (2.7, 2.8). Both v, and α_t will be estimated from (2.5). The series for CAP_t will be obtained by assuming likely values for a.

The part of the results we are interested in here is the smoothed estimates of $\alpha_{t|T}$. That is, estimates of the value of α_t conditional on information up until time T at the end of the sample. These are the estimates of CAP for each period. We have to assume a reasonable value for a, e.g a=0.1, and then CAP should represent an 'effective capital stock' series. A summary of the results is in the second line of table 2.1. Minford et. al. estimate that the capital stock fell 3.7 per cent over the 1979-81 period and by 5 per cent over the 1980-82 period. The CBI index is used extensively by Robinson and Wade and exclusively by Record and both of these authors estimate much larger falls in the capital stock. If nothing else, the Minford et. al. result suggests that this series does not unambiguously point to increased scrapping.

The problem with this approach is that the Kalman Filter restricts the capacity series to move fairly smoothly. This method is thus unlikely to find disastrous falls in capacity of the sort found by other authors. All of the above approaches have the weakness of depending on a host of subsidiary assumptions, few of which can be tested, to obtain their figures. We now go on to consider the direct evidence of changes in the capital stock over the early eighties.

2.3 Estimates of the Net Capital Stock in Manufacturing Using Current Cost Accounting Data

Since 1980 some U.K. companies have been providing information on their fixed assets valued on a 'current' or 'replacement' cost basis. This was a result of the introduction of a new inflation accounting standard (SSAP16). In this section we consider what we can infer about the extent of economic scrapping over the eighties by looking at this data.

We were not the first to exploit this source of information in order to make inferences about changes in the level of the capital stock. The Association of British Chambers of Commerce used it in their evidence to the House of Lord's Select Committee on Overseas Trade.[4] However, their evidence was based on the accounts of only one firm. This firm's assets had fallen by 24 per cent over the period 1980-83. Perhaps unfortunately, the committee's report asserted that, on the evidence of one firm, " between 1980 and 1983...(the) assets and capacity of manufacturing industry fell by 24 per cent." This estimate was widely quoted at the time. We hope to demonstrate that the experience of this firm was not typical by considering a much larger sample of U.K. manufacturing firms.

Firms were included in this sample if they were manufacturing firms and if they were included in the Financial Times 500 index. The relevant data, net fixed assets on a current cost accounted basis, was obtained from Datastream (item 461). This sample is biased in that it oversamples large firms, however we feel that there is no reason to believe that these firms would be immune from the economic circumstances that could lead to premature scrapping.

Another point to note is that we are using the net, not gross, capital stock. The latter is of greater interest to a study of productive capacity but we feel the advantages of using an unadjusted variable straight from the accounts outweigh this consideration. The gross capital stock will be studied in the next section.

The results for this sample are presented in table 2.2. These results may be considered somewhat surprising in the light of the proceeding discussion in that they imply very little scrapping over the period 1980-83. For our sample, net fixed assets ***rose*** in real terms between 1980 and 1981 whereas even the CSO's figure fell by 4.4 per cent. Our sample at this point contains about 27 per cent of the total capital stock of the manufacturing sector so, if the CSO's figure is to be a serious underestimate of scrapping the fall in the capital stock in the rest of this sector must be extremely large.

The sample is larger in 1981-2 covering 37 per cent of capital in manufacturing. Our firms report an average fall of 2.37 per cent against the CSO's 1.1 per cent fall. In 1982-3 our sample has a fall of 1.3 per cent against a CSO fall of 2.2 per cent.

We must re-iterate that our sample is selected on criteria which might conceivably affect our endogenous variable (e.g. we exclude firms that go bankrupt before 1983. In section 2.7 we discuss whether or not this will bias our results). That being said, we feel that for several reasons these results must be taken seriously and that much less scrapping occurred in the manufacturing sector over this period than previous estimates have suggested. These reasons are;

i) Our sample contains a very substantial proportion, up to 37 per cent, of the capital stock of the manufacturing sector. For our results to be consistent with, say Robinson and Wade's -11 per cent, then there must be extremely high scrapping in the rest of the sector and our sub sample must be to some extent pathological.

ii) There is no reason to believe that our firms are untypical of manufacturing firms other than that they are larger than average. In fact, employment in our sample fell proportionately more over this period than it did in the sector as a whole[5]. Therefore we feel that our firms did not have a 'good recession'. We now turn to estimates of the gross capital stock for a longer period.

2.4 Estimates of Gross Capital Stock in Manufacturing Obtained by Adjusting Historical Cost Accounting Data 1972-82

2.4.1 Methodology

The advantage of using accounting information to help estimate the capital stock is that it provides data on <u>actual</u> retirements of productive assets. This makes it potentially able to give us a much better measure of the capital stock than that provided by the CSO which relies on an assumed distribution of retirements. The disadvantage of using accounting information is that assets are valued on a historical cost basis and, when there is non zero inflation, this requires some adjustment to obtain a replacement cost valuation. Any such adjustment must rely on auxiliary assumptions of some kind and the validity of the results obtained will depend on the validity of these assumptions.

The capital stock is defined in historical cost terms as:-

$$HCK_{it} = \sum_{j=0}^{\infty} I_{it-j} \qquad 2.9$$

where I_{it-j} is investment made at time t-j that is still in place at the end of period t (i indexes firms and t time). This measure will be biased when there is positive inflation because more recent purchases will be valued more highly than older assets even though they might be equally as productive. What we wish to obtain is the capital stock defined in replacement cost terms.

$$RCK_{it} = \sum_{j=0}^{\infty} \frac{P_t}{P_{t-j}} I_{it-j} \qquad 2.10$$

where P_{t-j} is the price of the asset at time t-j. Hence, each periods vintage will be converted into year t pounds and we will be summing real, not nominal, investment. Given that we do not have an investment history of the firm, we must make some assumption about the distribution of vintages in the capital stock in order to proceed. One method (used by Davidson, Stickney and Weil (1976)) is to infer the <u>average</u> vintage of capital directly from the accounts and write;

$$RCK_{it} = HCK_{it} \frac{P_t}{P_{t-A_{it}}} \qquad 2.11$$

A_{it} = average age of assets in firm i at time t. A can be estimated in a number of ways. One way is to use the ratio of accumulated to current depreciation.

$$A_{it} = \frac{ACD_{it}}{D_{it}} \qquad 2.12$$

However, this estimate can be shown to be biased when there is heterogeneity in the service lives of assets or when there is inflation (in appendix A2 we discuss the problems with estimates of this kind in more detail). In principle then, 2.11 and 2.12 can be used to obtain a series for replacement cost capital. We do not adopt this method because we feel we can usefully exploit the further information on changes in fixed assets that the accounts contain.

Movements in historical cost capital are defined by the identity:-

$$HCK_{it} = HCK_{it-1} + AD_{it} - DISP_{it} + NSC_{it} - SDISP_{it} + REV_{it} + CC_{it} + OTH_{it} \qquad 2.13$$

AD_{it} = additions during period t (investment)

$DISP_{it}$ = disposals during period t (scrapping, retirement)

NSC_{it} = Capital stock of new subsidiary companies acquired by firm i during period t.

$SDISP_{it}$ = Capital stock of subsidiary companies sold by firm i during period t.

REV_{it} = revaluations

CC_{it} = currency changes

OTH_{it} = Other movements in assets (e.g. payments on account, reclassification where impending disposals are added to current assets etc..)

(See the data appendix for full details of the sources of these variables)

We hope to show that a better understanding of how the capital stock has changed is available by disaggregating the change in the stock of fixed assets into the various constituent parts. REV_{it} and CC_{it} have to be subtracted before we begin since these are not treated consistently in the accounts. Our objective then is to obtain a series for the replacement cost value of capital for each firm.

The first thing to note is that both additions and acquisitions of subsidiaries, are already in year t pounds. By definition new equipment purchased will be at replacement cost. Also, in the accounts, new subsidiaries will be given, 'a fair market value at the time of acquisition' (SSAP 14, para 29). Therefore to convert these two quantities into year zero prices we simply multiply by (p_0 / p_t).

Disposals, both of assets and subsidiaries, will be valued at historical cost. We have to make some assumption as to the age of these assets within firm i (AG_{it}) in order to adjust for inflation. Since it is not obvious which of the possible assumptions about AG_{it} is the best, we offer several alternatives:-

1) $AG_{it} = A_{it}$ i.e assets disposed of are of average age. This would, in general, understate the age of disposals since we would expect scrapping to be concentrated in the older vintages of capital. This would certainly be the case if the increase in energy prices had made pre-1973 or pre-1979 equipment non economic.

2) $AG_{it} = T_{it}$. We can estimate, indirectly, the average length of life of scrapped assets, T_{it}, and assume that assets are always scrapped after T_{it} years. One way to estimate T_{it} is:-

$$T_{it} = HCK_{it} / D_{it} \qquad 2.14$$

(The reasoning behind this estimate is discussed in the appendix and see also Mayer (1982) for a variety of methods for estimating AG_{it}). This estimate unfortunately, suffers from the same problems as the estimate of A_{it} in equation (2.12). When there is positive inflation and heterogeneity in service lives then (2.14) will be biased. A further point to note is that when a company hives off a subsidiary the capital involved will not necessarily be of scrapping age, so, in this case AG_{it} will overestimate the average age of disposals. It is clear that none of these alternatives is, *a priori*, superior. Because of this we subjected the capital stock series, derived from these alternative assumptions, to a validation exercise. Specifically, we compared the change in our measures over the 1980-82 period with the change in our current cost accounts figure from section 2.3[6].

The results of this exercise were not as clear cut as we may have hoped. Neither of the alternatives performed satisfactorily well in the exercise and so we tried an extra variant of the form:-

$$AG_{it} = \lambda\, T_{it} = \lambda \frac{HCK_{it}}{D_{it}} \qquad 0 < \lambda < 1 \qquad 2.15$$

λ is chosen so as to give a series that is the best 'fit' with the current cost data (this will be made more specific in the next section). This also did not yield a satisfactory adjustment. Our final alternative was to use $AG_{it} = B$, where B is an integer, constant over both firms and time. This gave us the best results and is thus our 'preferred' method of inflation adjustment.

A few further points to note before we turn to our empirical findings:

1) So far we have not mentioned leased assets. These became of increasing importance over the sample period. We include these in the

additions figure by firstly, expressing the plant hire figure in year zero prices, secondly, capitalising the figure assuming a real interest rate of 5 per cent per year (i.e. multiplying by 20) and thirdly adding the growth in this figure each year to additions. This is because, although leased assets are not recorded as full value assets in the accounts, they are part of the productive capacity of the firm.

2) The 'other' category is usually comprised of assets that have been bought and have not arrived or of assets that are about to be sold. Therefore we treat them exactly the same way as the other additions and disposals[7].

2.4.2 Empirical Results

This exercise is conducted using the published accounts of 333 U.K. manufacturing companies. In 1979 these companies, between them, employed 1.9 million people or about 26 per cent of total employment in manufacturing. Over 1973-82 the average employment in these firms fell by 25 per cent. This is compared with a fall of 27 per cent for manufacturing as a whole. We hope that this is some indication that the experience of these firms was not untypical of the manufacturing sector. The data is drawn from the EXSTAT data tape. The criteria for inclusion in this sample is that a complete set of consistent data is available for the period 1972-82.

The validation exercise is conducted using a sub-sample of 153 firms for which DATASTREAM provide current cost figures on net fixed assets. The results are presented for the whole 333 firm sample but the validity of the adjustment can be checked for only the sub-sample.

Table 2.3 shows the changes in the gross capital stock that are implied by the various assumptions.

Measure (i) assumes $AG_{it} = A_{it}$ i.e. disposed of assets are of average age[8]. If we are allowed to make inferences for the whole of manufacturing from our sample then measure (i) implies that the CSO's estimated growth in the capital stock over 1974-82 (13.3%) is an overstatement. Our measure grows by 9.33 per cent over the same period. However, this overstatement is much less than that suggested by, say, Mendis and Muellbauer who claim that, in 1980, the actual capital stock was 35 per cent less than the CSO estimated. Measure (i) also finds that there is no more scrapping over the 1979-82 period than is estimated by the CSO, in other words there is no 'unobserved' scrapping. This is our most conservative assumption about the age of disposed assets. As we increase the implied service lives of disposals this will tend to increase the value of scrapping. This is because all we know about these disposals is their original cost. The replacement cost today of a machine that cost £100 20 years ago would tend to be greater than that of a machine that cost £100 10 years ago. Deflating disposals figures by a more remote price index we makes their real cost today larger. Measure (ii) assumes $AG_{it} = T_{it}$ i.e T_{it} is the estimate of the average age of disposals[9]. This will, in general, overstate the age of assets sold or scrapped by the firm. Hence , it can be regarded as the opposite extreme to measure (i). Measure (ii) gives substantially greater estimates of scrapping than measure (i). The capital stock is estimated as falling by 18.9 per cent over 1974-82 as compared to the CSO's 13.3 per cent growth and over 1979-82 there is a 16.1 per cent fall in measure (ii). The wide divergence of the series obtained by using these assumptions emphasizes again the importance of some sort of validation exercise to choose a satisfactory adjustment.

Specifically, this validation exercise consisted of running regressions of the form:

$$\Delta RCK_{it} = \alpha_0 + \alpha_1 \, \Delta \, ERCK_{it} \qquad 2.16$$

where t=1981,1982

RCK_{it} is the measure of gross fixed assets obtained from the current cost accounts and $ERCK_{it}$ is our inflation adjusted figure for gross fixed assets obtained from the historical cost information. If we have adjusted the latter series accurately then we would expect $\hat{\alpha}_0 = 0$ and $\hat{\alpha}_1 = 1$. When we test measure (i) in this fashion we obtain:-

$$\underset{(4.27)}{\hat{\alpha}_0 = -.023} \qquad \underset{(1.2)}{\hat{\alpha}_1 - 1 = .08} \qquad R^2 = .47$$

$$F(2,308) = 9.29 \qquad (F_{0.05}\,(2,308) = 3.03)$$

t ratios are in parentheses

for measure (ii):-

$$\underset{(1.77)}{\hat{\alpha}_0 = .013} \qquad \underset{(22.53)}{\hat{\alpha}_1 - 1 = -.73} \qquad R^2 = .18$$

Both these measures are clearly unsatisfactory and measure ii is more firmly rejected than measure i. Measure ii implies a large amount of scrapping between 1979 and 1982 and so it is not surprising that it is rejected given the results of the previous section.

The next experiment was to estimate AG_{it} based on equation 2.15 (measure ii is a special case of 2.15 with $\lambda = 1$). We reduced lambda in steps of 0.1 and re-ran the above regressions with the capital stock series that we obtained. Since we are here shortening AG_{it} towards A_{it} this will reduce scrapping and hence will increase capital growth over the period. However no value of λ was found that gave a satisfactory result (i.e for every value of λ we could reject the hypothesis $H_0 : \hat{\alpha}_0 = 0$,

$\hat{\alpha}_1=1$). The final alternative was to assume $AG_{it} = B$, where B is an integer constant over both firms and time. The best results (i.e. the lowest F value on hypothesis H_0) were obtained setting $AG_{it} = 8$ years. The regression is:

$$\hat{\alpha}_0 = \underset{(1.54)}{-8.53 \times 10^{-3}} \quad \hat{\alpha}_1 - 1 = \underset{(.057)}{3.51 \times 10^{-3}} \quad R^2 = .46$$

$$F(2,308)=1.26 \qquad (F_{0.05}\,(2,308)=3.03)$$

The capital stock series obtained by setting $AG_{it}= 8$ years is presented in the table as measure iii. This grows by 3.08 per cent over 1974-82 which is less than a quarter of the CSO's 13.3 per cent growth. Measure iii falls by 1.6 per cent over 1979-82 as against a 2.25 per cent rise in the capital stock estimated by the CSO.

The conclusions of this exercise are that critics of the CSO measure of gross fixed assets are correct in their belief that it overstates the growth in the capital stock over the period 1974-82. On the other hand, the amount of unobserved scrapping that has occurred is considerably less than some of the estimates reviewed in section 2.2.

We also thought it may be of interest to present a variant of measure iii calculated using $AG_{it} = 8$ years, but setting acquisitions and disposals of subsidiary companies to zero. The reason for doing this is that such buying and selling of companies is a transfer of assets within the company sector and does not reflect either a real growth or a real fall in the capital stock. This variant is measure iv in table 3. This measure implies a greater amount of scrapping than measure iii. It grows by 8 per cent over 1974-82 as against the 3.08 per cent of measure iii and falls by 2.3 per cent over 1979-82 as against the 1.6 per cent fall of measure iii.

Our results suggest that the CSO overstates the growth rate of the capital stock between 1974 and 1982 but, if anything, understates the 1972-76 growth rate. The degree of mis-measurement implied is not systematic but varies widely over the sample period. Table 2.4 presents the implied percentage error in the CSO estimate of the growth rate of capital. This would suggest that using the CSO's figure as an input into econometric work could lead to misleading results. In table 2.1 our estimates are reported alongside those of other authors. Note that the results of Minford et. al (1988) are very close to ours, despite the completely different approaches taken.

2.5 How Robust are Our Results?

We have made several assumptions that may be invalid. In this section we investigate the sensitivity of our results to changes in these assumptions.

(i) We assumed a 5 per cent real rate of return when capitalising leased assets. To assess the importance of this assumption we re-computed our preferred series (measure (iv)) with leased assets capitalised at 20 per cent. This does not significantly change the results. The estimated fall in the capital stock over 1979-82 rises from 2.3 per cent to 3.1 per cent.

(ii) Many of the companies in the sample have overseas subsidiaries. This means that it is possible that we have understated the decline in the UK capital stock because our results are biased by the inclusion of prosperous overseas sectors in the accounts. We tried to estimate the importance of this bias by using our data on the proportion of the firms total employment that is overseas. Specifically we scaled measure (iv) by the ratio of each companies domestic employment to overseas employment. Again the results did not change greatly. Over 1979-82 the decline is now estimated at 2.9 per cent.

(iii) Another possible problem is that the estimate of α_1 in (2.16) could be inconsistent. This is because ERCK is measured with error (we are grateful to John Muellbauer for drawing our attention to this problem). Therefore we re-estimated (2.16) using our inflation adjusted measure of additions, which should be accurate, last years measure of disposals and a time dummy as instruments. This exercise yielded the 'best' result at $AG_t = 1.2\ A_t$, which, in this sample, has an average value of 8.4 years. The results were:-

$$\hat{\alpha}_0 = \underset{(0.343)}{-2.08} \times 10^{-2} \qquad \hat{\alpha}_1 - 1 = \underset{(0.85)}{0.067}$$

$$F(2,308) = 0.46$$

This measure does imply more scrapping than in table 2.3. Over 1979-82 this preferred measure of the capital stock is estimated to fall by 4.23 per cent (as against 2.3 per cent). Also the estimated growth in the capital stock over 1973-79 is 1.33 per cent (as opposed to 1.44 per cent in our preferred measure). There although we may have underestimated the scrapping that took place after 1979, these alternative estimates are unlikely to effect our estimates of the contribution of capital to the post-1973 productivity slowdown in any significant way.

2.6 The Implications of our Estimates of the Capital Stock for Measures of Productivity Growth

There have been two major controversies regarding productivity growth in the UK in the period 1972-82.

1) The seventies saw a marked slowdown in the rate of growth of productivity (see Lindbeck (1985) for a survey). The authors Baily (1981) and Raasche and Tatom (1981) have suggested a proximate cause for this might be an unobserved fall in the capital stock in the period following 1973. This would occur because, in 1973, a large proportion of the existing capital stock was using techniques of production that were no longer efficient in a period of high relative prices of energy and raw materials. Once firms realised that these new relative prices were not a temporary phenomenon they would scrap these machines.

2) The Thatcher government has claimed to have caused increased productivity in the U.K. It claims to have achieved this by changing the attitudes of workers and management to make them more conducive to technical progress. Mendis and Muellbauer (1984, henceforth MM) have attempted to assess the existence and strength of this 'Thatcher Effect.'

Our estimates can help solve the first controversy directly. Also, if in the early eighties there was a significant amount of unobserved scrapping then this would make the measured growth in labour productivity even more impressive.

1) The Productivity Slowdown. MM estimate the trend rate of productivity growth as 3.4 per cent per annum between 1955 and 1973 and 1.4 per cent per annum between 1973 and 1979. The fall in the growth rate of the recorded capital stock can only explain 0.4 of this 2 per cent slowdown. Our estimates suggest that the capital stock grew at 1.44 per cent per annum on average during this period. The CSO estimates a growth rate of 2.4 per cent

per annum. If we use MM's estimate of the output elasticity with respect to capital of .319 then unobserved scrapping accounts for .31 of the 2 per cent slowdown. This does not necessarily mean that Baily (1981) is incorrect. A decline in the productivity of the existing capital stock could help explain the rest of the slowdown. However, we would suggest such a steep decline in the productivity of capital is unlikely given the small amount of economic scrapping that is implied by our estimates.

2) Thatcher Effects. MM estimate productivity as falling by 0.3 per cent over 1979-80. If this is all attributable to unobserved scrapping then the capital stock must have fallen by 14 per cent over this period. We have found no evidence to suggest a fall of this magnitude. For the period 1980-82 MM's corrected estimate of productivity growth is 2.9 per cent per annum. This is compared with 3.4 per cent per annum during 1955-73. However, in the pre-1973 period the CSO's estimated capital stock was growing at 3.7 per cent per annum, whilst our estimate of the capital stock was falling by 0.6 per cent per annum over 1980-82. If the capital stock had grown at the same rate over 1980-82 as it apparently had prior to 1973, i.e. by 4.3 per per annum more than it actually did, then corrected productivity would have grown at a very impressive 4.28 per cent per annum (i.e. .043 x 0.319 + .029 = .0428, where .319 is the MM elasticity of output w.r.t. capital).

2.7 Summary and Conclusions

We have argued that a reasonable estimate of the decline in the capital stock of the manufacturing sector over 1979-82 is 2.3 per cent. Our implied estimate of unobserved scrapping is much smaller than that of other authors. On the basis of this result we argue that a demand expansion is less likely to lead to capacity constraints.

Several people have suggested to us that the assets we measure could include equipment that is no longer involved in production because of the high relative price of energy. Since this equipment would not be brought back into production following a demand upswing it would not form part of the 'effective' capital stock even though it would be included on the firm's asset sheet. We would argue that this form of capital hoarding is much more likely to be exploited when the firm is facing a temporary period of low demand rather than a potentially long term change in relative prices. Plant and machinery will become obsolescent even when not in production and once firms realise that the relative price shift is not a temporary phenomenon then such machinery will be scrapped. For this reason we believe the amount of energy-inefficient hoarded capital will be only a small part of our recorded assets.

We have also used our estimates to evaluate the importance of unrecorded or economic scrapping to the measured productivity slowdown in the seventies and the rise in productivity in the early eighties (the Thatcher Effect). We estimate that unrecorded scrapping can account for only 0.31 of the measured 2 per cent per annum slowdown in the trend rate of corrected productivity growth after 1973. On the other hand, once unrecorded scrapping is accounted for, corrected productivity growth over the period 1980-82 could be as high as 4.3 per cent per annum.

We should again point out some of the problems with our approach. The most serious of these is to do with the representativeness of the sample. Large firms are clearly over represented in this sample. This gives us the advantage of including a large proportion of the total capital stock within the sample but the disadvantage that these firms may behave very differently to the typical manufacturing firm when subjected to the same price and demand shocks. Another problem is the endogeneity of firm survival over the sample period. Firms that do not survive the sample period are excluded because of the advantages of working with a balanced panel. Since our data is drawn from accounts, which have to be provided by law, a firm will only leave the sample if it merges with another firm or is liquidated[10]. Therefore, the survival of a firm is not random. A firm can choose liquidation or merger as part of its optimising behaviour. The amount of capital scrapped or invested in is also the result of optimising behaviour. This suggests that survival may be endogenous to the problem we are interested in. The question is: do the variables that determine survival also determine a firms capital accumulation behaviour? A proper approach to this problem would require that we include the conditional probability of survival explicitly in the model. Informally, this is what we do in the econometric work reported in later chapters by including variables that should affect the firm's survival probability explicitly in the model[11] In this chapter we have tried to show that our firms are not untypical of manufacturing firms as a whole and that we are not sub-setting on any relevant variables.

Company survival poses another problem. Over 1979-82 company liquidations increased by 153 per cent overall and by 268 per cent in the manufacturing sector. It could be argued that the large fall in the capital stock estimated by other authors could be the result of the capital lost through these company failures rather than through within firm shedding of capital. We would argue that:-

i) Liquidations are concentrated in smaller firms and an increase in the number of liquidations tells us nothing about the amount of productive capital involved.

ii) Productive capital may not be lost to the manufacturing sector through liquidation. It could just be transferred to other firms.

The fixed eight year inflation adjustment chosen by us is satisfactory in that the derived series fits the current cost series. It can also be regarded as unsatisfactory that the firm specific adjustment did not prove optimal. The use of a single number AG_{it} , used to deflate all disposals, seems to be insufficient to cope with the whole distribution of service lives that the firm's assets have (e.g. we have simply added buildings to plant and machinery to obtain our gross fixed assets figure). The fixed adjustment would then be seen to be second best. Further work may be done as to whether better results are available if buildings and machines are assumed to have different lengths of life or disposals of subsidiaries are treated differently. The basic problem we face is that accounts are not drawn up to provide economic information. This is most problematical when we come to valuation of assets in the accounts. For this reason, when we use this derived series as an input into empirical work, we will always present results for two alternative capital stock series. One will be derived using an eight year length of life and the other assuming capital is disposed of after sixteen years.

FOOTNOTES

1 Mendis and Muellbauer (1984), Robinson and Wade (1985) and Record (1985).

2 i.e. the C.S.O. overestimated the capital stock in 1980 II by an amount that was equal to 35 per cent of the 1973 I capital stock

3 The program used is STAMP (1988) written by Harvey, Peters and Peseran.

4 Report from the Select Committee on Overseas Trade, Vol II, session 1984-85, pp. 632-633, HL 238 (I-III).

5 Employment in our sample fell by 15% over 1980-81 compared with 8.7% nationally, 8.1% in 1981-82 compared with 5.6% nationally and 4.5% in 1982-83 compared with 4.2%.

6 Our C.C.A. figures are for ***net*** capital. To obtain a current cost figure for ***gross*** capital, in order to make the comparison, we assumed that the ratio of gross to net capital was the same for current and historical cost.

7 We are extremely grateful to Martin Walker for helpful conversations on this point.

8 A_{it} takes an average value of 7.7 years in 1972, falls to 6 years in 1980 and is 6.3 years in 1982 so there is some evidence here that firms were retiring assets earlier in 1980. This is quite a good indication of premature scrapping because we would not expect the technical lifespan of capital to vary in this fashion.

9 T_{it} takes an average value of 20 years in 1973 falling to 15 years in 1982.

10 This is not strictly true. EXSTAT check all the data before entering it onto tape. If they believe, for various reasons, that there has been a change in the method of reporting a particular item in the accounts

than they will enter that item as missing. Thus a company will still be alive and filing accounts but it's useful life has ended as far as we are concerned because because we can no longer obtain a consistent data series for that item.

11 This problem is studied in a paper by Meghir (1988)

Appendix A2

Estimating the Average Length of Life of the Capital Stock

This exposition closely follows that of Mayer (1982). We make several assumptions:-

(i) Capital is homogeneous and has a life of T years.

(ii) Capital is depreciated for accounting purposes on a straight line basis over T years.

(iii)None of the capital stock is prematurely disposed of and there are no assets left in place older than T years.

(iv) There is no inflation.

Note that given (i)-(iv)

$$A_t = \sum_{i=0}^{T-1} \frac{iI_{t-i}}{K_t} \qquad \text{A.1}$$

K_t= the capital stock = HCK given assumption (iv). Accumulated depreciation is given by:

$$ACD_t = \sum_{i=0}^{T-1} \frac{iI_{t-i}}{T} \qquad \text{A.2}$$

and current depreciation,

$$D_t = \sum_{i=0}^{T-1} \frac{1}{T} I_{t-i} \qquad \text{A.3}$$

K_t is defined by,

$$K_t = \sum_{i=0}^{T-1} I_{t-i} \qquad \text{A.4}$$

Using A.3 and A.4 we obtain,

$$T = \frac{K_t}{D_t} \qquad \text{A.5}$$

which is equation 2.14 in the text. Using A.1, A.2 and A.5 we obtain

$$\frac{ACD_t}{D_t} = \frac{\frac{1}{T} \sum_{i=0}^{T-1} iI_{t-i}}{\frac{1}{T} K_t} = \sum_{i=0}^{T-1} \frac{iI_{t-i}}{K_t} = A_t \qquad \text{A.6}$$

Which is what we require. For example if a firm invests 100 a year in assets that last 8 years then the average age of the capital stock will be 3.5 years. Using A.4 K_t=800, D_t=100 and ACD_t will be 350, so A.6 will give us the correct answer. The main problem with these formula is that the assumptions imposed are very stringent and in general, if we relax any of the assumptions the formula will no longer hold. For example if we relax assumption (i) and allow for two types of assets with differing service lives then A.6 will ***understate*** the true average age of these assets. Assume that assets of type 1 have a life of T_1 years and those of type 2 have a life T_2 where $T_1 \ll T_2$, then what A.6 will actually estimate is:

$$A_t = \frac{\sum_{i=0}^{T_2-1} i \left[\frac{T_2}{T_1} I^1_{t-i} + I^2_{t-i} \right]}{\sum_{i=0}^{T_2-1} \left[\frac{T_2}{T_1} I^1_{t-i} + I^2_{t-i} \right]}$$

This will tend to overvalue the assets with shorter lives. For example, consider a firm that invests 100 each year, 50 in assets with 5 year lives and 50 in assets with 20 year lives.

$$K_t = K^1_t + K^2_t = \sum_{i=0}^{4} I^1_{t-i} + \sum_{i=0}^{19} I^2_{t-i} = 250+1000 = 1250$$

So at any time the capital stock is made up of 4/5 type 2 assets and 1/5 type 1 assets. The average age of type 1 assets is 2 years and type 2 assets 9.5 years. Therefore the true average age of the capital stock is

4/5 x 9.5 + 1/5 x 2=8 years. Now,

$$ACD_t = ACD^1{}_t + ACD^2{}_t = 1/5 \sum_{i=0}^{4} iI^1{}_{t-i} + 1/20 \sum_{i=0}^{19} iI^2{}_{t-i} = 100+475 = 575$$

$$D^1{}_t = 1/5 \sum_{i=0}^{4} I^1{}_{t-i} = 50$$

$$D^2{}_t = 1/20 \sum_{i=0}^{19} I^2{}_{t-i} = 50$$

So $\frac{ACD}{D}$ = 5.75 which is an underestimate of the true value of 8.

Assumption (ii) is fairly reasonable, straight line depreciation is common accounting practice (in 1980-81 88 per cent of a sample of 300 firms used straight line methods- see Institute of Chartered Accountants' Survey of Published Accounts 1980-81).

Assumption (iii) should not cause problems if premature disposals are recorded under accelarated current depreciation. However, this is not always the case. Ignoring inflation will means that we understate average asset lives because older capital will receive too low a weight. Similarly the estimate of T will be understated because K_t will understate the true replacement cost of capital

TABLE 2.1.

Comparisons of Estimated Growth Rates of The Capital Stock

Period % growth	79-81	80-82	79-82	74-82
This chapter (company accounts)	-1.4	-1.2	-2.3	0.8
Minford et. al. (Kalman Filter)	-3.7	-5.0	-5.4	-9.1
CSO (assumed retirements)	2.6	1.5	3.3	16.6
Robinson-Wade (econometric)	-11.3	-8.2	-14	-
Record (CBI data)	-11.0	-	-	-
Mendis-Muellbauer (production function)	-14	-	-	-19

TABLE 2.2

Net Capital Stock in Manufacturing

Years	Estimated changes in capital stock from sample	sample size	Proportion of MFG. capital stock accounted for by sample	C.S.O.'s estimated changes
1980-81	+3.48%	140	0.27	-4.4%
1981-82	-2.37	241	0.37	-1.1%
1982-83	-1.29	187	0.34	-2.2%

TABLE 2.3

Alternative Measures of the change in the gross capital stock in manufacturing

Years	C.S.O. Measure	Measure(i) $AG_t = A_t$	Measure(ii) $AG_t = T$	Measure(iii) $AG_t = 8$	Measure(iv) $AG_t = 8$ (Excl. subsidiaries)
1972-73	+2.64%	+4.3%	+3.3%	+4.16%	+3.54%
1973-74	+2.91%	+4.17%	+3.37%	+4.08%	+3.74%
1974-75	+2.29%	+2.53%	+1.54%	+2.31%	+2.11%
1975-76	+1.96%	+2.15%	+1.06%	+1.93%	+1.33%
1976-77	+1.97%	+1.06%	-0.76%	+0.59%	+0.33%
1977-78	+2.10%	+0.41%	-2.55%	-0.26%	-0.31%
1978-79	+2.16%	+0.71%	-2.74%	+0.08%	-0.25%
1979-80	+1.44%	+0.80%	-3.80%	-1.07%	-1.13%
1980-81	+0.45%	+1.28%	-4.16%	+0.46%	-0.30%
1981-82	+0.25%	+0.06%	-8.97%	-0.95%	-0.90%
1974-82	+13.33%	+9.33%	-18.9%	+3.08%	+0.83%
1979-82	+2.25%	+2.16%	-16.07%	-1.56%	-2.31%
1972-76	+11.30%	+13.79%	+9.58%	+13.06%	+11.13%

TABLE 2.4

Percentage error in estimating the growth rate of the capital stock

Years	% error
1972-73	- 25.4
1973-74	- 22.2
1974-75	+ 8.5
1975-76	+ 47.4
1976-77	+497.0
1977-78	+777.4
1978-79	+954.0
1979-80	+227.4
1980-81	+250.0
1981-82	+127.8

Note: $\% \text{ error} = \left[\frac{\text{C.S.O. Measure} - \text{measure (iv)}}{\text{measure (iv)}} \right] \times 100$

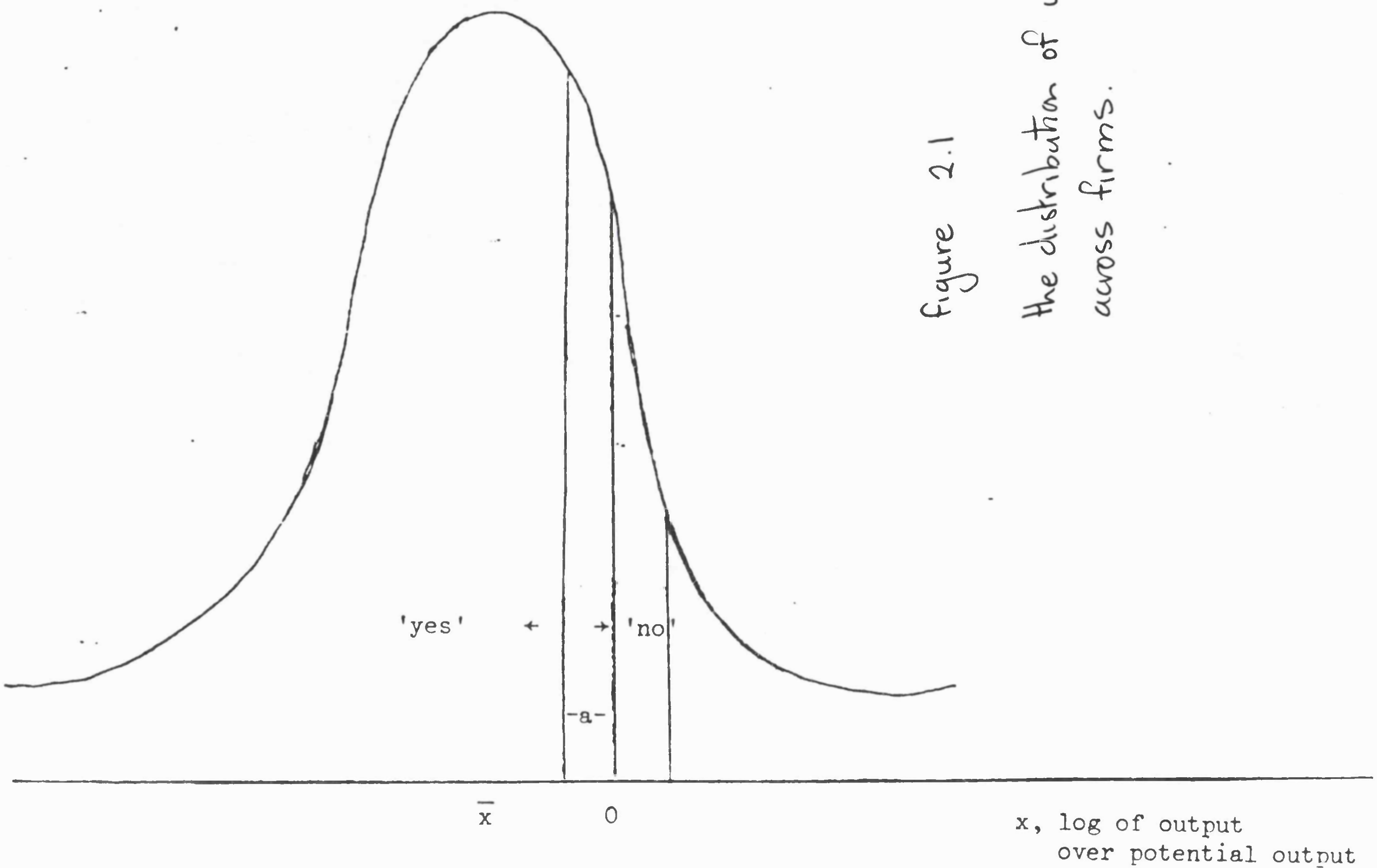

figure 2.1

the distribution of utilisation across firms.

Chapter 3. The Effects of Profit Sharing on Employment, Wages, Stock Returns and Productivity

3.1 Introduction

In this chapter we use a sample of 101 manufacturing firms to assess the effects that Profit-related pay (PRP) schemes have on economic behaviour.[1]

Profit sharing has recently been the subject of much academic and political interest. It's proponents argue that introducing a profit related component into pay will beneficially affect productivity and employment. There are usually two main types of argument used to justify the introduction of profit sharing.

i) Theories of labour market behaviour that rely on the notion of a workplace 'culture', are enjoying increasing popularity. These theories are motivated by the observation that, in general, the economic performance of workers depends to a great extent both on the workplace environment and on the social organisation in which production is carried out. If firms ignore this fact and treat their workers simply as economic units, they will tend to experience lower productivity through lower motivation, higher turnover and poorer industrial relations. Some firms (e.g. Hewlett-Packard, Jaguar) have taken account of this and have made strenuous efforts to instill a sense of 'common purpose' between workers and managers and obtain a higher level of job satisfaction. In some cases firms that have adopted this attitude have enjoyed higher productivity growth and larger profits (see Levering et.al (1985) for some evidence on this, also see ***Employment for the 1990s*** para. 2.15 for the government's current view on this issue). Proponents of profit sharing argue that, by tying the workers fortune to that of the firm you break down the conflict of interest between workers and managers. It is important to note that supporters of profit sharing rarely argue that it is the direct incentive effect of PRP that leads to productivity enhancing behaviour. An individual worker, or even a group of workers, will find the effects of their efforts on the profits of a large company minimal. Certainly you might expect that a system whereby bonuses were paid for increases in productivity would act as a much more direct incentive to increased efforts than a promised share in the profits. PRP is therefore often seen as necessary but not sufficient to cause greater productivity. The benefits will come from a greater sense of 'common purpose', better conflict resolution, greater co-operation between workers and management and between workers and workers.

ii) The work of Martin Weitzman (1983, 1986, 1987) provides a different motivation for introducing PRP. He argues that, if all firms were to switch to paying a large part of their total remuneration as a profit share then the economy would move to a stable full employment equilibrium. Governments could pursue anti-inflationary policies without worrying about the adverse effects on employment. This is then nothing less than a cure for stagflation. These beneficial effects depend crucially on firms regarding the base wage (i.e that part of remuneration that is independent of profits), *not* total remuneration, as the marginal cost of labour.

In this chapter we attempt to test three propositions:-

I. Operating a PRP scheme will lead to higher productivity.

II. Firms that operate PRP schemes regard the base wage, not total remuneration, as the relevant marginal cost of labour.

III. Profit sharing leads to lower wage pressure.

Proposition I reflects the traditional microeconomic argument for profit sharing. Proposition II is the underlying assumption of the Weitzman model.

In this model it is not advantageous for a firm to adopt PRP unilaterally. It's workers will resist the switch because the firm will employ new workers who will dilute their profit share and hence their total remuneration will fall. The benefits of adopting PRP in the Weitzman model depend on widespread, or even universal, use of the scheme. Because PRP is publicly optimal but privately sub-optimal, Weitzman proposes that tax advantages be given to encourage adoption of these schemes. The UK government has introduced legislation along these lines. If we can show that proposition II does not hold then there is no basis for this policy (or at least no justification at a macroeconomic level). Proposition III relates to another implication of the Weitzman model and is also a prediction of a profit sharing model used in a paper by Jackman (1988). We are also interested in proposition III because it is popularly believed that exactly the opposite is true. The profit related element of pay will be treated simply as an add-on component to wages negotiated in the normal fashion. Hence, profit sharing will ***increase*** total remuneration. This opinion has been voiced by trades union negotiators and remuneration consultants.

We estimate four equations in order to test these three propositions. Proposition II is tested directly by estimating an employment equation and indirectly by using a stock returns equation. Proposition III is tested by estimating a wage equation and proposition I by estimating a production function. Section 3.2 contains a discussion of the relevant theory, section 3.3 contains a summary of the data, the methodology and the results and section 3.4 contains our conclusions.

3.2 Theory and Tests

3.2.1 Employment Behaviour

Weitzman's claim that the introduction of profit-sharing will provide a cure for stagflation rests crucially on changes in wage and employment behaviour. Specifically, firms should only regard the base wage (and not total remuneration) as the true marginal cost of labour. i.e., in a wage economy, a firm maximises profits,

$$\Pi(L) = R(L) - WL \tag{3.1}$$

(R(L) denotes total revenue, L is employment, and W the wage) sets the marginal product of labour R'(L) to the wage W. In a share system, workers may be paid according to, say,

$$W(L) = \theta + \tau \left[\frac{R(L)-\theta L}{L}\right] \tag{3.2}$$

where θ denotes the base wage, and $\tau>0$ represents the profit-sharing coefficient. Here, provided unlimited amounts of labour can be hired under the contract (3.2), the firm will choose to hire workers up to the point where the marginal product of labour is equal only to the base wage, θ (rather than W).

Hence, if we convert a wage economy to a share economy, but choose θ, τ such that the existing workers get the same level of remuneration, firms will be out of equilibrium because they will wish to hire more workers (as $\theta<W$). It is this insight which underlies Weitzman's claims that, under profit-sharing, firms will be in an excess demand for labour regime, and that this will, then, help to reduce unemployment.

Note, though, that when a firm converts to a share contract, its act of hiring extra workers will have the effect of reducing the compensation of existing workers. It is therefore, crucial that firms feel able to reduce average total remuneration, for, if they were to feel that they must continue to pay the same amount to each worker as in the existing wage system, introducing profit-sharing will not alter hiring behaviour, i.e., if firms feel committed to paying a certain total amount, the manner in which this amount was divided into the two components: base wage and profit-linked pay, would become irrelevant. These would merely be labels.

More formally, this is true because constrained profit-maximisation of the form

$$\text{Max } \Pi(L) = (1-\tau)\ (R(L)-\theta L) \qquad (3.3a)$$

$$\text{s.t. } \theta + \tau \left[\frac{R(L)-\theta L}{L}\right] = W \qquad (3.3b)$$

is equivalent to;

$$\text{Max } \Pi(L) = R(L) - WL, \qquad (3.4)$$

(which is evident by substituting for θ from (3.3b) into (3.3a)).

An example of a situation where the firm will feel committed to paying the same total level of remuneration is in the efficiency wage class of theories (see, Wadhwani (1987b) for further discussion of this).

We may attempt to discriminate between the alternative views by estimating a labour demand equation. On the conventional view,

$$\ln L = -\alpha_1 \ln (\theta+B) + \alpha_2 \ln X \approx -\alpha_1 \ln \theta - \alpha_3 \left({}^{B}/_{\theta}\right) + \alpha_2 \ln X \qquad (3.5)$$

where B = bonus, X = other relevant variables, and $\alpha_1 = \alpha_3$. Instead, Weitzman's argument suggests that only the base wage is relevant, so $\alpha_3 = 0$.

3.2.2 Wage Setting Behaviour

An implication of the profit sharing model is that wages (total remuneration) will fall. This implication is contained in Weitzman (1987) and Jackman (1988). The basic reasoning behind this is as follows: A profit sharing system has a shallower trade off between employment and remuneration than a wage economy. A 1 per cent fall in the base wage causes a less than 1 per cent reduction in total remuneration. However, since employers look at the base wage when deciding how many workers to employ, this will cause the same increase in employment as a 1 per cent reduction in total remuneration under a wage scheme. Similarly, if the inside workers in a firm attempt to push up the base wage by 1 per cent this will not increase total remuneration by the same amount. In Weitzman's model , although the workers care about total remuneration, they are restricted to bargaining only over θ, the base wage. Wage pushiness by insiders will not, therefore, feed through from the base wage to total remuneration one-for-one. Indeed by adversely effecting employment, and hence profits, total remuneration could actually fall. Because of this consideration and "...because the employer has to give up such a large amount of profit in order to improve the pay of inside workers by even a slight amount." (Weitzman 1987, p101), the Nashian arbitrator of this bargain will decide on a wage outcome that is lower than that desired by the inside workers.

A problem with this model is that insiders will always want to revert to a wage system. Because there is a divergence between what is socially optimal (profit sharing) and what is privately optimal (the wage system), Weitzman proposes that tax incentives be used to overcome the externality and ensure that profit sharing becomes privately, as well as socially, optimal. However, this raises the possibility of firms and workers operating a 'cosmetic' profit sharing scheme. Firms and workers would keep their preferred wage system and bargain over total remuneration as before. Some part of the wage agreed upon would be defined as 'profit related' and would earn a tax advantage. The costs of policing a profit sharing system so as to ensure that cosmetic schemes did not occur would be likely to be high.

A reasonable person might object that this possibility is simply too sophisticated to be a feature of real wage negotiations. We would then draw their attention to the Trades Union Congress guidelines for negotiations on profit-related pay where just such a 'cosmetic' scheme is suggested.[2] There is also a fully worked-out example contained in the appendix.

Another model where profit sharing would not lead to a reduction in wage pressure is the efficiency wage model. In this model workers have a notion of a 'fair' wage for the job. A fall in wages would cause a reduction in productivity that would outweigh any possible increase in profits.

One other possible outcome of introducing a PRP scheme is that it might actually increase total remuneration. The TUC guidelines mentioned above state: "As a substitute for basic pay, profit-related pay represents a cut in existing pay rates and should not be accepted. The rate for the job should be subject to collective bargaining and should take account of profit levels in the normal way. If the company proposes a PRP scheme as an additional bonus, related to company performance, then this should be negotiated separately." The view that the profit related component will just be regarded as an add-on payment is also held by independent remuneration consultants. The *Financial Times* (11/9/87) quotes one such consultant: "People will expect their normal pay increase, whatever that is, and on top of that a PRP scheme. This is bound to lead to an increase in the salaries bill".

There is also evidence that employees do view the PRP element as the 'icing' on the 'cake' of their negotiated wage. A survey of 2,500 employees in companies that operated some form of PRP scheme was carried out by Wallace Bell and Hanson (1986). They found that 96 per cent of respondents felt that profit sharing should not be seen as a substitute for an adequate wage. Weitzman and Kruse (1989) argue that this result is mainly due to the employee's dislike for income variation. This should not be surprising, profit sharing, in effect, concentrates the employee's portfolio in just one company. His human capital is tied up with the fortunes of the same enterprise as determines his income. Because this portfolio is non-diversified it is also very risky. Employees would then require a higher return to compensate them for this risk. This would also tend to increase wage pressure.

We have then, three possible outcomes, each with some prior justification. We estimate a wage equation of the form:

$$\ln \theta = -\gamma_0 \ (B/\theta) + \gamma_1 Z \qquad (3.6)$$

θ is the base wage, bargained over in both wage and profit sharing systems. B is the profit related bonus, Z is a set of variables that affect wages. If Weitzman and Jackman are correct and profit sharing reduces wage pressure then $\gamma_0 > 1$. If we have a purely cosmetic scheme then $\gamma_0 = 1$, i.e we can write the left hand side variable as ln $(\theta + B)$. If $\gamma_0 < 1$ then profit sharing will lead to higher total remuneration with $\gamma_0 = 0$ representing the extreme case where the bonus payment is simply an add-on.

3.2.3 Stock Returns Behaviour

In this section we propose an alternative test of proposition I, that firms regard the base wage as the relevant marginal cost of labour. For this test we estimate a stock returns equation. If rational investors believe a profit sharing scheme in a particular firm is 'genuine', as opposed to 'cosmetic', then the required rate of return on that firm's equity will fall.

The reasoning is as follows: By adopting a profit sharing scheme the firm has put some of the riskiness involved with fluctuating profits onto the workforce. Because there is now lower risk for equity holders, investors will accept a lower rate of return on this asset. In effect the workers claims on the firm have been converted into equity. The adoption of a genuine profit sharing scheme will cause the debt-equity ratio to fall. Standard corporate finance theory (e.g. Modigliani and Miller (1958)) predicts that the required return on a firms equity increases with its debt-equity ratio. Modigliani and Miller proved that, under certain assumptions:-

$$r_E = r_A + \frac{D}{E} (r_A - r_D) \qquad (3.7)$$

Where r_E is the expected return on equity, r_A is the expected return on assets for a particular risk class, D/E is the debt-equity ratio and r_D is the expected return on debt. We would estimate (3.7) using standard measures of the debt-equity ratio, these would ignore cash based profit sharing schemes. Hence, if shareholders believe the scheme is genuine, the coefficient on the debt-equity ratio will fall following the introduction of such a scheme. This result would suggest that the shareholders agree with Weitzman that the marginal cost of labour is the base wage. We can also derive our estimated equation from the traditional Capital Asset Pricing Model which has :

$$r_E = r_F + \beta_E (r_M - r_F) \tag{3.8}$$

Where r_M is the expected return on a market portfolio, r_F is the return on a 'safe' asset and β_E is that stocks' 'beta' or 'systematic' risk. Beta is defined as:

$$\beta_E = \frac{\text{cov}(r_M , r_E)}{\text{var}(r_M)} \tag{3.9}$$

and is related to the debt-equity ratio by:

$$\beta_E = \beta_A + {}^D/_E (\beta_A - \beta_D) \tag{3.10}$$

with β_A being the average beta of assets and β_D the beta of debt. So β_E will increase with the debt-equity ratio. The equation we will estimate will be of the form:

$$r_{E,it} = r_i + r_t + (\delta_0 + \delta_1 \text{PSDM}_{it})(D/E)_{it} \tag{3.11}$$

Firms are indexed by i and t indexes time. r_i and r_t are firm specific and year specific dummies respectively, and PSDM_{it} is a profit sharing dummy that takes the value 1 if firm i operates a profit sharing scheme in year t and zero otherwise. Equation (3.11) encompasses linearized versions of

(3.7) and (3.8) as special cases. If there is a 'Weitzman effect' then $\delta_1<0$ whilst conventional theory would have $\delta_1=0$. A point to note is that, because D/E is the expected value of the debt-equity ratio, we shall instrument it for estimation.

3.2.4 Productivity Enhancing Behaviour

One of the justifications for profit sharing mentioned in the introduction was the positive effect it can have at microeconomic level. Profit sharing can increase the sense of identification that workers have with the objectives of the firm, and act as an incentive towards co-operative behaviour. This might be called the 'traditional' argument for profit sharing and it seems to be given some credence by the UK government. The 1986 green paper spoke of profit sharing encouraging "...an improvement in efficiency and productivity leading to enhanced competitiveness and better performance..." (para. 13). This view has widespread support but there is very little understanding as to *how* profit sharing can work to increase productivity.

The problem is this: It is easy to see how profit sharing can increase productivity in the case of a single worker producing a certain amount of output from a certain amount of input (for example a single farmer working a fixed area of land). A wage system in this context, would lead to output being below the social optimum. This is because the social value of an extra unit of output exceeds it's marginal cost. If the worker is paid on the basis of what he produces then he will adjust his efforts to the optimal degree. However, can we extend this parable to a complex industry employing many workers? Will profit sharing cause workers in such an industry to adjust their effort to a socially optimal level? There are three main arguments as to why such an extension may not be possible.

i) The free-rider problem. Each individual worker will find it optimal to 'shirk'. This is because he knows that his own diminished effort has little effect on the final profit and he also knows that everyone else finds it optimal to shirk. Weitzman and Kruse (1989) liken this to the prisoner's dilemma problem in game theory. In this game the payoff is greater if the parties co-operate, but, if the game is only played once, the non-cooperative outcome will be the equilibrium. A way out of this dilemma is to allow the players to build up a reputation for cooperating when the game is played repeatedly. This allows the possibility that a cooperative equilibrium can occur. Weitzman and Kruse believe this may provide a solution to the free-rider problem. Workers will perceive the gains from cooperation and there will be peer pressure on each worker not to shirk.

ii) Risk bearing: We discussed in the previous section the risk aspects of profit sharing. Employees may face unnacceptable variation in wages under such a scheme. Weitzman and Kruse (1989) argue that consideration of risk factors would lead to an optimal remuneration system consisting of less than 100 per cent profit sharing but they still feel that there will be a substantial part of the wage linked to profits. Also they argue that employment will be much more stable under a PRP system. Thus we will have a trade-off with less stability in wages being compensated for by more stability in employment. This will tend to benefit the ***marginal*** worker at the expense of the ***median*** worker. The marginal worker is in a part time or unskilled job. He has low employment status and bears the brunt of any employment fluctuations. This type of worker will benefit from more stable employment. The median worker is an 'insider', a member of the core labour force. This type of worker already has high job security but will lose out from there being a more variable wage. Since the political stance of the union is usually assumed to depend on the preferences of the inside, median worker this will lead to union resistance against the introduction of such a scheme. Thus, as with wage setting, in order to succeed, profit sharing schemes must overide the preferences of the insiders.

iii) Co-determination: Workers now have a share of the profits, will they demand the right to co-determine the decisions of the enterprise? The capitalists now do not receive all the residual profit, will this lead to the capitalist incentive being diluted? This might be a particular problem in the case of investment. Capitalists will know that any rents earnt by an investment project will be shared with the workers. This could prove a disincentive to invest and adversely affect the firm's productivity growth.

Again we require empirical work to assess whether the above problems with profit sharing are sufficient to outweigh any positive effects. Survey evidence is broadly supportive of the contention that profit sharing helps productivity (see Wallace Bell and Hanson (1984) and Weitzman and Kruse (1989) for a review of this evidence). A problem with these surveys is that they are concentrated in firms that operate PRP schemes. Therefore there is a sample selection problem in that, if PRP did not bring positive effects, these firms would probably have reverted to a wage system. There might also be a degree of self justification in their answers. We decided to estimate a production function so as to directly test whether productivity is affected by profit sharing. For example we could estimate a log linearized Cobb-Douglas function of the form:

$$y_{it} = a_i + \alpha\, k_{it} + \beta\, \ell_{it} + a_t + \gamma\, PSDM_{it} \qquad (3.12)$$

where lower case letters denote logarithms and, as above, i indexes firms and t, time periods. Value-added is denoted by y, k is the capital stock, ℓ is employment and PSDM is again the profit sharing dummy, unity only if firm i is operating a PRP scheme in year t. The a_t are time dummies. These capture the effects of all 'aggregate' variables on output (aggregate variables are defined as those that do not vary across firms). The a_i are firm-specific fixed effects. These control for all unobserved heterogeneity between firms. It is crucial that these variables are included otherwise it would be difficult to draw any conclusions from the results. For example, if 'good' managers introduce profit sharing then any positive productivity effect associated with profit sharing in equation (3.12) will just be proxying for good management. A drawback of including these variables is that a lot of interesting variation is lost also. We can only estimate γ in equation (3.12) for firms that introduce, or discontinue, a profit sharing scheme during the sample period. Thus, our results are obtained both by comparing PRP and non-PRP firms and by comparing PRP firms with their own past or future. Some points to note:

i) In equation (3.12) we allow the profit sharing dummy to affect only the constant term. There is no justification for this restriction and we will test whether α, β and the time dummies also change with the introduction of PRP.

ii) If $\gamma>0$ and PRP does increase productivity this might well appear in the employment and stock returns equations. If the technology is described by (3.12) then a standard employment equation would feature a term in γPSDM.

iii) A positive value for γ would effect the stock returns equation in a slightly more problematic fashion. If PRP increases productivity then, in a rational stock market, there would be a once-for-all jump in the price as soon as such a scheme was announced. Thereafter returns would be unaffected. To test for this possibility we include a 'scheme-on' dummy, for the year in which the scheme was introduced, and a 'scheme-off' dummy for the year in which it is discontinued. We are of course assuming here that the scheme is announced only shortly before it is introduced and that firms that discontinue a PRP scheme do not do so solely because they have failed to obtain an increase in productivity. Richardson and Nejad (1986) argue that, because the market will only assess the effects of a scheme over a period of time, any share price premium will also accumulate over time. We test for this by allowing firms operating PRP schemes to have different time effects in the stock returns equation.

3.2.5 Transition to Empirical Work

While equation (3.5) illustrates the basic test that we wish to carry out within the framework of an employment equation, we have yet to specify the other variables. In doing so, we closely follow the analysis in Nickell and Wadhwani (1987), and assume that:

(i) Each firm is a part of a monopolistically competitive industry, and faces a known demand curve of the form

$$Y_i = d\left[\frac{P_i}{P}, \sigma_i\right], \ d_1 < 0, \ d_2 > 0 \tag{3.12}$$

where Y_i = output of ith firm, P_i = Price in the ith firm, P = Aggregate price level, σ_i = Real aggregate demand in the economy relevant to ith firm.

(ii) Output is produced according to the constant returns production function

$$Y_i = \overline{F}\ (L_i, K_i, M_i) \tag{3.13}$$

(iii) The firm faces bankruptcy when

$$\tilde{R}_i - \frac{W_i}{P} L_i - \rho \frac{D_i}{P} + \frac{BC_i}{P} < 0 \tag{3.14}$$

i.e., Real revenue - Real Wage Bill -

Real interest Cost + Maximum amount that it can borrow is negative (ρ = real interest rate, D_i = nominal debt, BC_i is the constraint on additional nominal borrowing). In the light of past empirical work, we shall proxy BC by various financial variables, including income gearing, the debt-equity ratio, and market capitalisation.

(iv) The firm chooses employment to maximise profits net of expected bankruptcy costs, where the latter are increasing in employment.

(v) The outside wage might be allowed to affect wages in this firm, either because of 'efficient bargain' considerations, (see, e.g., Brown and Ashenfelter (1986) for an application with this) or because, in an efficiency wage model, the production function includes the relative wage.

Under these assumptions, Nickell and Wadhwani (1987) obtain,

$$\ln L_{it} = c_{0i} + c_1 \ln \left[\frac{\theta_{it}}{P_t}\right] + c_2 \ln \left[\frac{PM_{it}}{P_t}\right] + c_3 \ln k_{it} + c_4 \sigma_{it} + c_5 \frac{BC_{it}}{P_t} + c_6 \ln \left[\frac{\overline{W}_{it}}{P_t}\right] + c_t + U_{it} \qquad (3.15)$$

where $i = 1, \ldots, N$ (number of firms)

$t = 1, \ldots, T$ (number of time periods),

c_{0i} denotes a firm-specific fixed effect, c_t represents a time varying effect common to all firms, and we assme that $U_{it} \sim N(0, \sigma^2)$. Here, we generalise this equation by including, as additional terms, $c_{11} (B/\theta)_{it} + c_7 PSDM_{it}$. The hypothesis that the firms views only the base wage as the marginal cost of labour would, of course, require, $H_1 : c_{11} = 0$, while the conventional view asserts that $H_{1c} : c_{11} = c_1$. The view that profit-sharing boosts the level of productivity implies $H_2 : c_7 > 0$. These, then, are the key hypotheses that we shall attempt to test within the framework of an employment equation. Note, though, that because of adjustment costs, habit persistence and decision lags, we shall allow for lagged values of these variables when we actually estimate the equation.

Turning to the wage equation, we loosely follow the analysis in Nickell and Wadhwani (1989). Given the employment equation (3.15), we define the insider wage W_i^I as that which will just sustain the existing level of employment n_{i-1}, provided that demand takes the same average value, say, $\overline{\sigma}_{it}$. Also, we represent the "outsider" wage (i.e., the wage necessary to attract, retain and motivate workers) by

$$W_i^0 = \bar{W} - B_2 u + z \tag{3.16}$$

where $\bar{W}$ is the relevant outside nominal magnitude, u = the unemployment rate, and z includes variables such as unemployment benefits which influence the attractiveness of the outside states. In our empirical work, we allow $\bar{W}$ to depend on the aggregate wage, W, and the retail price index, p. If we now assume that the actual wage outcome is some weighted sum of the insider and outsider wages, we have that

$$\theta_i = d_1 p_i + d_2 (y-\ell)_i + d_3 \Delta\ell_i + d_4 BC_i + d_5 W + d_6 p + d_7 u + Z + \gamma_i + \gamma_t \tag{3.17}$$

where we have used the production function to eliminate the capital stock, using output per man instead, γ_i represents a firm-specific fixed effect, and γ_t denotes time-varying effects common to all firms.

In order to examine the effects of profit-sharing on wages, we add the ratio of the bonus payment to the base wage (B/θ) to (3.17), i.e., the term $-d_0 \,(^B/_\theta)$. If Weitzman is correct and profit-sharing does lead to a reduction in wage pressure, then H_3: $d_0 > 1$ would not be rejected. The case $d_0 = 0$ corresponds to the extreme case where the profit-sharing component is merely an additional payment.

3.3 Data and Empirical Results

3.3.1 Data

The data is drawn from the accounts of 219 UK manufacturing companies over the period 1972 to 1982. We have obtained this sample by merging the EXSTAT data tape (supplied through the ESRC Data Archive) with information from the DATASTREAM on-line service. The 219 firms have sufficient consistent data to enable us to estimate wage and employment equations over this period. In principle we also have information on whether these firms operated profit sharing schemes and, if so, the amount of the bonus. However, since it is obviously vital to our results that we measure the existence and extent of profit sharing accurately, we chose to use only those firms for which we had independent information on PRP schemes. This was obtained from a survey carried out by Dr. Richardson at the LSE (under the aegis of the stock exchange)[3]. This left us with 101 firms for which we had information on PRP schemes corroborated by two independent sources. Of these, 21 operated a scheme for some part of the sample period. There is a good deal of variation in the number of firms operating schemes, 4 in 1972 and 18 in 1982. No firm has a PRP scheme for the whole sample period since this would make it impossible to disentangle the PRP effect from the firm-specific fixed effect.

The payout ratio (bonus/wage) also varies significantly over firms, from a minimum of zero to a maximum of 10 per cent. The mean payout is 4.5 per cent of total remuneration in 1973, falling to 1.7 per cent in 1982. This might be considered very low, but there is evidence to suggest that this figure is not unrepresentative of UK manufacturing (e.g see the evidence from the Wider Share Ownership Council survey quoted in appendix

A3). Supporters of profit sharing could argue that any negative results found by us could be because of the low committment shown to profit sharing by UK firms. Much of the impetus for studying profit sharing came from comparative studies of countries such as Japan, Taiwan and Korea. These countries have enviable employment and productivity records coupled with much more substantial profit sharing. In Japan the profit related bonus will constitute, on average, 25 per cent of a workers total renmuneration, in Taiwan and Korea the same figure is 15 per cent (although Wadhwani (1987a) studies how far we can attribute Japan's economic record to profit sharing). While we admit that, compared to these figures, our payout ratio is low, we feel that there is significant variation in this variable and that there is no reason to believe that profit sharing will only begin to affect behaviour after a certain critical level.[4]

There is no doubt that the tax advantages given to PRP schemes by UK government legislation over the seventies and eighties has provided an impetus to the introduction of such schemes (see appendix A3 for details of this legislation and the various schemes operating in the UK). This has led to a lot of our firms introducing PRP schemes towards the end of the sample period. Of the 18 firms operating PRP schemes in 1982 the oldest scheme had been in existence for 5 years and the mean age of schemes was two years. The survey data we have also provides us with information as to which profit sharing scheme these firms were operating. Of these 18 firms, 13 were operating a scheme set up under the 1978 finance act and 3 under the 1980 finance act. This concentration of interesting variation in the last few years of the sample is another problem that we have to face and we are currently updating this sample to 1986 in order to fully assess the effects of the PRP schemes set up under the 1978 and 1980 acts.

We do not take advantage of this extra information on what type of scheme is being used. There are only sufficient degrees of freedom to estimate independent effects for PRP and non-PRP firms. Allowing different schemes to have different effects on behaviour might be an area for future research.

Table 3.1 contains some basic features of the dataset. The split is between firms that operate a scheme for at least one year of our sample and firms that never operate a scheme. All the firms are large (average employment>10,000) and this is due to the sample selection criteria used (this sample is a subset of the dataset used in chapter two). The PRP firms are slightly smaller, have a smaller decline in employment over 1972-82 and lower volitility of this change in employment. The PRP firms also pay a slightly higher level of remuneration though, over 1972-82, this increased slightly less than for non-PRP firms (this comparison excludes bonuses).

The non-PRP firms have had greater growth in productivity over 1972-82 and have also outperformed the PRP firms in terms of stock returns. This is contrary to the results of Wallace Bell and Hanson (1987) and Richardson and Nejad (1986).

While straight comparisons such as those given in table 3.1 are useful to check on the data, we cannot draw any conclusions since we are not controlling for all relevant variables. The econometric results should allow us to assess the effects of PRP with greater confidence.

3.3.2 Estimation and Empirical Results

We first remove the firm-specific fixed effects by subtracting firm-specific means from our variables

The equations are, then, estimated by ordinary least squares and/or using instrumental variables (whichever is appropriate).

(i) The Employment Equation Our estimate of the employment equation is reported in Table 3.2. The results are, in the main, plausible and consistent with our prior theory.

Turning to the main hypothesis of interest, the conventional view (H_{1c}) requires that, both, the base wage and the bonus/wage ratio reduce employment by the same amount, while Weitzman's view requires that the bonus/wage ratio does not affect employment. On the basis of the point estimates, neither view is supported with the bonus/wage ratio depressing employment by much more than the base wage (a coefficient of -1.15 against -0.13). However, this is a reflection of the fact that the coefficient is poorly determined, and that, formally, one cannot reject either hypothese H_1 or H_{1c}. All that we can say is that the hypothesis H_{1c} (the conventional view) fails to be rejected with greater confidence than Weitzman's view (embodied in H_1).

There is also some interest in whether any effect that profit-sharing has in terms of boosting productivity manifests itself in the employment equation. A profit-sharing dummy does attract a positive coefficient, 0.02, but one that is only barely significant. So, the effect is not very well defined (statistically), although, if valid, it implies a long-run increase in employment of 8.4 per cent.

There is one more issue that deserves some discussion here. It is that profit-sharing firms might exhibit greater employment stability - this effect might derive either from Weitzman's model where such firms are in a short-run 'excess demand for labour' regime, or from the possibility that profit-sharing will cause remuneration to adjust more quickly to shocks (see Mitchell (1982)).[5]

It is, though, hard to believe that the PS firms were, in fact, in an excess demand for labour regime for much of our sample period, which was, in fact, characterised by high unemployment. We may test for this effect by examining the response of employment to, say, demand shocks. These are proxied here by the change in industry output. Therefore, we re-estimated our equation, but interacted the industry output variable with the profit-sharing dummy. A smaller responsiveness to demand shocks requires that the coefficient on the change in industry output be ***smaller*** for profit-sharing firms. However, our estimates suggest that there is little difference - the coefficient for non-PS firms is 0.346 (4.51) while that for PS firms is 0.435 ('t' test for difference = 0.49). So, if anything, employment in profit-sharing firms seems to respond ***more*** (not less) to demand shocks. It may be of some independent interest to examine whether the response of profit-sharing firms to negative industry demand shocks is less than that of fixed-wage firms. Therefore, we included two separate interactions with the profit-sharing dummy - one, corresponding to rises in industry output, the other with falls in industry output. The difference in the response to negative demand shocks between PS and non-PS firms is only -0.007, with a t-ratio of 0.03.

(ii) The Wage Equation Our estimated wage equation is reported in Table 3.3 column (1). Notice that both "insider" variables (e.g., output per man, output price, deposits) and "outsider" variables (e.g., unemployment, retail price index etc) matter.

Turning to the main hypothesis of interest, we cannot rejec the view that the coefficient on the bonus/base wage ratio is insignificantly different from zero. This, therefore, is consistent with the view that the profit-share component is an 'add-on' payment, and that any such payments are not allowed to reduce the base wage. Hence, our point estimates suggest that far from leading to a reduction in wage pressure, *the*

introduction of profit-sharing schemes actually raises total remuneration by about 90 per cent of the profit-share component. Further, notice that the result is robust to including time dummies instead of aggregate time-varying variables (column (2). This result also remains valid when we use a profit-sharing dummy instead of the bonus/base wage ratio. Hence, far from providing a cure for inflation, profit-sharing may well be inflationary! In addition, this effect will tend to reduce employment. To illustrate this, suppose the payment ratio is 3 per cent. Then, the base wage only falls about 0.3 per cent, so there is a very limited offset. In terms of the employment equation, this implies that employment falls by about 12.4 per cent which easily swamps the beneficial effect flowing from higher productivity (≈ 8.4%). Of course, this estimate is absurd, as the crucial coefficients are estimated very poorly in the employment equation. If one uses, instead, an estimated labour demand elasticity of about -0.5, the 'add-on' character of bonuses implies that employment only falls by 5.4% instead, so, overall, employment would rise. However, the basic point stands. Even if profit-sharing boosts employment through possibly beneficial effects on productivity, the fact that PS leads to higher wages will tend to offset this effect. Thus, we find no evidence that would support the claim that profit sharing boosts employment.

(iii) The Stock Returns Equation The equation that we estimated here was

$$r_{E,it} = r_i + r_t + (\delta_0 + \delta_1 \, CPSDM_{it}) \, (\frac{D}{E})_{it} + \delta_2 \, SCHD_{it} + \delta_3 \, SWOD_{it} + \delta_{4t} \, CPSDM_{it} \, r_t \qquad (3.11")$$

where, recall that Weitzman's view that firms view the base wage as the marginal cost of labour requires that $\delta_1<0$ (the conventional view has

δ_1=0), where $CPSDM_{it}$ is a dummy variable that takes the value one where the firm operates a cash-based profit-sharing scheme (for it is only then that the debt-equity ratio is mismeasured). $SCHD_{it}$ is a dummy variable that takes the value one in the year when a scheme (share-based or cash-based) is introduced, while $SWOD_{it}$ is the corresponding dummy variable if a scheme is discontinued. If the Efficient Market Hypothesis were valid, any effects of the scheme on productivity should be immediately incorporated into the current share price. As a consequence, we would expect
$\delta_2 > 0$, and $\delta_3 < 0$.

If, on the other hand, it takes time for the market to appreciate the impact of such a scheme, then we might expect effects on returns beyond the year of the introduction of the scheme. In order to capture such effects, we interact the profit-sharing dummy with the time dummies, r_t.

Our estimates of (3.11") are presented in Table 3.4. The coefficient on the debt-equity ratio is consistent with the Modigliani-Miller view that a higher debt-equity ratio raises the required return on equity. However, the coefficient on the debt-equity ratio for profit-sharing firms is, if anything, ***higher***, rather than being ***lower*** (as in terms of Weitzman's theory). So there is no evidence in stock returns for the view that profit-sharing actually leads to the firm only viewing the base wage as the marginal cost of labour.

Turning to the evidence relating to productivity, the coefficient on $SCHD_{it}$ suggest that, if anything, the introduction of a scheme ***lowers*** (rather than ***raises***) stock returns. There is no perceptable effect on the stock returns of discontinuuing such a scheme. We also allowed for the possibility that it takes time for the effects of profit-sharing to be appreciated, and, therefore, included time dummies interacted with the profit-sharing dummy. However, none of them were significant and, in fact, a F-test for the inclusion of all of them yielded a value of F(6,690)=0.60 suggesting that, on the basis of these estimates, it is hard to believe that the stock market thinks that these schemes lead to a higher level of productivity. We obtained largely similar results when we used a market value measure of the debt-equity ratio.

(iv) The Production Function The equation that we estimated was

$$y_{it} = a_i + \alpha k_{it} + \beta \ell_{it} + a_t + \gamma_1 PSDM_{it} + (\gamma_2 PSDM_{it} k_{it}) + (\gamma_3 + PSDM_{it} \ell_{it}) + (\gamma_4 PSDM_{it} a_t) \qquad (3.12")^{6}$$

where we have allowed profit-sharing firms to have a production function with different coefficients. Having estimated (3.12'), we dropped these interacted variables with t-ratios less than one. The resulting estimated equation is reported in Table 3.4.

There is some evidence here of profit-sharing boosting productivity in that the coefficient on the dummy interacted with the capital stock is statistically significant, while the profit-sharing dummy itself also attracts a positive coefficient.

This result is fairly robust, in that it is maintained under a variety of other assumptions. For example, we estimated the equation by ordinary least squares instead, and also estimated a CES production function instead (and could not reject the hypothesis is that the elasticity of substitution was equal to unity, which brings us back to the Cobb-Douglas specification). We also explored the possibility that the effect of profit-sharing varies over time by interacting the dummy with the number of years since the adoption of profit-sharing. There was, however, no evidence that companies which had introduced the scheme some years ago were more productive than companies who had only just started such a scheme.

3.4 SUMMARY AND CONCLUSIONS

We have argued above that:-

(i) The evidence from, both, an employment equation, and a stock returns equation, is consistent with the view that, under a profit-sharing system, the firm views the total level of remuneration (and not just the base wage) as the marginal cost of labour. This conflicts with a key assumption which underlies much of Weitzman's work.

(ii) The wage equation estimates are consistent with the popularly-held view that these profit-sharing payments are, very largely, an 'extra', in addition to the 'normal' wage. Other things being equal, this implies that such schemes can be inflationary.

(iii) The production function estimates are consistent with the view that profit-sharing boosts productivity. This evidence is also, to some extent, corroborated by our estimates in the employment equation, where higher productivity appears to boost employment. However, we did not find any evidence for productivity gains in the stock returns equation, although this may be because of the serious difficulties associated with testing for this effect.

Although profit-sharing appears to increase productivity, one should not assume that it will increase employment, the fact that PS leads to a higher wage, (even after controlling for productivity) will tend to depress employment.

Of course, we must be cautious, as our results are based on a rather small sample of firms, where the share of PRP in the total pay packet is also relatively small. Further, these firms are confined to the manufacturing sector. Also, some of our crucial coefficients were statistically insignificant and, therefore, should not carry too much weight. The introduction of tax incentives to encourage PRP in the UK should lead to a greater take-up of these schemes, and will, hopefully, provide us with some more data to examine the veracity of our conclusions above. We are currently working on updating this sample to 1986 and obtaining as many profit sharing firms as possible off the EXSTAT tape. This has given us a sample of 154 firms of which approximately 70 operate a profit sharing scheme at some point in the sample period. The next stage in the research is to repeat the above experiments using this extended sample.

Nevertheless, if our results were correct, they would suggest that profit sharing is not a panacea for all the evils of stagflation and attempts to make it more widespread should not be justified on those grounds.

FOOTNOTES

* We are deeply grateful to Steve Nickell who has made a substantial contribution to this project. We are also greatly indebted to Ray Richardson, who kindly allowed us access to data from the survey that he undertook. Three anonymous referees made several useful suggestions, and have helped improve the paper. Financial support from the Economic and Social Research Council is gratefully acknowledged.

1 For other relevant empirical work in this area, see e.g., Blanchflower and Oswald (1986, 1987), Kruse (1987), Richardson and Nejad (1986), and Wadhwani (1987a)

2 A possible modification in the proposal in the TUC's document is for the firm to include an earnings guarantee as a part of the deal, which then provides workers partial insulation against unanticipated falls in profits as well.

3 We are deeply grateful to Ray Richardson for allowing us access to this data

4 Note also that not all employees are necessarily covered by these schemes, and because our measure is total bonuses divided by the total wage bill of ***all*** employees, this ratio will understate the bonus/wage ratio of workers who qualify. This should not affect our estimation of the relevant parameters.

5 See Kruse (1987) for some evidence in this regard.

6 Due to data limitations, we were unable to use value added, and had to use sales instead. This, of course, is incorrect if there are non random changes in inventories or in the ratio of materials input to output. Equation (3.12') is still valid if we are willing to assume that the differences between value added and sales can be subsumed into

the error term, the firm-specific effect, and the time dummies. This allows the ratio between value added and sales to vary systematically over time but restricts this variation to be the same for all firms. See the next chapter for further discussion of this.

Appendix A3.1

Profit Sharing Schemes in the UK

Up until 1982 there were basically five different types of profit related pay schemes operated by UK firms. Of these only two were recognised by the Inland Revenue to receive tax concessions.

A. Schemes approved by the Inland Revenue:

i) APS (Approved Profit Sharing). This scheme was set up under the 1978 Finance act. The company sets up a trust to buy shares for its employees. The trust then allocates shares to the employees on an individual basis. The employees cannot sell the shares until two years after the allocation. If they sell the shares between two and five years they incur a percentage of the income tax. If they sell after five years they incur no tax. The scheme is open to all full time employees that have been with the firm at least five years. There were 562 of these schemes in operation by June 1986. However, a survey by the Wider Share Ownership Council (WSOC 1985) showed that, on average, the share component will be less than 2 per cent of total wages and salaries and the amount of money allocated for the purchase of shares will be less than 3 per cent of profits. This is very similar to the payout ratios we find in our sample.

ii) SAYE (Save As You Earn)

The Savings Related Options Scheme was set up under the 1980 Finance act. In this scheme companies give their employees an option to buy shares at a given price and at a fixed date in the future (usually five or seven years from the start of the contract). Employees are not liable to income tax on any gains they make when exercising this option. Again, this scheme is open to all employees of five years standing. The UK emphasis on share options is unique among profit sharing systems. Despite the significant tax concessions of this scheme the WSOC survey showed that, for almost half the firms operating a scheme of this sort, less than 10 per cent of the workforce participated.

B Schemes without Inland Revenue approval

iii) Any other share ownership scheme open to all employees.

If not falling within the ambit of the above two acts PRP schemes will not qualify for tax concessions.

iv) Share ownership schemes for selected employees.

A 1984 act allowed tax breaks on discretionary share option schemes, but this would not have been relevant to the firms in our sample.

v) Cash based schemes.

This is the 'traditional' way in which firms have shared profits. The main problem with assessing these schemes is that it is often difficult to judge whether bonuses paid through such schemes are actually related to profits rather than something like productivity.

In the survey carried out by Smith (1986, survey carried out in 1985) 21 per cent of her sample had schemes covering all employees. Fifteen per cent were 'Inland Revenue approved' in that they fell within catagories i) or ii) above, and 6 per cent were cash based.

TABLE 3.1

Basic Features of the Data

(numbers refer to location of variables in the Data Appendix)

	PROFIT-SHARING FIRMS	NON-PROFIT-SHARING FIRMS
EMPLOYMENT (variable 1)		
Average level (1974-82)	10,942	11,255
% change (1972-82)	-24.2%	-26.7%
Standard deviation of changes	9.4%	10.4%
WAGES (Base wage only, variable 3)		
Average level in 1980	£5,305	£4,978
% change (1972-82)	307.8%	316.6%
PRODUCTIVITY (Output per Man) ('sales', variable 5, over 'employment')		
% change (1972-82)	21.54%	28.96%
REAL STOCK RETURNS (variable 11)		
% change (1972-82)	3.48%	12%
CAPITAL STOCK (variable 4, method 1)		
% change (1974-82)	28.8%	21.9%
DEBT-EQUITY RATIO (variable 7)	25.5%	36.7%

TABLE 3.2

Employment Equation (1974-82)
(Using firm fixed effects)

Dependent variable:- ln $(\text{Employment})_t$

Independent variables	
ln $(\text{Employment})_{t-1}$	0.838 (18.09)
ln $(\text{Employment})_{t-2}$	-0.082 (-1.77)
ln $(\text{Capital Stock})_t$	0.234 (9.43)
Δln $(\text{Base Wage})_t$	-0.207 (-3.59)
ln $(\text{Base Wage})_t^*$	-0.129 (-1.99)
$(\text{Bonus/Base Wage})_{t-1}$	-1.154 (-1.01)
ln $(\text{Industry Wage})_t$	0.232 (1.33)
$\frac{1}{3}\sum_{i=0}^{2}$ ln $(\text{Relative Raw Materials Price})_{t-i}$	-0.119 (-2.14)
Δ ln $(\text{Industry Output})_t$	0.363 (4.91)
Δ ln $(\text{1-Ind. Unemployment})_t$	0.679 (1.46)
ln $\left(\frac{\text{Market Capitalisation}}{\text{Captial Stock}}\right)_t$	0.046 (5.94)
$(\text{Debt-Equity Ratio})_{t-1}$ - book value	-0.069 (-3.20)
$(\text{MLR}_{t-1}$ Income Gearing Dummy$)_y$	-0.273 (-4.19)
Profit-Sharing Dummy	0.021 (1.59)
Sample size (TN)	900
s.e.	0.0866

Notes to Table 2
(i) t-ratios in parentheses
(ii) The regression includes *time dummies*.
*(iii)** denotes variables that are treated as endogenous in the estimation , additional instruments used include ln $(\text{Capital Stock})_{t-1,t-1}$, ln $(\text{Real Sales})_{t-1,t-2}$, ln $(\text{Market Capitalisation})_{t-1,t-2}$, $(\text{Debt Equity Ratio})_{t,t-2}$, ln $(\text{Industry Wage})_{t-1,t-2}$, $(\text{Real Profits})_{t,t-1,t-2}$, $(\text{Union Density})_t$, $(\text{Directors' Remuneration})_t$, and all variables in the equation interacted with the profit-sharing dummy.

TABLE 3.3
Firm Level Wage Equation

Dependent variable: ln (Base Wage)$_{it}$

Independent Variables	(1)	Including Time Dummies (2)
ln (Output per Man)$_{it}$	0.20	0.21
	(4.09)	(3.43)
ln (Output per Man)$_{i,t-1}$	-0.09	-0.10
	(-2.66)	(-2.44)
ln (Output Price)$_{it}$	0.15	0.16
	(2.77)	(2.45)
ln (Output Price)$_{i,t-1}$	-0.10	-0.11
	(-2.62)	(-2.41)
ln (Base Wage)$_{i,t-1}$	0.39	0.40
	(13.63)	(13.14)
(Bonus/Base Wage)$_{it}$	0.07	0.32
	(0.10)	(0.45)
(Bonus/Base Wage)$_{i,t-1}$	-0.01	-0.22
	(-0.02)	(-0.37)
ln (Industry Unemployment)$_{it}$	-0.06	-0.04
	(-3.67)	(-2.17)
(Deposits-Current liabilities ratio)$_{it}$	0.05	0.05
	(2.18)	(2.21)
(Deposits-Current liabilities ratio)$_{i,t-1}$	0.05	0.05
Δ ln (Employment)$_{it}$	0.06(1.88)	0.08(1.72)
(Union Density)$_{it}$	0.04	0.05
	(0.86)	(0.90)
(Union Density)$_{i,t-1}$	0.04	0.05
ln (Retail Price Index)$_{t-1}$	0.65	-
	(13.69)	
(Minimum Lending Rate)$_{t-1}$	-1.29 (-9.52)	-
ln (Unemployment)$_{t-1}$	-0.08	-
	(-3.67)	
ln (Union Mark-up)$_t$	0.28	-
	(9.43)	
Δ ln (Aggregate Wage)$_t$	0.48	-
	(8.43)	
T	9	9
N	96	96
Time period	1974-82	1974-82
s.e.	0.044	0.044

Notes to Table 3

(i) t-ratios in parentheses.

(ii) Estimation by IV with individual firm dummies. (Bonus/Base Wage)$_t$, Δ ln (Employment)$_{it}$ and ln (Output per Man)$_{it}$ are treated as endogenous.
Additional instruments used are:
ln (Output per Man)$_{t-2}$, ln (Employment)$_{t-2}$, ln (Capital Stock)$_{(t-1,t-2)}$, ln (Industry Output)$_{(t-1,t-2)}$, ln (Industry Wage)$_{(t,t-1,t-2)}$, Profits$_{t-1}$, Directors' Remuneration$_t$, (MLR$_{t-1}$+Income Gearing Dummy), (Debt-equity ratio)$_{t-1}$ and all these variables interacted with the profit-sharing dummy.

TABLE 3.4

Stock Returns Equation and Production Function Estimates

Dependent Variable: Independent Variables	Ex post return	ln $(Sales)_{it}$
$(Debt\text{-}equity\ ratio)_{it}$	1.747 (5.74)	
$(CPSDM\ Debt\text{-}equity\ ratio)_{it}$	1.549 (0.47)	
$SCHD_{it}$	-0.217 (-1.11)	
$SWOD_{it}$	-0.038 (-0.16)	
$\ln(Employment)_{it}$		0.721 (19.36)
$\ln\ (Capital\ Stock)_{it}$		0.238 (4,91)
$PSDM_{it}$		0.027 (1.80)
$PSDM_{it}\ \ln\ (Capital\ Stocks)_{it}$		0.268 (2.10)
N	101	97
T	7	9
Time Period	1974-80	1974-82
s.e.	0.475	0.121

Notes

(i) t-ratios in parentheses

(ii) Stock returns equation inlcudes time dummies, plus cash profit-sharing interactions with time dummies. IV estimates treated debt-equity ratios as endogenous. Additional instruments used include logged values of the debt-equity ratio at book and market values.

(iii) Production function equation includes time dummies

(iv) IV estimates treating employment and capital stock as endogenous. Additional instruments used: ln(Employment)t-1, t-2, ln(Capital Stock) (t-1, t-2) $Profits_{t-1}$, $\ln(Wages/Raw\ Materials\ price)_t$, ln(Sales), (t-1, t-2), ln(Market Capitalisation), $\ln(Capital\ Stock/Employment)^2$ (t-1, t-2), and all these variables interacted with the profit-sharing dummy.

Chapter 4: A Direct Test of The Efficiency Wage Model

4.1 Introduction

In this chapter we assess to what extent the efficiency wage model is consistent with UK data over the period 1972-82. In the previous chapter we found evidence that profit sharing leads to increased productivity. We argued that this might be due to a greater sense of 'common purpose' between workers and managers. The efficiency wage model also exploits such 'sociological' theories of the labour market to argue that higher wages can lead to higher productivity. However, the efficiency wage model can also be justified on individual firm profit maximising grounds. Part of the purpose of this chapter will then be to assess which version of the efficiency wage model, if any, provides the closest description of the workings of the labour market.

Efficiency wage models are characterised by firms setting wages at above the market clearing level. At these wages employees are earning economic rent and there are unemployed workers of the same quality who would strictly prefer to work at that wage. These models then, can help us explain both involuntary equilibrium employment and inter-industry wage differentials.

Most of the literature on this topic has been theoretical, however, in recent years several empirical papers have featured the efficiency wage hypothesis. Krueger and Summers (1986, 1987) studied the wage structure across industries and argued that it is consistent with efficiency wages. Murphy and Topel (1987) and Dickens and Katz (1987) interpret this data differently.

This chapter is an empirical test of the efficiency wage model. We use data on 219 UK manufacturing firms over the period 1972-82 to assess this model by examining it's predictions for the determinants of productivity. In this type of model higher productivity is associated with a higher relative wage. This relative wage is the ratio of the firms own wage to the worker's perception of his outside opportunities, or, how well he will do if he leaves this job. Thus, efficiency wage models predict that a higher wage within the firm, a lower 'alternative' wage and a higher level of unemployment outside the firm, will lead to higher productivity. The latter two variables because they affect 'outside opportunities'. *If* we are measuring labour quantity and quality correctly *then* neither of these variables would enter a neo-classical production function. We find empirical support for both of these effects and hence our results are consistent with firms setting their wages for efficiency considerations.

The association of high wages with high productivity is also a feature of several models that remain within the market clearing paradigm. For example, firms could be paying higher wages to more productive workers (the 'unobserved human capital' model where the firm can observe a worker's quality but the econometrician cannot, here the wage is proxying for skill levels), a firm could be earning excess profits and sharing them with it's workforce (the 'rent sharing' model where causality runs from higher productivity to higher wages), or firms could be bargaining with their workforce over both effort and wages (compensating differentials). We attempt to deal with these issues by appealing to the work of other authors and by experimenting with the functional form of our model and we believe that the best explanation of our results is that firms are paying higher wages for efficiency considerations.

We also find support for a modified version of an efficiency wage model where workers compare not only their current wage with current outside opportunities, but also their current relative wage with their past relative wage. In this model the notion of what is a 'fair' wage is adjusted over time. This is consistent with the psychological theory of adaptation and gives us the prediction that changes in the relative wage will boost productivity. We find that there is evidence to support this.

Section 4.2.1. reviews the theory of efficiency wages, 4.2.2 summarises some existing empirical evidence, 4.2.3 formulates our test, 4.2.4 describes our data and estimation techniques and 4.2.5 presents the basic results. Section 4.3 is concerned with assessing the robustness of our results. Section 4.4 contains conclusions.

4.2 Theory and Estimation

4.2.1 A Review of Efficiency Wage Theories

Efficiency wage models are characterised by having a positive linkage between wages and productivity or profitability. Firms will find it optimal to set wages above the market clearing level. The wage will have a dual role, clearing the external labour market and solving the firm's internal profit maximising problem. This linkage between high wages and high profitability is not new, it has been noted by such authors as Adam Smith, Karl Marx, Alfred Marshall, Henry Ford and Max Weber. However, it is only in the last decades that economists have formalised models which involve this linkage. There are five main rationalisations as to how paying higher wages can cause higher productivity (see Akerlof and Yellen (1986) for a survey).

i) One of the first modern formulations is due to Liebenstein (1957). In the context of an underdeveloped country the linkage is straightforward. Higher wages will enable the worker to afford better nutrition and health care and hence become more productive. This would not be expected to be an important effect in a developed country.

ii) 'Work or Shirk' models. The classic paper on this type of model is due to Shapiro and Stiglitz (1984). In their model we have a set of homogeneous firms and workers. Firms can only imperfectly monitor the effort levels of their workers. Workers make a discrete decision whether to work or shirk. They would prefer to shirk but they know that there is a chance that they will be detected and sacked. The problem arises because, if all firms are paying the wage that clears the labour market, then there will be no costs to shirking. If a worker is detected and sacked he will straight away find another equivalent job. In this model the equilibrium occurs when firms are paying above the market rate. The labour market will not clear since, at this wage, there will be an excess supply of workers willing to do the job. This policy works because there are now costs to being detected shirking. Workers will face a spell of unemployment at low income. In this model equilibrium unemployment exists as a worker discipline device.

This model contains several testable predictions:

a) The wage will be higher if the cost of monitoring workers' efforts is higher.

b) The wage will be higher the greater is the potential damage inflicted by a worker's poor performance (there is considerable evidence that the wage structure within firms depends largely on the 'responsibility' of a given position. 'responsibility' is often directly related to the amount of damage that an inefficient incumbent worker could inflict. The counter argument to this is that 'responsibility' is an undesirable job characteristic and the higher wage is simply compensation).

c) Productivity will increase with the costs of job loss. A worker will base his 'work or shirk' decision upon his comparison of his current internal wage with his expected income outside the firm. It is more likely he will decide not to shirk if these 'outside opportunities' decrease. Outside opportunities will depend on his expected alternative wage, length of unemployment spell and unemployment income.

The main objection to this model is that there are more efficient (in terms of having lower unemployment) ways of preventing shirking. One alternative is for workers to post 'performance bonds' when they obtain a job. These would be forfeited if they were detected shirking. Another way is for workers to pay 'entrance fees' into high paying jobs. The cost of being caught shirking is then having to pay another entrance fee. The problem with these alternatives is that, if monitoring costs are high, the amount of bond required could be very large. With imperfect capital markets it may be impossible for new hires to post such bonds. There is also the observed rarity of such arrangements in the real world. One way around these objections is to argue that the bonding is implicit. Workers spend a probationary period in the firm earning a wage below their marginal product. This will pay for the bond. This could be an explanation for the upward sloping seniority-wage profiles of many firms. There is another problem with the use of bonds, caused by moral hazard. Once the worker has (explicitly or implicitly) posted the bond, the firm has an incentive to claim he is shirking, even when he isn't, and to pocket the bond. These problems reflect the many practical difficulties associated with bonding systems and may make the payment of efficiency wages optimal in such an 'unobservable effort' model.

iii) Labour Turnover models (see, for example, Salop (1979)). A high turnover of labour is costly to firms because of hiring and training costs. If the quit rate is reduced by paying employees rents then this could again give an equilibrium where firms are paying wages above the competitive level and there is involuntary unemployment. This is also the result of the wage playing a dual role. It has to clear the market both for new hires and for trained workers. This model also predicts that a higher level of productivity will result either from a higher internal wage or lower outside opportunities. This time the mechanism is operating through the lower quit rate. The market failure in this model can again be obviated by using a system where new workers post a bond or pay an entrance fee. For example new hires could pay their own costs of training. However we have the same problems as in the previous case. Unemployed workers will face liquidity constraints and will be unable to meet such costs. If they pay for their training by accepting a wage below their marginal product for a period, they run the risk of finding themselves unsuitable for the job. Again there seems no practical way that such a market mechanism could totally solve this problem and so firms will always have to bear at least some of the costs of turnover.

iv) Adverse selection models. A model of this sort was formalised by Weiss (1980). Firms cannot observe the ability levels of their applicants. However, if we assume that the reservation wage of an applicant is positively related to his ability, then, by paying higher wages, the firm will attract a better class of applicant. The main objection to this model is that it seems infeasible to suppose that the firm can never assess the ability levels of it's workers. Sooner or later low ability workers will be detected and fired. If applicants are required to post performance bonds, liable to forfeit if they are detected as of low ability, then efficiency wages need not be paid. We again face the practical difficulties associated with bond systems outlined above. This model again predicts that the inside wage relative to outside opportunities will affect productivity. This is the relevant variable for applicants seeking work in the firm.

v) Sociological models (see for example Akerlof (1982, 1984)). These models are characterised by workers having a notion of a 'fair' wage for their work. If the firm pays above this 'fair' wage then the workers will reciprocate this 'gift' from the firm by giving the firm the 'gift' of higher effort. The outside opportunities facing a worker will determine what he regards as a fair wage. This model further predicts that efficiency wages will be important where work groups and teamwork is important. Product market conditions may affect what the workers regard as a 'fair' wage since they will affect the firm's 'ability to pay'.

Some authors have argued that another rationalisation for efficiency wages is the 'union threat' model. In this model firms are paying higher wages in order to forestall the workforce from organising themselves into a union. In this model higher wages would result if, for example, the firm was a non-union firm in a highly unionised industry. Krueger and Summers (1988) have argued that this is not a 'pure' efficiency wage model since it is not the firm reaching an internal optimum that determines wages, but rather the reaction of the firm to the threat of an outside agency.

All the above variants of efficiency wages predict that the internal wage relative to outside opportunities has an important role to play in determining productivity. A workers' outside opportunities will depend on several variables. The unemployment rate will affect the expected time it takes to find another job. The level of benefits will affect his income whilst unemployed and the general level of wages in his industry or nationally, will affect his expected earnings in his next job.

4.2.2 Some Empirical Evidence

There has been a good deal of work as to whether the structure of inter-industry wage differentials is consistent with competitive wage setting. Much of this evidence points to wages being set much more for rent-sharing or efficiency wage considerations.

Krueger and Summers (1987) begin with the observation that the structure of inter-industry differentials is stable over both space and time. For US data they find a rank correlation of .8 between the wage structure in 1984 and that in 1920. Similarly, when they compare the US with 13 other developed economies, eight of these countries have a rank correlation with the US of .8 or above whilst it was above .6 for eleven countries. This suggested that there was something fundemental determining the wage structure of mature economies. Changes in relative demand could not be expected to generate such robust pay differentials. They went on to estimate wage equations on a sample of workers drawn from the 1984 Current Population Survey. To test whether high wage industries are actually paying for higher quality workers, they include controls for observable human capital such as sex and occupation. This only marginally reduces the dispersion of wages and does not change the ranking. There remains the problem of estimating the effect of unobserved human capital. They conclude that this cannot explain the estimated wage differentials for two reasons.

i) Controlling for a large number of observable measures of human capital, including sex and occupation, has such little effect it seems unlikely that unobserved capital could have a larger effect.

ii) There have been panel studies of workers who have switched industries. The wage gain (loss) for a worker moving from industry i to industry j is, in general, very similar to the wage differential j over i, estimated from the cross-sectional studies.

Krueger and Summers also conclude that these are not compensating differentials, i.e. wage premiums paid because of the undesirable aspects of the job e.g. danger, high risk of unemployment etc. Apart from the anecdotal evidence that high wage industries are actually more pleasant places to work than average, there is evidence that industries that pay a wage premium have lower quit rates than average. This is not consistent with a compensating differentials explanation.

Krueger and Summers believe that there are strong elements both of rent sharing and of efficency wages in wage determination. The industries that pay high wages tend to have market power and high profit rates. When they bargain over wages with their workers they can afford to pay above competitive rates. Because the workforce feels fairly treated it puts in greater effort and there is higher productivity. The costs of not fully maximising profits are therefore not very great.

Analysing the same data leads Dickens and Katz (1987) to a similar conclusion. They try to isolate the characteristics that determine whether an industry is high wage or low wage. The problem is that industries tend to vary along only one dimension. At one end there are high wage industries with high profits, market power, capital-labour ratios and union coverage. The low wage industries have all the opposite characteristics. Because of the lack of independent variation in these characteristics, Dickens and Katz find it very difficult to isolate the independent effect of each variable. However some characteristics have enough variation for them to measure a significant effect. They conclude that a high profit rate does lead to a higher wage. Dickens and Katz suggest that this points to a non-standard theory of wage determination.

The panel studies of workers who have switched industries provide the most powerful single piece of evidence that wage premiums reflect industry effects rather than unobservable skill elements[1]. Murphy and Topel (1987) examined the strength of this result. They found substantial measurement error in the data on industry transitions. Re-classification of industry or occupation would often cause an individual to be counted as a 'job-switcher' even when they had remained in the same job. Murphy and Topel found a sub-sample of 'movers' who they were certain had actually switched. They then estimated an equation of the form:

$$\Delta W_{it} = \Delta X_{it} B + \delta\ (\theta_{It} - \theta_{It-1}) + V_{it}$$

Where W_{it} is the wage of individual i at time t, X_{it} is this individual's (time varying) characteristics, θ_{It} is the industry wage premium of industry I estimated from a cross section equation. Therefore if wages only reflect human capital $\delta=0$, if they are entirely determined by industry then $\delta=1$. Murphy and Topel found $\hat{\delta}=0.29$ and could not reject either hypothesis. So it is likely that at least a part of the observed cross sectional industry wage differential is valid and not an effect of our inability to measure relevant characteristics. In a later paper Krueger and Summers (1988) attribute the Murphy-Topel result to the fact that they do not control for occupational changes

This cross-sectional work is important for us because, in our work, all human capital is unobserved. We appeal to the above results as evidence that industries, and hence firms, are not paying more simply for higher quality workers. We attempt to show that these wage premiums are correlated with productivity.

A paper by Levine (1988) also attempts to test the pay-productivity relationship. He finds that the relative wage has a positive effect on productivity with an elasticity between .19 and .3. Levine has better data than us on inventories and materials input but he only has four years of data compared with our eleven. The problem that both him and us face, is that when the fixed effect is removed from firm-level data, virtually all the variance in the relative wage term goes with it. He tries to circumvent this problem by using an 'estimated generalised least squares' (EGLS) procedure, but with only four years of data this does not work very well. Levine also does not include unemployment in his production function.

The famous Hawthorne experiments of the 1920's and 1930's provide some evidence for a positive effect of unemployment on productivity (see Franke and Kaul (1978)). These experiments were essentially trying to isolate the factors that caused workers productivity to vary. In 1929, about half way through the experiments, America entered the Great Depression. Franke and Kaul estimate that this event caused an increase in output of six units per worker per hour (about 12%).

We now turn to our own test of the efficiency wage hypothesis.

4.2.3 The Basic Approach

Our intention is to test some of the predictions of the efficiency wage theories considered above. In order to do so, we first begin with a standard Cobb-Douglas production function,

$$Y_{it} = A_i K_{it}^{\alpha} L_{it}^{\beta} \exp(\varphi_t) \qquad (4.1)$$

where Y_{it} - value added of firm i in year t

K_{it} - capital stock of firm i in year t

L_{it} - employment of firm i in year t

φ_t - time effects that are common to all firms

A_i - a firm-specific fixed effect, designed to capture a plethora of possible reasons (mainly unobservable) why one firm may always be more productive than another.

The efficiency wage theories that we considered above imply that the relative wage, unemployment and the level of income whilst unemployed should be included as additional explanatory variables in (4.1).

We shall embed efficiency wage considerations by, initially, replacing $L^{\beta}{}_{it}$ by $(e(.)L_{it})^{\beta}$ in (4.1), where e(.) denotes the effort function. Specifically, we shall assume that

$$e(.) = -a + b \left[\frac{W}{W^*}\right]^{\gamma_1} u^{-\gamma_2} \qquad (4.2)$$

where W is the wage, W^* - average wage available at other firms, u - unemployment rate, and the choice of (4.2) has been guided by the need to ensure that the elasticity of effort with respect to wages declines with wages (to satisfy the second order conditions for a profit maximisation) and the choice of a negative intercept (-a) rules out the problem that if positive effort is obtained at a 0 wage, a 0 wage is optimal (cf. Akerlof (1982)).

If we log linearise 4.2 we obtain the approximate effect of e.

$$\frac{\partial \ln Y}{\partial \ln e} \approx \delta_1 \text{Ln} \left[\frac{W}{W^*}\right] - \delta_2 \ln u \qquad (4.3)$$

Recall though, that because effort enters the production function in the required labour augmenting way, then, profit-maximisation requires that the elasticity of effort with respect to the wage be unity, i.e., we require

$$\delta_1 = \beta \qquad (4.4)$$

(i.e., the coefficient on the relative wage be equal to labour's share in output). We shall, therefore, test restriction (4.4).

However, a rejection of (4.4) does not, in any sense, imply a rejection of the efficiency wage model. For example, the wage term may enter the production function in a different way. In general, it may be more plausible to have production functions where a unit effort-wage elasticity is not assumed (see, Akerlof and Yellen (1987, pp.14-16) for a discussion of this issue). Suppose then that we instead assume that the exponent of labour in (4.1) is influenced by the relative wage and unemployment i.e.

$$\beta = \beta_0 + \beta_1 \ln \left[\frac{W}{W^*}\right] + \beta_2 \ln u \qquad (4.5)$$

Then, profit-maximisation only requires that

$$\beta_0 = \beta_1 \left(\ln L - \ln \left[\frac{W}{W^*}\right]\right) - \beta_2 \ln u \qquad (4.6)$$

Of course, we have, so far, assumed that wages and employment are ***only*** determined by a pure efficiency wage model. It is, though, possible that wages and employment are determined as a result of bargaining between firms and employees, but that efficiency wage considerations in the sense that a higher wage ***ceteris paribus***, boosts productivity, are relevant. To illustrate this consider the simple case where the production function is

$$Y = (e(W)L)^{\beta}, \qquad 0 < \beta < 1 \tag{4.7a}$$

and there is a monopoly union that maximises

$$U = WL^{\eta} \tag{4.7b}$$

Then, the wage is chosen at the point where

$$\frac{e'W}{e} = 1 + \left[\frac{\beta-1}{\eta}\right] < 1 \tag{4.8}$$

So, the effort-wage elasticity will, in general, be less than one, and, therefore, $\delta_1<\beta$ (i.e. (4.4) need not hold). More generally, we may have bargaining over both wages and employment. Again, there is no reason why the effort-wage elasticity should equal unity (see, Nickell and Wadhwani (1988)).

A part of our 'test' of the efficiency wage model is whether the relative wage affects productivity. Of course, it is possible that we may observe a positive association between relative wages and productivity for reasons that are unrelated to these embodied in efficiency wage models. One reason that this may occur is simultaneity bias. If workers share rents, as, for example, in 'insider-outsider' models of wage determination, (see Blanchard and Summers, 1986) then high productivity in this firm will cause high relative wages. We attempt to deal with this issue by using a standard instrumental variables estimator. We defer discussion of the appropriate instruments to the empirical section. Note, it may be argued that this 'rent-sharing' model *is* an efficiency wage model. If the firm is sharing rents with the the workforce because they feel it is 'fair' treatment then we are almost back to the sociological variant of efficiency wages. Krueger and Summers (1987) make much the same point, "It is likely to be difficult to distinguish empirically manager's desire to pay high wages from their response to the potential sanction of withheld effort. But in the end the distinction may not be an important one. In either case , the appropriate theory of wage setting involves the determination of fair wages." (p.42) Econometrically though, it is important to determine the direction of the causality, high productivity to high wages or vice versa.

A second reason why a finding of a positive association between relative wages and productivity may be spurious is to do with differences in labour quality that are not observable to the econometrician. This is a potentially serious problem. We attempt to control for this by allowing for a firm-specific fixed effect, A_i, but we concede that this is unlikely to be wholly adequate. It is also worth emphasising that while differences in human capital may account for a positive influence of W/W^* on productivity they are less likely to explain why variations in unemployment would raise productivity (although we discuss this possibility below.)

We may also mention at this point that there is a sense in which our precise econometric formulation makes it ***less*** likely that we will find a significant effect for the efficiency wage variable. This is because our use of firm-specific constants eliminate all permanent differences between the wages of different firms. Now, to the extent that such relative wage differentials are persistent (and the evidence in Krueger and Summers, (1986, 1987), and Levine, (1988), does suggest that inter-industry wage differences are very stable over time.), we lose much of the information that there is in the data. Indeed, in our dataset, the rank correlation between the relative wages of firms in 1974 and 1982 is 0.85, which is consistent with considerable persistence. On the other hand, there are a large number of reasons why fixed effects are essential, and, so, we have no alternative.

Finally, the simplest equation that we seek to estimate is based on 4.1, 4.2 and 4.3 and is of the form (lower case letters denote logarithms):

$$y_{it} = a_i + \alpha k_{it} + \beta_0 \ell_{it} + \beta_1 (eW)_{it}) + \beta_2 \, Un_{jt} + \varphi_t + u_{it} \qquad (4.9)$$

where we have added an error term, u_{it}, which is assumed to be normally distributed with mean zero, and variance σ^2.

4.2.4 Data, Methodology, and Estimation

We have 219 firms in our sample that have the relevant data over the period 1972-82. Table 4.1 contains a few summary statistics of this sub-sample. As can be seen the firms are still fairly large with an average employment of 6046 in 1982. The average fall in employment over 1974-82 is almost 30 percent whereas the corresponding figure for total manufacturing is 25 per cent. Whilst we confine precise data definitions and sources to the appendix there are several points that must be made about the data used in this chapter.

i) Employment and Hours: It is not sufficient just to use firm level employment as the labour input variable in this model. We have to control for how heavily the workforce is utilised. A firm could obtain greater output from a fixed number of workers by paying them to work overtime. This would give us a positive relationship between pay and productivity but it is not due to efficiency wages. To control for utilisation we follow a method proposed by Muellbauer (1984). Specifically, we write our labour input variable as:-

$$\ln(L_{it}*AH_{jt}) = \ln(L_{it}*NH_{jt}) + \ln(AH_{jt}/NH_{jt}) \qquad (4.10)$$

Where AH_{jt} and NH_{jt} are 'average hours' and 'normal hours' worked in industry j respectively (variables I6 and I10 in the data appendix). 'Normal hours' are the standard number of hours worked per week per person as specified in national agreements. These are essentially constant until 1979 and then decline slightly to 1982. We may rewrite (4.10) as

$$\ln(L_{it}*NH_{jt}) + \ln(1+OH_{jt}) \approx \ln(L_{it}*NH_{jt}) + OH_{jt} \qquad (4.11)$$

where

$$OH_{jt} = \frac{AH_{jt} - NH_{jt}}{NH_{jt}} = \frac{OVHR_{jt}}{NH_{jt}} ,$$

is an overtime variable, $OVHR_{jt}$ is the number of overtime hours worked in industry j (OH is variable I5 in the data appendix). Muellbauer's labour input variable is:

$$\ln(L_t * NH_t) + UT_t \qquad (4.11')$$

where UT_t, the utilisation variable,is defined as,

$$UT_t = c_0 + OH_t + c_1 OH_t^{-1} \qquad (4.12)$$

As can be seen our (4.11) is a special case of this. OH_t^{-1} is included to proxy for 'undertime', i.e hours worked ***below*** normal hours. This reflects a discontinuity in the data on hours worked. Firms are much more willing to increase the number of hours worked through paid overtime than they are to reduce them by placing workers on short time. Workers will often be paid for contracted 'normal' hours even though they are effectively working less. If we define U_t as 'true' utilisation and assume that it is distributed evenly over workers at any time and we define U_t=0 where employees are working normal hours, then OH_t is a measure of $U_t^* = E(U_t | U_t > 0)$. If we also define the analagous concept $U_t^+ = E(U_t | U_t < 0)$ then, depending on the distribution of U_t, U^* and U^+ will have a symmetric trade-off such as: $U^* = c/U^+$. Therefore we can argue that OH_t^{-1} will measure U^+. Since, by definition, $E(U_t) = U^* + U^+$, summing OH_t and OH_t^{-1} will give us an estimate of mean utilisation. C_1 will be estimated because we do not know the exact trade-off between U^* and U^+.

There is, though, one further consideration here. There may be good reasons why the elasticity of output with respect to hours may exceed that on employment (for a classic statement of this position, see Feldstein, 1967). For this reason, we generalise (4.12) as

$$U_t = c_0 + c_2 OH_t + c_1 OH_t^{-1} \tag{4.12'}$$

where we would expect $c_2>1$, and it is (4.11') and (4.12') that are used in our empirical work.

(ii) K_{it} - capital stock (variable 4 in the data appendix). To calculate a firm level measure of the capital stock we used a variant of our preferred version of chapter two. This is fully detailed in the data appendix as method 1 of calculating the capital stock. We obtain two alternative capital stock measures. The 'A' measure assumes that assets are disposed of after eight years and measure 'B' assumes that they are disposed of after sixteen years. This is meant to encompass all reasonable estimates of the average age of scrapped capital. It is clear (see Table 4.1) that it is hard to pin down the actual movements in the inflation-adjusted level of the capital stock. For our purposes, we shall report estimates of our production function using both measures of the capital stock and will, in fact, find that the choice of the measure does not materially affect our inferences. Since we only observe the capital stock at the end of each period, we used an average of the values at time t and t-1 as a proxy for the appropriate average level of capital during the period.

(iii) Y_{it} - total sales (variable 5). Notice that, of course, this differs from the theoretically appropriate concept, value added, which is not generally available in our sample. This is due to the scarcity of data, both on materials input and on changes in inventories.

For our basic estimates, we assume that

$$\text{Sales}_{it} = (\text{Value Added})_{it} \ Z_i \ \exp(\gamma_t) + V_{it} \qquad (4.13)$$

where Z_i - firm-specific fixed effect

γ_t - time effects that are common to all firms, that may be subsumed within φ_t

V_{it} - random, white noise error.

So, equation (4.13) allows some change in the value-added/sales ratio, but except for a random white noise error, it is restricted to be common to all firms. (We relax this assumption below.) In terms of equation (4.9), the above assumption means that, any error caused by using Sales on the left hand side, rather than value added, will be subsumed into a_i, φ_t and u_{it}. This is a very strong assumption to make and we try an alternative way of proxying for the missing data on inventories in section 5.4.

There is another advantage of using common time effects, φ_t. Muellbauer (1984) and Mendis and Muellbauer (1984) use a plethora of variables to allow for possible measurement biases in the output measure. Specifically, they point out that the price indices which are commonly used may be misleading either because they do not include exports (and export prices may differ significantly from domestic prices), or because of the list price bias (since actual transaction prices may differ significantly from those in the indices), or because reported prices are distorted during periods of price control. Mendis and Muellbauer also concern themselves with identifying periods when the trend growth rate changes (e.g. due to oil shocks or 'Thatcher effects', see chapter two). Therefore, we may bypass all these difficulties, by including year-specific dummies. We then control for the ommission of all aggregate variables and can concentrate on firm-specific and industry effects.

In addition, we only have information on nominal sales. Therefore, we need a price index for output. We do not have firm specific data on output prices so we used the most disaggregated price indices that were available in the UK (published in British Business or available from the Business Statistics Office - variable I1 in the data appendix

(iv) EW_{it} - the 'efficiency wage' variable. This has four separate components, W_{it} (the firm's own wage), W_{it}^* (the alternative wage), u_t (the unemployment rate) and B_t (the level of benefits). For W_{it}, we use the average remuneration of each employee (variable 3). In order to proxy W_{it}^*, we use the industry wage (variable I2) so, in fact, it only actually varies between firms in different industries, while B_t (Variable A1) is the implied benefits measure obtained from the weighted replacement rates used by Layard and Nickell (1986). For unemployment, we either use the aggregate male unemployment rate, or the industry-specific unemployment rates (Variable A3 or I4, the aggregate rate will not in this case be co-linear with the time dummies as it is interacted with employment).

Before turning to the formal estimation procedure, it is fairly illuminating to further inspect the data. There is, in fact, substantial variation in output per man, with the difference between the 90th percentile and the 10th percentile, scaled by the median (we denote this measure SPREAD hereafter) averaging about 95 per cent over our sample period although there is some significant inter-year variation as well. (SPREAD ranges from 87 per cent in 1980 to 105 per cent in 1974). The productivity differentials do exhibit some persistence, with the rank correlation of output per man in 1974 and 1982 being 0.8.

Turning to relative wages, there is fairly significant inter-firm variation, with SPREAD averaging about 18 per cent. Once again, as already mentioned, there is significant persistence in relative wages (rank correlation = 0.85).

Turning to our hypothesis of interest, there is, here substantial support for it in the rank correlation between output per man and relative wages is 0.5. However, we clearly cannot stop here because there are a variety of other factors that we need to control for and this is why we need to estimate a production function.

As for the estimation technique, we used the two-step Generalised Method of Moments (GMM) estimator proposed by Arellano and Bond (1988)[2]. We remove the fixed effect by taking first differences. This causes two problems, one theoretical, one practical.

i) Differencing will usually induce serial correlation (e.g., if u_{it} is white noise, the transformed error term, Δu_{it} has a MA(1) structure). The GMM estimator that we use, calculates the first step estimates taking account of the MA(1) structure of the errors. It then estimates the variance-covariance matrix of the residuals in order to, a) provide robust estimates of the standard errors, b) obtain more efficient two-step estimates by re-estimating the equation using this variance matrix as a GLS weighting matrix. Therefore the estimates are robust to any form of heteroscedasticity. However, for the instruments to be valid, the underlying errors must not be serially correlated. We report two tests of this hypothesis, a direct test on the second order correlation coefficient and a Sargan test of instrumental validity.

ii) If the equation is to be estimated using instrumental variables, then, because we induce serial correlation by differencing, the first lag available for instruments is t-2. The standard Anderson-Hsiao estimator used in such models uses lagged differences dated t-2 or earlier as instruments. This estimator suffers from the instruments being very poorly correlated with the endogenous variables. The GMM estimator is so-called because it uses every available moment restriction in the data, i.e. for period t the instruments used will be lagged levels dated t-2,t-3, ... ,t-t+1. This will, in general, be more efficient then the Anderson-Hsiao estimator because the Anderson-Hsiao instruments will be linear combinations of the GMM instruments. Some Monte-Carlo evidence presented in Arellano and Bond (1988) suggests that the efficiency gains can be quite substantial.

4.2.5 Basic Results

Our basic results are reported in Table 4.2. Notice that the coefficients of the relative wage variable and unemployment have the correct sign and are statistically significant. The coefficient of the relative wage term is significantly less than that on employment, so, the elasticity of effort with respect to wages appears to be less than one. As we argued above, this may either be because there is bargaining over wages, or, because an alternative functional form is relevant. Therefore, we also experimented with the case where the relative wage only affects the exponent of labour in (4.1) (we did try estimating the nested specification - but the estimates were rather poorly determined). These estimates are reported in column 2. The equations in columns (1) and (2) are very comparable in terms of fit. Now the elasticity of output with respect to the relative wage is still low (≈0.38 as compared to 0.39 in column (1) and is certainly still too low to be consistent with a pure efficiency wage model (i.e., restriction (4.4) is easily violated, with the LHS=0.59, RHS=0.265). Our results do not appear to depend on the measure of capital stock used, on that if we use the one with a larger assumed life for disposals, we still obtain statistically significant effects for the efficiency wage variable and unemployment (see column (3)), although the fit of the equation worsens a little.

Further, our results are not substantially affected by the use of our GMM technique - if we use OLS instead (col (5)) the coefficient on the relative wage is about 40 per cent higher (i.e. upward biased, as you would expect), but the other results are very similar.

Our equation implies that the effects of unemployment on productivity are fairly substantial. The estimates in Column 1 imply that firms in industries where unemployment grew 10 per cent more than the average, also experienced an increase in productivity of 0.5 per cent above the average.

In terms of the coefficient on employment and the capital stock, the sum of the coefficients on employment and capital is about 0.80, which implies mild decreasing returns to scale.

Turning to the effect of the variables measuring hours, notice that the non-linear term, OH_t^{-1}, which Muellbauer (1984) suggests will proxy for 'undertime', plays a significant role. This is clear, for when we include $\ln(\text{average hours})_{it}$ (variable I6) directly in the regression instead of the OH variables (see column (4) the fit of the equation is significantly worse.

4.3 Some Further Experiments

The framework employed so far is, admittedly, a rather simple one. It is, therefore, necessary to investigate whether our basic result that the efficiency wage variable is significant survives various modifications. Further, there are some other possiblities that we have not yet considered,

4.3.1 Controlling for Unobserved Human Capital

Differences in human capital are, at present, subsumed into the firm effect A_i. This means that differences in the skill mix between firms is only allowed to affect total factor productivity. This is reasonable in the context of an empirical specification such as (4.9), where the relative wage term effects TFP. However, when we allow EW_{it} and unemployment to affect β, the exponent of labour, we should allow skill heterogeneity to affect β also. In principle it is possible to estimate an equation with $\beta=\beta_i+\beta_1\ EW_{it}+\ \beta_2\ \ln\ (Un_t)$. The β_i are firm specific exponential terms. Constraints on the GMM program prevented us from following this course. We instead allowed β to vary only across industries; $\beta=\beta_j+\beta_1\ EW_{it}+\beta_2\ \ln(Un_t)$. Even so, if our relative wage result is largely due to the ommission of human capital effects, then allowing β to vary across industries should cause a fall in it's magnitude or significance. When we estimate this equation the coefficients on EW_{it} and log (Un_t) scarcely change from those reported in table 4.2.

We also appeal to the results of Krueger and Summers (see section 4.2.2). They conclude that, on US data at least, human capital, unobserved or observed, cannot explain the existing inter-industry wage differentials. These differentials are not being paid because of differing labour quality. However, we have to concede that it is impossible using our data set, to isolate the effect of the relative wage from unobserved capital considerations.

4.3.2 The Manner in which the Efficiency Wage Variable Enters the Production Function

The precise way in which relative wages and unemployment affect effort is of some importance. For example, in analysing the effect of various taxes and subsidies with a production function including the term $e(U, W/W^*)$, $e_1>0$, $e_2>0$, Johnson and Layard (1986) point out that the sign of e_{21} is highly relevant,[3] and assume that $e_{21}<0$. For this reason, we included $\ln(Un_t)$, $\ln(W/W^*)$ and the cross-product term $(\ln(Un_t) \times \ln(w/w^*))$ separately in the production function. These estimates are presented in column (6) of Table 4.2.

Our estimates do suggest that e_{21} is negative and significant, which is consistent with the Johnson-Layard assumption. In addition, the elasticity of output with respect to relative wages is about 0.48, while that with respect to unemployment is 0.1.

4.3.3 Functional Form of Production Function

Using a Cobb-Douglas production function is rather obviously restrictive in that it imposes an elasticity of substitution of unity, which may regard as being too high. However, we also experimented with a CES production function instead, i.e.

$$Y_i = A\exp(\varphi_t)[\alpha K^{-\rho} + \beta L^{-\rho}]^{-1/\rho} \qquad (4.14)$$

where the elasticity of substitution is $1/1+\rho$. In order to facilitate estimation, we used the log-linear approximation suggested by Kmenta (1967), so

$$y = a + \theta_t + \alpha k + \beta \ell - \tfrac{1}{2}\rho\beta\alpha(k/\ell)^2 \qquad (4.15)$$

and, just as before, $\beta = \beta(w/w^*, u)$. On estimating (4.15), we obtained the result that the coefficient of $(k/\ell)^2$ was positive and statistically significant (0.07 (2.82)), suggesting that, if anything, the elasticity of substitution is bigger than one. This, though, is not very plausible, and may arise from the mis-measurement of the capital stock. Importantly, the coefficients on relative wages and unemployment were still significant.

4.3.4 The Role of Raw Materials

One problem with our dataset is the absence of information on value added. We have, so far, retained the assumption that the ratio of value-added to total sales moves by the same amount for each firm over our sample period (up to a random white noise error).

An alternative way of treating raw materials is to write the production function as

$$Y_{it} = A_i K_{it}^{\alpha} L_{it}^{\beta} M_{it}^{\tau} \qquad (4.16)$$

where Y_{it} is now gross output, and M_{it} refers to raw materials. Since M_{it} is unobservable, we need to eliminate it. Profit-maximisation requires that the marginal products materials must equal the real factor price, i.e.,

$$M_{it} = \tau \, Y_{it} \left[\frac{PM}{P}\right]_{it}^{-1} \qquad (4.17)$$

where PM is price of raw materials (variable I3). Substituting (4.17) into (4.16), we obtain

$$Y_{it}^{1-\tau} = A_i K_{it}^{\alpha} L_{it}^{\beta} \left[\frac{PM}{P}\right]_{it}^{-\gamma} \qquad (4.18)$$

So, we need to include the real raw material price as an additional regressor. We proxied PM_{it}, by using the industry-specific price indices for materials and fuels that firms themselves use when preparing current cost accounts (so the variable used is actually PM_{jt}). However, when we included $(PM/P)_{it}$, it attracted a perverse ***positive*** coefficient (0.16 (2.53)). Importantly, though, it left the coefficients in the relative wage and unemployment largely unchanged.

4.3.5 Is the Effect of Unemployment on Productivity Spurious?

The effect of unemployment on productivity appears robust to the respecification of the equation in various ways. For example, when we use the industry unemployment rate, we may control for general, unobservable, time-varying effects in β, i.e. we set

$$\beta = \beta_{0t} + \beta_1 \ln EW_{it} + \beta_2 (\ln u_{jt})$$

instead. This is, clearly, a more general specification. On doing this, we still obtain

$$\beta_2 = 1.21 \times 10^{-2} \ (3.81),$$

suggesting that unemployment is not merely proxying for some unspecified time-varying effect.

However, despite the statistical robustness of the coefficient on unemployment, a sceptic may argue that it only matters because we do not measure the skill mix of our workers. To the extent that the skill mix remains unchanged, it doesn't matter, because it will be subsumed within the fixed effects. In periods of substantial employment change, though, it is less likely that the skill mix remains unchanged. Consider a model[4] in which there is unemployment, and the jobs are rationed according to the level of skill, so the less-skilled tend to be unemployed more often. Therefore, firms that decrease employment will, other things being equal, see an increase in output per man as their skill mix improves. Now, it is possible that because we do not control for this possibility in an adequate fashion, unemployment may, then, act as a proxy variable.

However, our estimates already partially attempt to incorporate the effects of a change in skill mix. For, suppose that the change in a measure of the skill mix (in logs) from the base period, $\Delta_1 skl_{it}$, say, were related to the change in employment relative to the base period, i.e.

$$\Delta_1 skl_{it} = -\xi \Delta_1 \ell_{it} + v_{it} \tag{4.19}$$

then, after taking first differences, the relevant proxy variable would be

$$\begin{aligned} \Delta\Delta_1 skl_{it} &= -\xi \Delta\Delta_1 \ell_{it} + \Delta v_{it} \\ &= -\xi \Delta \ell_{it} + \Delta v_{it} \end{aligned} \tag{4.20}$$

which are terms already included in our equation.

So, all in all, we believe that these numbers suggest that higher unemployment does, in fact, lead to greater effort.

4.3.6 How Can These Results Be Reconciled With Okun's Law?

We have found that high unemployment is associated with high effort and, hence, high productivity. Okun's Law states that productivity moves pro-cyclically, i.e. exactly the opposite result to us. In general there will be a problem reconciling the microeconomic implications of efficiency wage theories with the empirical macroeconomic relationship known as Okun's Law. Akerlof and Yellen (1986) deal with this problem by presenting a model which uses the idea of implicit contracts to explain pro-cyclical movements in productivity independently of efficiency wages. Thus, in their model, effort responds to internal wages and external unemployment for efficiency wage considerations and responds also to the level of demand in the economy because "..workers generally work faster when there is more work to do" (Akerlof and Yellen (1986) p. 13). They regard the evidence for Okun's law as suggesting that the pro-cyclical output effect outweighs the counter-cyclical unemployment effect on productivity. We take a different approach. We intend to separate out the cyclical movements in productivity from the unemployment effects

We first carried out regressions of the form

$$\ln Y_t = a_0 + a_1 t + a_2 t74 + a_3 \ln ER_t \quad (4.21)$$ [5]

where Y_t denotes GDP or manufacturing output, ER_t is the employment rate, and t74 denotes a split time trend to account for the productivity slowdown of the early seventies.

Okun's coefficient corresponds to $\hat{a}_3$. Table 4.3 records the estimates that we obtained. Notice that although the coefficient for manufacturing output is above two for 1955-81 (and, therefore, appears to be consistent with unemployment reducing productivity), it has fallen below one for the period 1973-85, which suggests a breakdown in the relationship. Moreover, the coefficients on GDP are, in any case, rather smaller (only barely above one over 1955-81, and well below unity for 1973-85).

Even when $\hat{a}_3 > 1$ is estimated, this does not necessarily imply that there is a positive relationship between employment and productivity. The coefficient could be explained by either:-

i) cyclical variations in the relationship between the level of employment and the rate of employment

ii) cyclical variation in the utilisation of labour.

We investigated how important the first of these was by regressing output on the level of employment rather than the employment rate.

$$\ln Y = b_0 + b_1 t + b_2 t74 + b_3 \ln E \qquad (4.22)$$

where E denotes total employment or employment in manufacturing.

During a boom people will be encouraged to enter the labour market. A ten per cent increase in employment during this period will cause a less than ten per cent increase in the employment rate because of pro-cyclical movements in the labour force. This will cause the estimated effect of the employment rate on output to be overstated. Our estimates are reported in table 4.3. The coefficients are below unity for both measures of output. Thus changes in the relationship between the rate and level of employment are important for estimating Okun's coefficients.

The second issue is to do with utilisation. Firms can increase their labour input in three ways; they can employ more people, they can increase the hours worked of their existing workforce or they can make their employees work harder in each hour. Productivity or 'effort' is concerned only with the third of these. We measure changes in productivity by looking at changes in output holding the numbers employed and the hours worked, constant. Our firm level estimates show that output will increase with utilisation. However this is not an increase in productivity. Therefore, since utilisation moves pro-cyclically, controlling for hours worked will tend to weaken any positive link between the rate of employment and productivity. Muellbauer's (1984) estimate of the elasticity of output with respect to employment falls from 1.7 to .68 when utilisation is included. The importance of this effect should not be overstated however, when we exclude hours it only has a relatively modest effect on the coefficient on unemployment.

Considering the above issues leads us to conclude that the evidence of an Okun's Law relationship pointing to a negative link between the rate of unemployment and productivity, is not sufficient to contradict our evidence of a positive link. It is clear, however, that further work needs to be done on this issue.

4.3.7 Allowing for adaptation

In the discussion so far we have often appealed to the notion of a worker deciding on his level of effort by comparing his income inside the firm with what perceives are his opportunities should he quit or be sacked from this particular job. A psychologist might regard this as a restrictive assumption. In particular we should allow a worker to have an idea of his 'normal' position relative to outside opportunities. His effort then will not only depend on his current status relative to outside but also on comparing his current relative position with his 'normal' relative position.

The motive for introducing this modification comes from the psychological theory of adaption. This theory states that people become accustomed, or adapt, to their relative status, whether good or bad, and that only deviations from what they regard as 'normal' will effect their behaviour. For example Brickman and Campbell (1971) found that severely disabled people were, on average, no less 'happy' than able-bodied people. Recipients of windfall gains, such as pools winners, express no greater satisfaction with life than other people. Argyle (1987) argues that adaptation theory can explain many initially puzzling findings; the fact that there seems no correlation between wealth and happiness across countries or why different classes in the same country seem to have equal levels of satisfaction.

There has also been work specifically done on pay comparisons. Goodman (1974) found that many of his respondents compared their pay both with the pay of others and with their own past pay. Locke (1976) argues that employees would find it very hard to evaluate whether they are 'overpaid'. They would adjust their idea of an equitable payment to their current wage. This should not be surprising. The longer a worker is in a particular job the less knowledge he may be expected to have about his 'market worth' outside this job. His best estimate of his current worth would then converge on his current relative wage. " If the firm is willing to pay me this much then this is what I'm worth."

It would seem unwise to go too far with this and impose complete adaptation. 'Happiness' or 'satisfaction' does have some objective basis and if people perceive that they are better or worse off than other people this will affect whether they find their status satisfactory or not.

Given the above discussion we introduce adaptation into our model by having the worker compare his current wage, W, with his alternative wage, W^A, where,

$$\ln(W^A)_t = \ln(W^*)_t + \varphi(\ln W - \ln W^*)_{t-1} \qquad 0\leqslant\varphi\leqslant1 \qquad (4.23)$$

so, instead of having $\ln W^A = \ln W^*$, as above we allow workers to build in a proportion, φ, of their past differential into what they expect.

Therefore, the new efficiency wage variable will be

$$\ln(W/W^{A})_t = \ln(W/W^*)_t - \varphi \ln(W/W^*)_{t-1} \qquad (4.24)$$

We re-estimated our production function, but now taking (4.24) into account. The coefficient on the current efficiency wage variable was 0.04(3.57), and the lagged efficiency wage variable attracted a coefficient of -0.008(-1.74). Therefore, there is some evidence of adaptation here, with a value of φ of about 0.20.

Evidence for an adaptation model would seem to favour the efficiency wage hypothesis. It is hard to see how the result that the ***change*** in the relative wage affects productivity can be explained by unobserved human capital. Similarly the shirking, adverse selection or labour turnover variants of the efficiency wage hypothesis would not predict such a result (though it would be straightforward to reformulate them so that they would, e.g. when a worker is uncertain of his outside opportunities his estimated alternative wage might depend on his past wage). We believe that evidence for adaption points most strongly towards an efficiency wage model based on sociological considerations[6]. In a sociological model where workers decide on their level of effort based on what they regard as a 'fair' wage, it is natural to assume that workers become accustomed to their differential over time and hence that a given wage premium will have less and less effect.

4.4 Conclusions

We have found evidence that firm-level productivity increases when either relative wages rise, or the level of unemployment rises. The estimated effort-wage elasticity is about 0.4, while the effort-unemployment elasticity is about 0.05. Moreover there is some support for the idea that a change in the relative wage also increases productivity. Our result that higher relative wages lead to higher productivity is consistent with that of Levine (1988), while evidence of a link between unemployment and work intensity has also been reported by Schor (1988). This provides some support for the efficiency wage models. Note, though, that our estimate of the effort-wage elasticity is significantly less than the value of one implied by the Solow equilibrium condition. So, our results either point to an efficiency wage model where effort does not enter in a labour augmenting way, or an eclectic model where although efficiency wage considerations are relevant, wages are actually set in some other way (e.g. bargaining).

Of course, it is possible that our results are consistent with other theories. A prime candidate for an explanation of our results is the existence of unobserved human capital, which could easily explain the link between wages and productivity. However, it cannot easily explain the effect of unemployment on productivity, and it also would be hard to rationalise an association between a ***change*** in the relative wage and productivity within a standard human capital framework.

A second alternative explanation for our result is the existence of rent-sharing, which would mean that higher productivity leads to higher wages. However, we attempted to allow for possible endogeneity by using an instrumental variables estimation technique. Nevertheless, it is possible to conceive of a union model where the firm and the union bargain over manning ratios, and a rise in unemployment may lead to a high productivity because it reduces the union's ability to enforce restrictive work practices (see chapter 5).

The finding that productivity responds to the changes in the relative wage is of some interest, for it suggests that a part of the gain to a firm of raising wages is dissipated as workers adjust their aspirations upwards. This finding is offered in the spirit of the sociological rationale for efficiency wage models, although it could well be consistent with the other models.

The finding that higher unemployment raises productivity may surprise one given the evidence on Okun's law. We suggest that the aggregate evidence on Okun's law is not very reliable and that, in any case, it does not actually answer the question at hand - which is whether higher unemployment, ***holding labour utilisation constant***, leads to a rise in labour productivity.

The issue of whether unemployment raises productivity is of some relevance to policy in the UK, where some have spoken of a 'Thatcher miracle' in productivity (see Muellbauer (1986) for a review of the competing explanations of productivity growth). To the extent that some of the rise in productivity that has occurred is traceable to higher unemployment, it is, then, something that will be reversed if unemployment falls, and therefore, makes it less likely that any 'Thatcher miracle' has occurred.

Of course, we must be cautious about our results - for much more work is needed on the issue of whether or not unemployment raises productivity. On the other hand, those who believe that efficiency wage models have something to offer to our understanding of unemployment will not be disappointed by our results.

FOOTNOTES

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1 This section draws on chapter 6 of Jackman et. al. (forthcoming)

2 Manolo Arellano and Stephen Bond gave us a great deal of help and advice on implementing their DPD program.

3 We are grateful to Richard Layard for suggesting the possible importance of this issue.

4 We have benefitted from useful conversations on this point with Chris Pissarides.

5 If we regress the employment rate on output, we do, in general, obtain different estimates for Okun's coefficient (see also Blanchard and Summers, 1987). In presenting our informal evidence here, we do not tackle this issue. One possible way of achieving identification is an approach taken in Blanchard and Quah (1987).

6 Akerlof (1982) does allow the 'fair wage' to depend on the past wage.

TABLE 4.1

a. Basic Features of Our Data

	Sample Measure	C.S.O. measure (for manufacturing)
Employment (1974-82)	-29.5%	-25.0%
Average in 1982	6046	
Output (1974-82)	-13.05%	-14.4%
Wages 1975	£2,461	£2,678*
1982	£6,120	£6,864*

* New Earnings Survey estimates.

In 1980 the total number of employees covered by the sample is 1.324 million. This is about 22% of the 6.007 million employed in the manufacturing sector at that time.

b. Growth of Capital Stock

Time-Period	Measure A	Measure B	C.S.O.
1974-82	16.7%	0.75%	+13.3%
1979-82	1.3%	-3.4%	+ 2.25%

TABLE 4.2

GMM Estimates of Production Function

Dependent Variable:- $\ln(\text{Real Sales})_{it}$

Independent Variables	(1) Equation(6)	(2) Non-linear Efficiency wage terms	(3) IV Estimates Alternative Measure of Capital Stock	(4) Including Average hours Separately	(5) OLS estimates	(6) Including Cross-product term IV Estimates
$\ln(\text{Employment})_{it}^{*}$	0.65 (13.66)	0.59 (12.92)	0.60 (13.52)	0.60 (13.11)	0.48 (14.83)	0.56 (7.79)
$\ln(\text{Wage/Ind.Wage})_{it}^{*}$	0.39 (4.89)	-	-	-	-	-
$\ln(\text{Unemployment})_{it}$	0.05 (2.12)	-	-	-	-	-
$\ln(\text{Employment})_{it}^{*}$ $\times \ln(\text{Wage/Ind.Wage})_{it}$	-	0.05 (4.80)	0.05 (4.69)	0.05 (4.50)	0.07 (12.85)	0.03 (1.74)
$\ln(\text{Employment})_{it}$ x ln(Unemployment	-	1.28×10^{-2} (4.87)	1.31×10^{-2} (5.00)	1.23×10^{-2} (4.84)	1.16×10^{-2} (3.47)	5.32×10^{-2} (4.21)
$\ln(\text{Unemployment})_{it}$ $\text{x}\ln(\text{Wage/Ind./Wage})_{it}$ $\text{x}\ln(\text{Employment})_{it}$	-	-	-	-	-	-1.36×10^{2} (-3.52)
$\ln(\text{Capital Stock})_{it}^{*}$	0.15 (4.84)	0.14 (4.43)	0.12 (4.34)	0.12 (3.66)	0.13 (4.01)	0.15 (4.40)

Contd....

TABLE 4.2 Contd..

Independent Variables	(1) Equation(6)	(2) Non-linear Efficiency wage terms	(3) IV Estimates Alternative Measure of Capital Stock	(4) Including Average hours Separately	(5) OLS estimates	(6) Including Cross-product term IV Estimates
(Overtime/Normal Hours)$_{it}$	1.64 (6.73)	1.64 (6.73)	1.62 (6.61)	- -	1.56 (5.02)	1.69 (6.97)
(Overtime/Normal Hours)$_{i,t}^{-1}$	$-7.68\text{x}10^{-4}$ (-2.92)	$-8.08\text{x}10^{-4}$ (-3.13)	$-7.9\text{x}10^{-4}$ (-3.08)	-	$-8.6\text{x}10^{4}$ (-2.76)	$-9.6\text{x}10^{-4}$ (-3.50)
Time dummies included	Yes	Yes	Yes	Yes	Yes	Yes
ln (Average Hours)$_{it}$	-	-	-	0.41 (2.85)	-	-
T	8	8	8	8	8	8
N	219	219	219	219	219	219
s.e.	$4.68\text{x}10^{-3}$	$4.67\text{x}10^{-3}$	$4.70\text{x}10^{-3}$	$4.75\text{x}10^{-3}$	$4.61\text{x}10^{-3}$	$4.61\text{x}10^{-3}$
Sargan test for instrument validity	87.02 ($\chi^2(71)$)	84.06 ($\chi^2(71)$)	84.03 ($\chi^2(71)$)	92.20 ($\chi^2(71)$)	- -	93.64 ($\chi^2(69)$)

Notes
(i) t-ratios in parentheses.
(ii) All variables are in first difference form.
(iii) * denotes variables treated as endogenous.
Additional instruments used include: All valid lags on employment (t-2 onwards), ln(Capital Stock)-t-1,t-2, ln(Real Sales),t-2, ln(Eff.Wage Variable)-t-1,t-2, (real profits)$_{t-1}$, (cash ratio)$_{t-1}$, (real directors'remuneration)$_{t-1}$, ln(real wage)$_{t-2}$, ln(wage/raw materials price)$_{t-1}$, ln(industry unemployment)$_{t,t-1}$, ln(Eff.Wage Variable)xln(Employment)-t-1,t-2.

TABLE 4.3

Estimates of Okun's Coefficients and output-employment coefficients

Output Variable	Okun's oefficient $\hat{a}_3$ 1955-81	1973-85	Output-employment coefficient, $\hat{b}$
Manufacturing	2.21	0.97	0.68
	(4.36)	(1.31)	(3.50)
GDP	1.05	0.55	0.57
	(3.94)	(2.01)	(2.37)

Chapter 5: Unions and Productivity Growth in Britain 1974-86

5.1 Introduction

In the next two chapters we are concerned with assessing the effects that unions have on the economic behaviour of firms. This chapter attempts to assess whether firms with a unionised workforce experience lower productivity growth than non-unionised firms. The next chapter examines the differences in investment behaviour between union and non-union firms. If unionised firms invest less then this will affect their long term productivity growth relative to non-union firms.

We are also interested in the hypothesis that the changes in trade union legislation enacted by the Conservative Government weakened the union's ability to defend 'restrictive' practices and this was a significant contributory factor to the high rate of measured productivity growth over the 1979-86 period.

Over the period 1973-79 Total Factor Productivity in UK manufacturing grew at an average rate of -.2 per cent per annum. This performance was considerably worse than that of Sweden, France, Italy, Germany, the US and the EEC average growth rate over the same period (figures from Layard and Nickell (1989). The story is the same if we use output per head instead of TFP). The period 1979-86 saw the UK grow at an average 2.6 per cent per annum. This was a better performance than any of the above countries. How can we account for this change in the relative productivity performance of the UK manufacturing sector. Muellbauer (1986) offers four possible explanations.

i) 'Microchip'. The 1980's saw widespread introduction of computer technology into industry. This led to a great leap forward in productivity due to technical progress. Although there might be an element of this in the higher rate of growth since 1980 it cannot explain why there has been a change in the UK's relative position.

ii) 'Batting Average'. The deep recession of 1980-81 led to 'shedding' of the less productive resources in the economy. Less productive plants were closed and less productive workers laid off. This led to an increase in average productivity. The evidence that exists seems to contradict this hypothesis. Oulton (1987) reports that, during this period, closures were concentrated in larger, more productive, plants.

iii) 'Capital Scrapping'. The period 1973-80 saw above average capital scrapping and below average capital utilisation. The recession of 1979-81 saw a 'shake-out' of inefficient capital and after 1981 capital scrapping and utilisation returned to their 'normal', pre-1973 levels. This allowed growth rates in output per head to return to their 'normal' pre-1973 levels.

iv) 'Labour Utilisation'. The workers who have remained in jobs during the 1980's are now working harder. Firms have regained the 'right to manage' and working practices are now more flexible, more amenable to new technology and better organised than they were prior to 1979. There have been increases in both labour utilisation and effort[1] (the PUL index of Bennett and Smith-Gavine, which measures the intensity with which a given operative hour is worked, rose by 5.6 per cent between 1980 and 1984 and has remained at that level). This suggests that the productivity 'breakthrough' is to some extent attributable to an industrial relations 'breakthrough'. Several reasons have been suggested for this change.

a) Some authors have suggested that the legislation enacted by the Thatcher government in the field of Employee Rights and Trade Union reform, has weakened the union's ability to wage effective industrial action. This has led to increased flexibility and efficiency in both internal and external labour markets. If 'restrictive' practices were more prevalent in unionised firms then these firms would benefit most from this change and would 'catch up' with the non-union firms. Metcalf (1988) has suggested that this might lead to permanent changes in the ***growth*** of productivity in unionised firms. We feel this is unlikely but we test for this outcome.

b) The recession in the UK between 1979 and 1981 was much more severe than that experienced by it's competitors. Output fell by 3.5% and employment by 5.7%. It has been argued that this 'shocked' previously complacent managements and workers into realisation that the situation was very serious and that no one's job was safe. This would predict that higher observed effort in a firm would be correlated with the 'shock' it suffered over the 1979-81 period. There is also the related argument, drawn from efficiency wage theory, that workers supplied greater effort because of the high rate of unemployment.

We model these sort of considerations by having firms and unions bargaining over both wages and effort. Unions prefer lower effort because it gives higher utility to the representative worker and also because it *might* lead to higher employment. Firms are willing to trade lower effort for a lower wage. Section 5.2 presents a model of effort wage bargaining, section 5.3 discusses the empirical determinants of effort.

5.2 A Bargaining Model of Wages and Effort

Unions will, typically, bargain over effort either because there is disutility associated with greater effort, (and, hence, they may be willing to accept lower wages in exchange for a more comfortable pace of work) or because restrictions on effort like manning ratios might lead to higher total employment (so, again, they may be willing to accept lower wages in return). Such bargains are widespread - the Workplace Industrial Relations Survey (WIRS hereafter) found that, in 1980, 76 per cent of unionised establishments bargained over manning levels (55 per cent in 1984) and 65 per cent over major changes in production methods, (see Daniel and Millward (1983)).

Thus we suppose that bargaining takes place over effort and wages, but not over employment. This assumption may appear *ad hoc* but it has the profound advantage of being consistent with the facts. Direct negotiations over employment are very rare in both Britain and the United States (see, Oswald and Turnbull 1985, for example). Since employment varies continuously, this fact is perhaps less surprising than might appear at first sight.[2]

In order to set up our bargaining framework, we first consider what the objectives of the union are.

Unions' Objectives

Since we do not wish to rule out efficiency wages from our story, we being by assuming that an individual union member has a utility function of the form

$$\varphi = W^{\alpha} g_1(e_1)v(e_2, W/\tilde{W}), \qquad 0 < \alpha < 1 \tag{5.1}$$

W is the real wage, e_1 is observed effort, which is bargained over, e_2 in unobserved effort which generates the possibility of an efficiency wage element and $\tilde{W}$ reflects outside opportunities. More precisely, we define it as

$$\tilde{W} = \overline{W}\ p(u) \tag{5.2}$$

where $\bar{W}$ is the alternative wage and p is the proportion of the relevant period spent in employment. We make p a function of the aggregate unemployment rate u, with $p'(u)<0$.

In the individual's utility function, the function g_1 will obviously be downward sloping and we suppose it has the form shown in Figure 1. Defining the absolute elasticity $\eta_{g1}(e_1)=-g_1'(e_1)e_1/g_1(e_1)$, it is clear from the figure that

$$\eta'_{g_1}(e_1) > 0 \tag{5.3}$$

The element v has the property that for given effort, both the level of utility of effort and the marginal utility of effort are increasing in the wage relative to outside opportunities (v_2, $v_{12}>0$). That is, as this relative wage rises, additional effort costs less to the individual in utility terms. This formulation may be based on the standard shirking model as discussed in Shapiro and Stiglitz (1984), for example. Since effort e_2 is unobserved, it may be chosen by the individual to maximise v, the optimal choice satisfying

$$v_1\ (e_2,\ W/\tilde{W}) = 0$$

This implies that e_2 may be written as $e_2(W/\tilde{W})$ where $e_2'>0$ so long as $v_{11}<0$, $v_{12}>0$. The element v may now be written as

$$g_2(W/\tilde{W}) = v\ (e_2(W/\tilde{W}),\ W/\tilde{W}) \tag{5.4}$$

where $g_2'>0$. So the individual's utility is

$$\varphi = W^{\alpha}\ g_1(e_1)g_2(W/\tilde{W}) \tag{5.5}$$

where we shall assume that g_2 has a constant elasticity form. That is

$$\eta_{g_2} = \frac{g_2{}'W}{g_2\ \tilde{W}} = \text{constant} \qquad (5.6)$$

Our bargaining solution is based on the standard Nash formulation and we define the union contribution to the Nash objective as

$$(W^{\alpha}g_1(e_1)g_2(W/\tilde{W})-\tilde{\varphi})N \qquad (5.7)$$

This follows from the standard utilitarian union objective, N being employment and $\tilde{\varphi}$ the status-quo point. The latter we take to have the form

$$\tilde{\varphi} = \bar{W}^{\alpha}\ \bar{g}(u),\ \bar{g}' < 0 \qquad (5.8)$$

which simply reflects the utility obtainable during the course of an industrial dispute.

The Firm's Objective

We suppose the firm to have a Cobb-Douglas technology of the form

$$Y = AK^{\alpha_1}N^{\alpha_2}e_1{}^{\alpha_3}e_2(W/\tilde{W})^{\alpha_4} \qquad (5.9)$$

where Y is output and K is the capital stock. We also suppose it faces a constant elasticity demand curve of the form

$$Y = (P/\bar{P})^{-\eta},\ \eta > 1 \qquad (5.10)$$

In the context of our bargain, the firm is assumed to choose employment unilaterally once effort and wages have been fixed. Thus employment will satisfy

$$R_N = W \qquad (5.11)$$

where R is the real revenue function, that is

$$R = (P/\overline{P})Y = (AK^{\alpha_1}N^{\alpha_2}e_1{}^{\alpha_3}e_2{}^{\alpha_4})^{\epsilon}$$

$$\epsilon = 1 - \frac{1}{\eta} \tag{5.12}$$

The employment function thus has the form

$$N = N(W, e_1) \tag{5.13}$$

and we may show that the elasticities are

$$\eta_{NW} = \left| \frac{W}{N}\frac{\partial N}{\partial W} \right| = \frac{1-\alpha_4 \epsilon \eta_{e_2}}{1-\alpha_2 \epsilon} \tag{5.14}$$

$$\eta_{Ne_1} = \frac{e_1}{N}\frac{\partial N}{\partial e_1} = \frac{\alpha_3 \epsilon}{1-\alpha_2 \epsilon} \tag{5.15}$$

where

$$\eta_{e_2} = \frac{W}{\tilde{W}}\frac{e_2'(W/\tilde{W})}{e_2(W/\tilde{W})}, \quad \eta_{e2}'(W/\tilde{W}) < 0 \tag{5.16}$$

Thus, as is standard in efficiency wage models, we take the effort-relative wage elasticity to be diminishing in the relative wage. Notice that $\eta_{Ne1}>0$ here (because we have assumed Cobb-Douglas technology), so in this model, a rise in effort is associated with a rise in employment. With a more general production function, this relationship could go the other way.

<u>The Effort, Wage Bargain</u>

Before writing down the Nash objective, there is one further point worth considering in the present context, namely the threat of bankruptcy. Intuitively, if firms are in financial distress, it seems likely that this will affect the bargain because of the costs imposed on both managers and workers should the firm collapse. We model this here in a very simple fashion, by imposing a constraint on the firm's profit of the form

$$R - WN\ (W,\ e_1) \geq \bar{\pi} \tag{5.17}$$

where $\bar{\pi}$ is increasing in indicators of financial distress such as the debt-equity ratio.

In the light of this, W and e_1 are chosen to solve

$$\max\ \beta \log\ [(W^{\alpha}g_1(e_1)g_2(W/\tilde{W})-\tilde{\varphi})\ N(W,\ e_1)] + (1-\beta) \log\ (R-WN(W,\ e_1))$$

subject to (5.17). Note that β reflects the strength of the union. To write down the first order conditions in a simple form, it is worth defining the function

$$f(W/\tilde{W},\ u,\ e_1) = 1 - \frac{\bar{W}^{\alpha}\bar{g}(u)}{W^{\alpha}g_1(e_1)g_2(W/\tilde{W})} < 1 \tag{5.18}$$

$f_1 > 0$, $f_2 > 0$, $f_3 < 0$.

Then necessary conditions for a maximum are

$$\frac{\alpha+\eta_{g2}}{f(W/\tilde{W},u,e_1)} = 1 + \frac{(\alpha_2-\alpha_4\ \eta_{e2}(W/\tilde{W}))\varepsilon(1+\lambda)}{\beta(1-\alpha_2\varepsilon)} \tag{5.19}$$

$$\frac{\eta_{g1}(e_1)}{f(W/\tilde{W},u,e_1)} = \frac{\alpha_3\varepsilon(1+\lambda)}{\beta(1-\alpha_2\varepsilon)} \tag{5.20}$$

where λ is the multiplier associated with the constraint (17). This will, of course, satisfy the usual complementary slackness condition, namely

$$\lambda \geq 0,\ \lambda = 0 \text{ if } R\text{–}WN\text{–}\bar{\pi} > 0 \tag{5.21}$$

$$\lambda > 0 \text{ if } R\text{–}WN\text{–}\bar{\pi} = 0$$

We are now in position to undertake a comparative statics exercise to investigate the impact on effort of unemployment, u, union power, β, the elasticity of demand, η, and the multiplier, λ. In the last case, we suppose that λ tends to increase with the extent of financial distress, that is, the constraint (5.17) bites more severely as financial distress increases.

Taking total differentials of (5.19), (5.20) and noting that $\tilde{W}=\bar{W}p(u)$, we find that

$$\Delta de_1 = \frac{\eta_{g_1}\bar{\epsilon}\alpha_4(1+\lambda)f_2\eta'_{e_2}}{\beta p f^2}\,du + \left[\frac{\bar{\epsilon}\alpha_4\eta'_{e_2}(1+\lambda)}{\beta p} - \frac{f_1}{fp}\right]\left[\frac{\alpha_3(1+\lambda)}{\beta}\,d\bar{\lambda} + \frac{\alpha_3\bar{\epsilon}}{\beta}\,d\lambda - \frac{\alpha_3\bar{\epsilon}(1+\lambda)}{\beta^2}\,d\beta\right]$$

$$\Delta = \frac{\bar{\epsilon}\alpha_4\eta'_{e_2}(1+\lambda)\eta'_{g_1}}{\beta p f} - \frac{\bar{\epsilon}\alpha_4\eta'_{e_2}(1+\lambda)\eta_{g_1}f_3}{\beta p f^2} - \frac{(\alpha+\eta_{g_2})f_1\eta'_{g_1}}{f^3 p} < 0$$

$\bar{\epsilon} = \epsilon/(1-\alpha_2\epsilon)$, increasing in ϵ and hence in η.

Given that $\eta'_{e_2}<0$ and $f_1, f_2>0$, this immediately reveals the following results:

$$\partial e_1/\partial u>0,\ \partial e_1/\partial\eta>0,\ \partial e_1/\partial\lambda>0,\ \partial e_1/\partial\beta<0 \qquad (5.22)$$

So, in the context of this model, an increase in unemployment, the elasticity of demand and the probability of bankruptcy, and a decrease in union power all serve to increase bargained effort. However, this does not necessarily imply that overall effort will move in the same direction. The other aspect of effort , e_2, moves in the same direction as the wage and since the wage will typically move in the opposite direction to bargained effort in response to exogenous shifts, e_2 will also tend to move in the opposite direction. In our subsequent discussion we shall suppose that these indirect effects are dominated by the direct effects on bargained effort. Ultimately, however, this must remain an empirical issue.

Our analysis above has assumed that an interior solution to the effort-wage bargain exists. However, in general, we may conceive of e_1 as having some physical maximum, e_1^{max}, say. Therefore, in general, there exists a threshold value β^*, such that for $\beta \leqslant \beta^*$, equation (5.20) has no interior solution for e_1 such that $e_1 < e_1^{max}$. So, if β falls below β^*, a firm-union pair will switch from being in a situation where we have restrictive work practices to one where these are entirely eliminated, and $e_1 = e_1^{max}$.

Of course, the same exogenous variables that raise e_1 (in terms of the interior solution), also make it more likely that firm-union pairs might switch to $e_1 = e_1^{max}$.

Note, though, that the above extension could affect the interpretation of our results. For example, if it were, say, the case that non-union firms were already at $e_1 = e_1^{max}$ (as they have a lower value of β), then, a rise in unemployment would increase e_1 in union firms, but could not have any effect on non-union firms.

5.3 The Empirical Determinants of Productivity

5.3.1 The Effects of Unions

At the end of the 1970s there was a considerable amount of received wisdom that placed the blame for the UK's poor economic performance firmly onto the trade union movement. "To a large number of people (the unions) have become the scapegoats for national failure" (Taylor (1982) p 141). According to this view, by resisting technical change, by defending outmoded working practices and by insistence on overmanning, unions had (in the words of the 1981 green paper on Trade Union Immunities) "...inhibited improvements in productivity, acted as a disincentive to investment and discouraged innovation." (CMND. 8128 para. 1). This green paper reflected the Governments belief that the balance of power between capital and labour was now tilted too far towards labour. It also indicated the desire of the Government to rectify this imbalance by means of legislation. We give a more detailed account of the legislative background to industrial relations below, but briefly, 1975-79 might be characterised as a period when legislation encouraged the growth of union power and 1980-86 as a period when a comprehensive attempt was made to weaken unions by legislative means[3]. The Conservative Government, along with quite a few economists have argued that this policy was a major contributory factor to the productivity breakthrough of the 1980's. Unions are weaker, are no longer able to defend restrictive practices or resist technical change, the 'right to manage' is restored to firms and hence productivity increases.

There are many problems with this story. The most important is that it takes a very simplistic view of the role of unions and how they are supposed to effect productivity. An alternative (though perhaps, equally simplistic) view is contained the 'collective voice/institutional response'

(CV/IR) model of Freeman and Medoff (1984) (this model is also referred to as that of the 'Harvard School', because of where it first became popular). The idea underlying this model is that, in general, employment contracts will only set the limits of the powers that the entrepreneur has over the worker. Within these limits the entrepreneur has a great deal of discretion to change the conditions of employment as circumstances change. In the absence of unions, workers have only a limited number of responses to their dislike of the employers direction or utilisation of labour, they can quit, shirk or sabotage. All of these responses will negatively affect productivity. In a sense then, when the workforce is unhappy with the way it is being used by the employer its response will be determined by the least satisfied or marginal worker. A trade union will provide a way in which the 'collective voice' of the workforce can be heard. The 'collective voice' will express the preferences of the average worker. By providing a means by which workforce disaffection can be voiced and by which desirable work conditions can be obtained the union will be conducive to productivity. The presence of a union might also make it easier to introduce technical change. Union's could be involved in the consultation process and this might make adjustment less prone to industrial unrest (Daniel (1987) reports a positive association between unionisation and technical change). The union may also capture some of the firms rent and this may call forth the 'institutional response' of better management to earn the extra profits the firm now needs to survive.

This model has been criticised on the grounds that it is a 'black box'. There is no elaboration of how the union expresses the average preferences of it's workers or whether it is the 'collective voice' of the union or the 'institutional response' of the firm that leads to the increase in productivity. (see Turnbull (1989) or Addison and Hirsch (1989) for critiques of this model)

We intend to measure the differences in productivity between union and non-union firms. We also intend to examine how these differentials change over time. In our model a change in union power affects the coefficient β. As β falls, e_1, observed effort should rise. However we cannot say whether the change in unobserved effort, e_2, will outweigh it. The union voice model would predict that a weakening of union power would weaken the unions ability to express preferences effectively and hence might lead to lower productivity. On the other hand the Harvard School predict that the positive effect on productivity is the result of co-operation between union and firm. If instead unions and firms are in perpetual conflict then they would consider that the right circumstances do not hold and a negative union productivity effect would not be inconsistent with their model.

5.3.2 The Legislative Background

In this section we discuss the assertion that legislation enacted during the 1975-79 period increased unions bargaining power whilst since 1980 legislation has been intended to weaken the unions.

The relationship between unions and the law in the UK has developed along quite different lines to that in any other country. Trade unions and trade unionists have very few 'rights' enshrined in law. Instead they have statutory 'immunities' from the common law liabilities that they incur whilst pursuing trade disputes. Without these immunities most industrial action would be unlawful.

In the nineteenth century unions won the ability to organise effectively by acheiving immunity from the criminal law of conspiracy. In the twentieth century unions have largely required protection from civil liability. For example, even the simplest industrial action will involve the union inducing it's members to breach their employment contracts with the firm in dispute. Thus, even though the union itself has no contract with the firm it has committed a 'civil wrong' or 'tort' against the firm under the common law and without immunity could be sued. The historical path has been for parliament to give trade unions immunities against the specific liabilities that their actions have incurred under the common law. The basis for the modern system of immunities is the 1906 Trade Disputes Act. This gave trade unions immunity from actions in tort for any actions carried out by it or it's agents "in contemplation or furtherance of a trade dispute" (the so-called 'golden formula' of labour law). This provided the legal basis for industrial relations for the next seventy years. The enactments of the 1974-79 Labour government can be seen as extending the provisions of the 1906 act. The enactments of the post 1979 Conservative government (specifically the Employment Acts of 1980 and 1982 and the Trade Union Act of 1984) were intended to reverse what they saw as a trend towards increasing union power. We will summarise the changes in the law under five headings.

<u>Industrial Action</u> What turned out to be the most significant change in the 1970's was contained in section 13 of the Trade Unions and Labour Relations Act (TULRA 1974 and 1976). This extended to unions immunity from actions in tort for inducement to break ***all*** contracts. In effect this allowed unions to extend industrial disputes, virtually without limit, by 'secondary' action. The courts showed (in *Express Newspapers vs. MacShane 1979*) that there was no satisfactory way of defining how remote a 'secondary' dispute had to be from the 'primary' dispute in order to lose section 13 immunity. This increased union strength significantly, particularly in firms where the union was weak. 'Secondary' action, e.g. the blacking of supplies, sympathy strikes etc. was often a very effective way of pressurising the employer in dispute.

The Employment Act (EA) of 1980 completely reversed this legal position. Immunity for secondary action was given only where this action was directed at a direct customer or supplier of the firm in dispute and *only with regard to contracts with the employer in dispute*. As interpreted by the courts this has led to virtually all secondary action being outlawed (see Wedderburn (1986) p. 598). The Employment Act of 1982 further restricted trade union immunities by tightening the definition of what was a 'legitimate' trade dispute. The list of subjects for a legitimate trade dispute did not change[4] but now, to obtain immunity a dispute must be:

i) Between workers and their ***own*** employer.

ii) 'Wholly or mainly related to' the subject of a legitimate trade dispute, rather than merely 'connected with' as stated in TULRA 1976.

This change was made specifically to outlaw 'political' strikes. How 'political' and 'trade' disputes were to be distinguished in an economy where the government was direct or indirect employer of millions of workers was a problem that the 1981 green paper had no answer to (para. 199). A further change was that striking workers were now only allowed to picket their own firms.[5]

The policy on industrial action was to restrict workers to disputes within their own firms. "The dominant characteristic of the new policy is to remove obstacles to the 'free' market. The primary obstacle is trans enterprise industrial action" (Wedderburn p. 74). In 1984 immunity was further restricted to disputes approved by a majority in a strike ballot.

Collective Bargaining The Employment Protection Act (EPA) of 1975 set up (rather cumbersome) machinery whereby a union could obtain recognition from a firm without the firm's consent. Although this machinery was hardly ever used the EA 1980 abolished this procedure along with immunity for industrial action taken to win recognition.

The EPA also featured schedule 11 whereby workers with no bargaining machinery could appeal to the Central Arbitration Committee (CAC) to claim that their pay was below the 'general level' (usually the level obtained by collective bargaining) pertaining to their trade or industry. Schedule 11 was also repealed in 1980. The 1980's have seen the removal of most of the 'props' to collective bargaining. The Fair Wage Resolution was rescinded in 1982 and the scope of the Wage Councils was severely restricted. This meant there was no longer any floor or minimum wage below which no one could work. There was no longer any appeal to the 'going rate' or the 'union rate' only the 'market rate'. This policy was basically a complete reversal of the consensus view reflected in the Donovan Report (1968) and which had been the basis of government intervention in wage determination for a considerable time before that. "Contrary to the public policy of the last 100 years, there is now a clear committment to ***restrict*** collective bargaining" (Hepple and Fredman (1986) p.49 their italics).

Employee Rights Over the 1980's the period for which a worker must remain with a firm in order to claim unfair dismissal from that firm has risen from 6 months to 2 years.

The Closed Shop The law on 'closed shops' or 'union membership agreements' (UMA) has revolved around the 'fairness' of dismissing or disciplining workers who have refused to join the union. Under TULRA 1976 such a worker could only claim for unfair dismissal if his objection to joining was based on religious grounds. The changes under the Conservative government have been;

i) If a worker who refuses to join a union faces dismissal or 'action short of dismissal' then this is 'unfair' if either;

a) he expresses a 'deeply held personal conviction' against joining.

or

b) the UMA has not been validated by a majority in a ballot of 80 or 85 per cent. (EA 1980, 1982)

ii) If the employer is sued by the dismissed or disciplined worker, then he can 'join' the union as a defendent in the claim for damages. (EA 1980, 1982)

iii) Industrial action taken to induce another employer to maintain a UMA is no longer immune from action in tort (EA 1982).

The closed shop was perhaps the aspect of trade unionism that the Conservative party found most objectionable. It offended all their notions of what a 'free' labour market should consist of. 'The proposed legal restrictions around the closed shop shop were marketed as a deliverance' (Dunn (1985) p. 84). The Secretary of State for Employment, Mr King, could say in 1984 " The new laws (will) virtually mark the legal extinction of the closed shop in this country."

Trade Unions internal organisation The 1984 Trade Unions Act required that principal executive officers of the union be re-elected every five years. This comes too late to affect our sample but it indicates that government policy is still dedicated to enfeebling the unions in whatever way possible.

Summary "Never since the nineteenth century has there been such a determined drive to diminish the strategic strength of the unions and to do it by using the law" (Wedderburn p.383). Some authors (e.g. Dunn and Gennard (1984)) have argued that the law is a secondary force determining bargaining power when compared to economic factors and shopfloor industrial relations. However such is the marked shift in the the legislative background after 1980 it seems unlikely that the bargaining position of the union could have remained unchanged. If weaker unions have led to higher bargained effort then this should appear as a higher relative growth rate for the unionised firms.

5.3.3 Some empirical evidence

In the US union density has been declining steadily since the war. In the UK union density steadily increased until about 1980. The economic success of the US with respect to the UK has often been attributed to this difference. In the US, as the story goes, firms have successfully been able to exclude unions from organising their workers and this has led to the labour markets being more flexible and hence productivity being higher. The problem with this simple comparison is that the UK has also performed significantly worse than Sweden, Norway and Austria, countries with very high rates of unionism. This would suggest that the presence or absence of unions, as such, cannot explain 'the British Disease'. Much of the motivation for research into this topic is motivated by the need to estimate exactly what effects unions have on economic outcomes.

Addison and Hirsch (1989) review the American evidence for a link between unionisation and productivity. One of the earliest studies in this area is by Brown and Medoff (1978). Estimating a production function using data on aggregate manufacturing they find that unions increase productivity by 20 per cent. This has proved to be an upper bound on the union-productivity effect. Most other studies at aggregate level have found it to be small and negative or insignificant.

Studies based at firm or industry level provide a more varied picture. Clark (1980a, b) estimates a union productivity effect of between 6 and 10 per cent based on a panel data set of cement plants. Clark takes advantage of a feature of US industrial relations by selecting out a sub-sample of firms that change union status over time. This means his firms act as their own controls. Allen (1987) looks at the relative efficiency of unionised and non-unionised workers in the construction industry. He finds that unionised workers are more efficient once the construction project reaches a certain 'threshold' size. It would be difficult to attribute this to 'voice' effects because the employment relationship in construction is usually short term (though the firm-union relationship might be quite long term).

Addison and Hirsch conclude from the above studies that:

i) Union productivity effects are large where the union mark up is large. This is consistent with managements being 'shocked' into organising production more efficiently in order to pay for this premium. If productivity fails to increase then the firm will not survive to be observed.

ii) Higher productivity effects are found where competitive pressure is greatest. There is no room for 'slackness'.

iii) 'The impact of unions is not a datum'. It depends on the interaction of firm and union and the characteristics of the product market.

Metcalf (1988b) reviews the empirical evidence for the UK. He concludes that the evidence clearly points to unionised plants having lower productivity than non-union plants. However he agrees with Addison and Hirsch in making the point that the effects of unionisation cannot be assessed without taking into account the characteristics of both the union and the firm. For example, several authors (e.g Bean and Symons (1989)) have suggested that it is the peculiarly British characteristic of 'multiunionism' that leads to widespread restrictive practices and to unions having adverse effects on economic performance. Multiunionism is the existence of several recognised unions in a single workplace. This can lead to poorer economic performance because:-

a) If there are numerous bargaining units, each one is less likely to be concerned with the externalities resulting from it's specific bargain.

There is a 'free-rider' or 'prisoner's dilemma' type problem.

b) In British plants unions are often divided along craft lines (i.e by function), rather than by industry, such as in West Germany. It might be argued that craft unions are more likely to resist technical change as it can threaten their membership specifically.

However Machin and Wadhwani (1989) did not find that a 'multiunionism' variable had a significant effect. A problem with the work surveyed by Metcalf is that it is largely based on industry cross sections. The measured negative effect of unionism might reflect the higher union density in more mature, less productive industries. One other study worth mentioning is that by Pratten (1976). He compared plants owned by multi-national companies in order to assess what they regarded as the causes of productivity differences. He found that plants in the UK had lower productivity but he attributed only a small percentage of the differential to a higher incidence of restrictive practices or strikes. We now turn to assessing the other factors that affect effort and productivity.

5.3.4 Other Factors

i) *Unemployment*. The unobservable component of effort, e_2, will be positively related to the rate of unemployment because it affects the outside opportunities facing the worker. In our model higher unemployment will also cause an an increase in bargained effort, e_1 (see 5.22).

ii) *Product Market Structure*. Intuitively we would expect the incidence of restrictive practices to be greater where the firm has a degree of market power. This effect is contained in the model where effort, e_1, is increasing in the product demand elasticity η. The firm's market power is likely to be inversely related to the elasticity of the demand curve it faces. We have no direct measure of the market power of the firms in our sample so we attempt to proxy it in two ways:

a) We use the five firm concentration ratio for each firm's industry.

b) We expect that market power would be related to the firm's ***size***, so we test whether, ***ceteris paribus***, larger firms have lower productivity. We could also justify including firm size as a proxy for multi-unionism as in Bean and Symons (1989) or to test constant returns to scale (cf. Addison and Hirsch (1989)).[6]

iii) *Financial Performance*. In the previous paragraph we argued that if firms do not possess market power then they have no room for 'slackness' in productivity. Similarly if the firm faces binding financial constraints we would expect effort to increase. This effect appears in the model in (5.22) as $\delta e_1/\delta\lambda>0$. Bargained effort will increase as λ, the 'shadow price' of extra finance, increases. An increase in λ represents an increase in how 'biting' the financial constraint is. We would expect an increase in the variables that represent the financial contraints facing the firm (e.g. the debt-equity ratio) to increase bargained effort and productivity. This effect might work through either the unions recognising the firms precarious financial position or through the increased pressure on the management to make production efficient. Note that it is one of the arguments used by the defenders of leveraged buy-outs that managerial efficiency is stimulated by a high debt equity ratio.

iv) *Centralised versus decentralised bargaining.* There has been considerable discussion as to whether the incidence of restrictive practices depends on the ***structure*** of the system whereby wages and productivity are bargained over.

The core argument of the Donovan commission (1968) was that many of the problems of UK manufacturing stemmed exactly from the separation of the industry level wage bargain from the plant level productivity bargain.

It is one of the features of our traditional approach to collective bargaining that negotiations about pay are largely separated from considerations of efficiency...Our proposals for the reform of collective bargaining are therefore fundemental to the improved use of manpower...They will put in managements hand an instrument - the factory agreement - which, properly used, can contribute much to higher productivity. (paras. 327,328)

Imposing a nationally agreed wage onto our model introduces the constraint $W=W_n$ (where W_n is the nationally bargained wage). Intuitively, if the unconstrained wage is higher than W_n then imposing the constraint will lead to a lower level of effort than in the uncontrained case. This seems to be the argument of the Donovan commission. In terms of the model, adding an extra constraint of the form $W \leqslant W_n$ will lead to a lower bargained effort level if this constraint binds.

On the other hand national wage bargaining could lead to a ***higher*** wage than local bargaining. If we impose the constraint $W \geqslant W_n$ on the model then constrained effort in turn will be higher. Ulph and Ulph (1981) can be interpreted along these lines.

The incomes policies of the 1970's can be regarded as imposing $W \leqslant W_n$ on all local bargains. This will result in a lower level of effort than if effort and wages were freely bargained. Since these incomes policies were meant to be a 'voluntary' part of the social contract between the unions and the labour government it might be expected that non-union firms would have paid less heed to this constraint. Therefore we would predict that non-union firms would have had higher levels of effort and productivity during the incomes policies period.

v) *Shock*. We have already mentioned the extent of the negative demand shock that the UK suffered over the 1979-81 period. This was coupled with a large fall in competitiveness due to OPEC II. Thus the conditions facing the manufacturing sector, the sector most exposed to foreign competition, were such that for many firms bankruptcy could only be avoided by increasing productivity. Because of the imminence of unemployment, even for the core 'inside' employees, workers did not defend restrictive practices and co-operated with management to improve productivity. In terms of the model this 'shock' can be taken as an outward shift in the utility of effort function (see fig 5.2). At every level of effort utility is greater, disutility is less. Thus 'shock' will cause a discrete shift in η_{g1}, the elasticity of utility with respect to effort. This will increase the level of effort obtained from the bargain. This 'shock' variable is quite closely related to the efficiency wage variable in some ways. It suggests that over the 1979-81 period workers perceptions of their 'outside' opportunities were revised downwards and so now, for a given level of unemployment and the relative wage, effort will be greater.

5.4 Methodology, Data and Results

5.4.1 The basic approach

Our theorising in the previous section has largely been about 'effort' - yet, it is something that is not easily measured. Therefore, we shall, instead, be concerned with estimating a conventional production function that is augmented to incorporate the various considerations affecting effort that are discussed above.

Therefore, we shall estimate a production function of the form given in equation (5.9), that is

$$Y_{it} = A_i K_{it}^{\alpha 1} N_{it}^{\alpha 2} e_{1it}^{\alpha 3} e_{2it}^{\alpha 4} \exp(\Phi_t) \qquad (5.23)$$

where (i,t) denotes the ith firm in year t, Y_{it} is value added, K_{it} the capital stock, N_{it} denotes employment, A_i represents a firm-specific fixed effect designed to capture a plethora of possible reasons (mainly unobservable) why one firm may always be more productive than another and Φ_t represents common effects.

As before, e_{1it} represents the component of effort that is bargained over, and following the discussion in Sections 5.2 and 5.3 it is proxied by

$$e_{1it} = \psi_1 \,(Union_{it}, Unem_{jt}, CONC_{jt}, FH_{it}, IP_t, SHOCK_i) \qquad (5.24)$$

where $Union_{it}$ represents a proxy for union strength, $Unem_{jt}$ denotes the unemployment rate in industry j (to which firm i belongs), $CONC_{jt}$ is the five-firm concentration ratio, FH_{it} is a vector of variables measuring the financial health of this firm, IP_t is a dummy variable to represent incomes policies, and $SHOCK_i$ is based on the decumulation in employment in this firm during 1979-81 (it takes the value zero prior to these dates and is interacted with time dummies after).

The component of effort which is unobserved, e_{2it}, generates efficiency wage effects and is a function of the relative wage term $W/\tilde{W}$. As is clear from our model in Section 5.2, this is also a function of the same set of variables as e_{1it} and we may thus write

$$e_{2it} = \psi_2 \; (Union_{it},\; Unem_{jt},\; CONC_{jt},\; FH_{it},\; IP_t,\; Shock_i) \qquad (5.25)$$

Substituting (5.25) and (5.24) into (5.23) then provides us with our basic estimating equation.

5.4.2 Data

In this, and the next chapter, we again use data drawn from the published accounts of UK manufacturing companies (details in the data appendix). However, we have now extended the sample period to 1986. This was because it was felt that any change in behaviour induced by changes in legislation would not be detectable in a sample ending in 1982. The major problem with extending the sample period was that industry specific data is only available on the 1980 Standard Industrial Classification (SIC) after 1982. This required matching the data available on the new SIC with our previous data based on the 1968 SIC. The details of this procedure are contained in the appendix. Furthermore, many variables are no longer available after 1982 due to changes in the reporting requirements for company accounts and cuts in the government's statistical service. Again, details on alternative sources of the data is contained in the appendix.

The accounts and industry data was supplemented by information on union coverage, bargaining structure etc. obtained from two questionnaire surveys. One was carried out by the Centre for Labour Economics, and the other by Steve Machin, to whom we are grateful for allowing us to access his data. Both questionnaires are contained in the data appendix.

We have an unbalanced panel - the number of firms in each year is in Table 5.1. The sample size peaks in 1981, when there are 127 firms, 27 of which have union coverage < 50 per cent[7]. The firms that we have are large. Notice (see Table 5.2) that firms where union coverage exceeds 50 per cent (defined as "high" union) are larger than their non-union counterparts (i.e. higher median employment and real sales). Further, labour productivity is also somewhat higher in union firms.

We have plotted the labour productivity growth in the two sets of firms in Figure 5.3. Notice that there is no clear pattern , though unionised firms do appear to experience faster productivity growth during 1980-84.

The actual variables that we use are:- (precise definitions are to be found in Data Appendix, the numbers in brackets refer to the location of the variables in the appendix)

(i) N_{it} - total employment. (variable 1) In order to allow for the number of hours worked, we used information on average hours worked by industry AH_{jt} (variable I6).

(ii) K_{it} - capital stock: (Variable 4, method 1 used for most firms, method 2 for the remainder).

(iii) Y_{it} - total sales: (variable 5) We were forced to use sales because a value added measure is not generally available. The nominal sales figure from company accounts was deflated by using the wholesale price index (variable I1).

(iv) $Unem_{jt}$ - Aggregate movements in unemployment are subsumed within the common time effects, Φ_t, so we used industry-specific unemployment rates (variable I4).

(v) $SHOCK_{it}$ - We proxied this by taking the reduction in the firm's employment between 1979 and 1981 and interacting it with time dummies from 1982 onwards.

(vi) $Union_{it}$ - We only have information of a firm's union status at a point in time. However, theoretical considerations suggest that the anti-union legislation of the eighties, and the pro-union legislation and, possibly, the incomes policies of the seventies would have differential effects on the productivity of union vs non-union plants. Therefore, we interacted the time effects with firm-specific union coverage and/or union recognition. (variables 12 and 13).

(vii) FH_{it} - Our theoretical discussion also suggested that firms that experience financial distress are more likely to be forced to improve productivity by ridding themselves of restrictive work practices and the like. In order to capture this effect, we experimented with including the firm's borrowing ratio (denoted as BR, variable 7) as an explanatory variable.

(viii) $CONC_{jt}$ - If a firm's product market power is reduced, it may be forced to improve its productivity. We therefore included the five-firm concentration ratio for the industry as a potential explanatory factor for productivity movements. We also investigated firm size effects under this heading (variable I8).

5.4.3 Specification and estimation

The most serious problem with the empirical specification arises from the fact that we only have sales data as our measure of output. There are, in fact, two difficulties here. First, total sales are not the same as gross output and second, gross output is not the same as value-added output. Consider the first problem and let sales be Y_s, gross output, Y_g. Then if I represents inventories, we have

$$Y_{gt} = Y_{st} + \Delta I_t \tag{5.26}$$

Suppose we have a simple inventories model of the form

$$I_t = \lambda I_{t-1} + (1-\lambda)c_1 Y_{st} \tag{5.27}$$

where inventories adjust slowly towards a proportion of sales[8]. We have from (5.26), (5.27)

$$Y_{gt} = Y_{st} + (1-\lambda)\ c_1 \frac{(1-L)}{(1-\lambda L)} Y_{st}, \tag{5.28}$$

where L is the lag operator.
This reduces to

$$Y_{gt} = (1+(1-\lambda)c_1)\ Y_{st} - (1-\lambda)c_1\ Y_{st-1} + \lambda(1-\lambda)c_1 L \frac{\Delta Y_{st}}{(1-\lambda L)} \tag{5.29}$$

where the final term is a distributed lag in ΔY_{st} with relatively small coefficients (note $\lambda(1-\lambda) < 0.25$). If we drop this term, we have

$$Y_{gt} = (1+(1-\lambda)c_1)\ Y_{st} - (1-\lambda)c_1\ Y_{st-1} \tag{5.30}$$

Thus a gross output production function can be approximated by a dynamic sales production function of the form

$$Y_{st} = (1+(1-\lambda)c_1)^{-1}\ Y_{gt} + \frac{(1-\lambda)c_1}{(1+(1-\lambda)c_1)} Y_{st-1} \tag{5.31}$$

That is, we should include a lagged dependent variable at the very least.

Turning to the second problem, namely the discrepancy between gross output and value added, note that the relationship between value-added and gross output will in our Cobb-Douglas framework, have the form

$$Y_g = Y^{\gamma} M^{(1-\gamma)}$$

where Y is value-added and M is material input. Profit maximisation ensures that

$$(1-\gamma) \frac{Y_g}{M} = \frac{PM}{P}$$

where PM is the price of materials and P is the gross output price. Eliminating M from the production function yields

$$Y_g = (1-\gamma)^{\frac{(1-\gamma)}{\gamma}} Y \left[\frac{PM}{P}\right]^{\frac{-(1-\gamma)}{\gamma}} \tag{5.32}$$

Thus we should include the real price of materials in order to take account of the value-added/gross output discrepency.

In the light of (5.31) and (5.32), our value added specification (5.23) can now be written in log-linear form in terms of sales as

$$\begin{aligned} y_{sit} = {} & a_i + \lambda_1 y_{sit-1} + \alpha'_1 k_{it} + \alpha'_2 n_{it} + \alpha'_3 (pm-p)_{jt} + \delta_1 unemp_{jt} \\ & + \delta_2 shock_i \varphi_{1t} + \delta_3 FH_{it} + \delta_4 CONC_{jt} + \delta_5 ahr_{jt} + \varphi_{2t} \\ & + Union_i \varphi_{3t} + \epsilon_{it} \end{aligned} \tag{5.33}$$

where i=firm, j=industry, y_s=sales (real), k=capital stock, n=employment pm-p=real price of materials, unemp=unemployment (industry), shock=absolute fall in employment 1979-81, φ_{1t} is a time dummy coefficient which takes the value zero until 1982 and 1 thereafter, φ_{2t}, φ_{3t} are standard time dummies, FH=financial health, captured by the firm's borrowing ratio, CONC=industry five firm concentration ratio, ahr=industry average hours worked and ϵ_{it}=a white noise error. Finally, it should be noted that the lagged dependent variable might be important for reasons other than the gross output-sales discrepency. In particular, it would also arise if output adjusted only slowly to changes in factor inputs as new workers, for example, took some time to become fully productive in their new work environment.

In order to estimate (5.33), we take first differences to obtain

$$\Delta y_{sit} = \lambda_1 \, \Delta y_{sit-1} + \alpha'_1 \Delta k_{it} + \alpha'_2 \Delta n_{it} + \alpha'_3 \Delta(pm-p)_{jt} + \delta_1 \Delta unemp_{jt} + \delta_2 \, shock_i \, \Delta\varphi_{1t} + \delta_3 \Delta FH_{it} + \delta_4 \Delta CONC_{jt} + \delta_5 \Delta ahr_{jt} + \Delta\varphi_{2t} + Union_i \, \Delta\varphi_{3t} + \Delta\varepsilon_{it} \quad (5.34)$$

This enables us to eliminate the firm specific fixed effect, a_i. Employment and the lagged dependent variable are endogenous variables and the equation is estimated using the Generalised Method of Moments technique described in Arellano and Bond (1988) (see section 4.2.4).

5.4.4 Results

Our basic results are reported in Table 5.3. Initially, we restricted $\alpha'_3=\delta_1=\delta_2=\delta_4=0$ (we report some experiments with relaxing these restrictions below).

Starting with column 1, notice that in addition to the conventional terms in a production function - i.e. employment, capital stock and hours, we included the borrowing ratio (i.e. the debt-equity ratio), the market capitalization of the firm and the lagged dependent variable, as additional variables. Note that we have imposed long-run constant returns to scale on this specification. Financial distress should lead to higher productivity as managers attempt to 'save' the firm, so, a higher borrowing ratio should lead to higher productivity. The effect of market capitalisation is, though, a priori, ambiguous. A higher stock market value makes financial distress less likely, and, so, should lead to lower productivity. However, since the capital stock is mis-measured, market capitalization may form a part of a more appropriate measure of the capital stock. On this argument, it would attract a positive coefficient. In estimation, employment, the capital stock, market capitalisation and the lagged dependent variable are treated as endogenous variables. Notice that the borrowing ratio attracts a significant, positive coefficient - so, firms with high debt-equity ratios, who are therefore 'looking over the precipice', appear to be able to secure high productivity growth by eliciting an improvement in 'effort'. This is also consistent with the view that a higher level of debt stimulates managerial efficiency. The firm's market capitalization attracts a positive coefficient, which is consistent with it acting as a proxy for a better measure of the capital stock.

Turning now to the union effects, which are of especial interest, we find that there was no significant differences in average productivity growth between union and non-union firms during the 1975-78 period (i.e. a period during which there was pro-union legislation, and an incomes policy), but union firms experienced significantly higher productivity growth during the 1980-84 period (when anti-union legislation was introduced). Therefore, if one wishes to argue that the reason that union firms experienced faster productivity growth in the eighties is the introduction of anti-union legislation, one has to simultaneously explain why the pro-union legislation of the seventies failed to depress relative productivity growth in union firms.

Further, even if we argue that the 80-84 effect may be attributed to the anti-union legislation, it would merely take the firm to its production frontier from having been within it. So the legislation might be expected to have only once-for-all effects on productivity (albeit, effects that will manifest itself as differential productivity growth during the process of adjustment). This is contrary to the commonly expressed view that such legislation should be associated with a <u>permanently</u> higher growth rate of productivity (see e.g. Metcalf (1988) or Muellbauer (1986)). The evidence here suggests that, by 1985-6, productivity growth in union firms was not significantly different from that in non-union firms.

This would suggest to us that the change in legislation cannot be the whole story. We have found a strong union productivity effect lasting from 1980 to 1984. It might be argued that, although much of the new union legislation was on the statute books by 1982, it did not impinge on the practice of industrial relations until it had been tested in trade disputes and in the courts. The last enactment of a Conservative government in this area, the 1971 Industrial Relations Act had also been intended to re-shape industrial relations but, when faced with the determined opposition of the TUC, it proved to be almost completely unworkable. Fosh and Littler (1985) argue that the new legislation of the 1980s was not ***challenged*** until 1983 when the post office workers began industrial action to protest at the privatisation of British Telecom and the use of the BT network by Mercury Communications. 'During the 1980-82 period, the trade unions, shocked by the new economic depression, largely refrained from challenging the 1980 act, despite TUC banners' (Fosh and Littler (1985) p.4). The BT dispute was followed by two of the largest and most acrimonious disputes of the 1980s. The dispute between the National Graphical Association and Messenger Group Newspapers and that between the National Union of Mineworkers and the National Coal Board. Both of these later disputes demonstrated just how effectively the new legislation had narrowed the legitimate tactical options open to the unions. However, before 1983, managements tended to use the new legal remedies sparingly. Injuctions were sought more as a threat to force unions to curb unofficial strikes than as a means of purging unions from the workplace altogether (see Evans (1985a, b)). This is because the firms were more concerned with the damage that resorting to the law could do to long term industrial relations. For the above reasons we argue that the effectiveness of the new legislation could not have been accurately judged until at least 1983. The points we wish to make are:-

i) the effects of the change in legislation would be too weak in the early eighties to cause the abandonment of restrictive practices that our estimates suggest took place.

ii) We find the productivity effect to have diminished by 1985-86. This period, following the NUM dispute and the passing the 1984 Trade Unions Act, might be expected, ***a priori*** to be the period when the new legislation was perceived to be most effective.

One alternative interpretation of our results is that the legislation has had little effect. Instead, non-union firms were, say, already at

$e_1 = e_1^{max}$, but union firms had $e_1 < e_1^{max}$. Then, the massive rise in unemployment in the early eighties led to a rise in e_1 in union firms, and since e_1 could not increase in non-union firms, this was manifested in faster productivity growth in union firms. Once e_1 reached e_1^{max} in union firms, productivity growth in union and non-union firms was, once again, similar. This is certainly the opinion of Industrial Relations specialists who have studied the effects that the new laws had on the conduct of industrial disputes in the early eighties.

'The transformation of the employment situation brought about by the conditions of severe recession and high unemployment was undoubtedly the most significant determinant of managements' dispute handling. More or less uniformly, employers were induced by tighter product markets and the increased urgency of financial pressures and encouraged by the weakened labour market power of trade unions to take a tougher stand against strikes and picketing when they occurred.' (Evans (1985a) p.147)

One needs to be somewhat careful when interpreting the evidence in column 1, for it is based on an unbalanced panel. The changes in the values of the time effect may, therefore, be contaminated by effects arising from changes in sample composition. Therefore, we report some results based on a rather small, balanced panel consisting of 39 firms in column 2. Union firms still grow faster during 1980-84, though, there is now a suggestion that they grew more slowly during the seventies. Of course, given the small size of the sample, we need to be cautious, but our results suggest that there is no simple association between unionism and productivity growth.

We should emphasize, though, that in column (1) we have imposed long-run constant returns to scale even though it was statistically rejected. Our procedure may be defended on the grounds that decreasing returns to scale are implausible, and we only find evidence against CRS because the capital stock is mis-measured. Nevertheless, we also report, in column (3), estimates of a production function without imposing long-run constant returns to scale. The basic pattern of our results is, however, preserved. The union firms continue to experience faster productivity growth during 1980-84, with no discernible difference in other sample periods.

We next experimented with including relative raw materials prices. However, they attracted an insignificant coefficient, and the other coefficients were largely unchanged.

The production function that we have estimated is somewhat unconventional, in that it includes a lagged dependent variable. So, in column 4, we report our results when we exclude it. Notice that the pattern of coefficients on union coverage is essentially unchanged.

5.4.5 Some Further Explorations

(i) 'Shock' effects

We have argued above that a possible explanation for our results is that the rise in productivity growth in the 'eighties' occurred because of the 'fear' induced in workers by the deep recession of 1979-81. So, e.g., Metcalf, (1988), reports that, in an industry cross-section, differential productivity growth is *not* explained by differences in unionism, *once* we control for the 'shock' effect.

Therefore, we included the percentage fall in employment during 1979-81, interacted with a dummy variable that takes the value 1 from 1982-84, as a proxy for the 'shock' effect. When we include this variable we do find that firms who experienced a bigger 'shock' were more likely to have higher productivity growth during the 1982-4 period (Table 5.4, column 1). However, it is still true that unionized firms experienced faster productivity growth during the eighties.

There are several problems with this approach:

i) We call our variable 'shock' but it's effect is restricted until after the worst of the recession is over. Such a variable would be more relevant to the middle of the recession but, because of the way our variable is defined, we are unable to do this.

ii) It could be argued that we are simply detecting a 'batting average' effect. Firms have sacked workers in ascending order of marginal productivity. We discuss below whether we have sufficiently controlled for this.

iii) There is an endogeneity problem in that firms could have had a bad recession ***because*** they were unable to increase productivity.

All these would mitigate the effects of this variable. Ideally 'shock' should be a function of factors exogenous to the firm. To find a satisfactory measure would require some further work.

An empirical problem with this variable is that it's significance depends on the equation specification. If the lagged dependent variable is not included than 'shock' does not enter.

<u>(ii) Further investigation of the union effects</u>

Our theoretical discussion suggested that it was the potential power of unions to inflict damage on employees during strikes that was relevant. So, perhaps, conditional on there being a recognised union at a workplace, the anti-union legislation would have the biggest effect on firms where union coverage is high. Therefore, we interacted the dummies with ***both,*** union coverage within the firm, and a union recognition dummy (variable 13). The results are reported in column 2 of Table 5.4. These results suggest that the firms that experienced the highest productivity growth during the eighties were those that had high union coverage, and, in fact, firms with union recognition but low coverage actually did worse than their non-union counterparts. However, in 1985-6, the pattern of coefficients is reversed, and there is no obvious explanation for this.

Given our discussion regarding the possible effects of decentralised bargaining, we interacted the time dummies with a decentralisation dummy, (variable 14) which takes the value one for firms who ignore national/industry level bargains in setting wages. Since a question about the level of bargaining was only asked in one of our questionnaires, we were forced to use a smaller sample here. There is some evidence that decentralised firms experienced faster productivity growth during 1975-78, suggesting that these firms were better able to ignore the incomes policy of that period. Further, such firms also grew more slowly during 1980-84, which would be consistent with them not having $e_1 < e_1^{max}$ to begin with.

Of course, our dataset only contains information on the extent of unionisation within a firm at a point in time. Ideally, we should also use information on changes in unionisation over time. We, therefore, experimented with the inclusion of changes in union density in the industry to which the firm belongs (as an approximate indicator of such movements over time for this firm, variable I7). However, it never attracted a significant coefficient in any of our experiments.

<u>(iii) The Effects of Firm Size</u>

Other things being equal, large firms tend to have greater product market power, and greater financial strength. This might lead us to expect significant variation in the importance of restrictive practices in firms of different sizes (see Machin and Wadhwani (1989), who provide some direct evidence in this regard). Now, since larger firms are also more likely to be unionised, it is possible that the effects that we have been attributing to unionism are actually effects stemming from firm size.

Therefore, we interacted the time dummies with a dummy variable that takes the value one for larger firms (the variable is set to unity if the firm's employment in 1980 is greater than the mean). Our results are presented in Table 5.4, column 4. Notice that there are very significant 'size' effects through 1980-86. However the 1980-84 union effect remains significant.

(iv) Labour Utilisation

Following the influential analysis of Muellbauer (1984), we also experimented with proxying for actual utilization by including terms of the form

$$\alpha_1 \, OH_t + \alpha_2 \, OH_t^{-1}$$

where $OH_t = \frac{\text{Overtime Hours}}{\text{Normal Hours}}$,

Section 4.2.4 discusses reasons for believing that a term of this form will a more accurate proxy for utilisation than simply including average hours.

However, including this made little difference to our results.

(v) 'Batting average' effects

It is often argued that one reason for the increase in productivity growth in the eighties is the possibility that inefficient plant was shut down, and labour of inferior quality was laid off. So, to pursue the cricketing analogy, if the tail-enders no longer bat, the team's batting average will show an improvement.

There are several reasons why we believe that unobserved changes in the the skill level will not bias our results. Firstly we appeal to the argument presented in section 4.3.5. If the change in skill over the sample period is a linear function of the change in employment over the same period then, after differencing, the skill mix will be a function of variables that are already included in the equation (see equations (4.19) and (4.20)).

Secondly, Oulton, (1987), shows that during the 1979-81 recession, the proportionate fall in employment was greater in large firms, as compared to small firms. Now, since large firms have higher average labour productivity, this suggests that, if anything, productivity should fall.

(vi) Unemployment effects

In the light of our discussions in the theoretical section, we also included industry employment as an extra variable. However the effect of industry unemployment was not statistically significant (perhaps, a large part of the effect is subsumed within aggregate variations in unemployment, which belong to the time effects)

(vii) Concentration Ratio

Our theoretical discussion suggested that changes in product market power may be important in explaining changes in productivity. In terms of understanding the early eighties, we, therefore, experimented with including the change in the five-firm concentration ratio between 1977 and 1982, interacted with a dummy variable which takes the value one from 1982 onwards.

It typically attracted the right sign (i.e. negative), but was usually statistically insignificant, and left our basic message intact.

(viii) Measures of the Capital Stock

In computing our capital stock, we assume that the average length of life of disposals was eight years. This implies that, in our sample, the capital stock actually rises by 17 per cent during 1977-83. This is out of line with other estimates, (see chapter 2 and references therein) and might stem from the small size of our sample. However, we may also have been rather conservative regarding our length-of-life assumption, so we also experimented with allowing the length-of-life to be 16 years instead. The alternative assumption implies a decline of 7.4 per cent in the capital stock between 1977 and 1983.

However using the alternative measure of capital stock had no discernible effect on our substantive results (e.g. union firms still grow significantly faster over 1980-84).

5.5 Conclusions

Our substantive results are:

(1) Union firms experienced faster total factor productivity growth than their non-union counterparts during 1980-84. Therefore, on this evidence, contrary to what is often alleged in the literature, unions do not consistently reduce productivity growth.

(2) We have attempted to suggest reasons for this. The above result is consistent with unionised firms having levels of productivity below the technological frontier in 1979. This was due to 'restrictive practices', rules to control the 'custom and practice' of work bargained usually at establishment level by union representatives. We have modelled this as an 'effort bargain'. Therefore in 1979 unionised firms were more likely to have $e_1 < e^{max}$. Meanwhile because workers at non-union firms had less

bargaining power they were more likely to be at the frontier with $e_1 = e^{max}$. The 1980-84 period saw the widespread abandonment of restrictive practices. Our measured union productivity effect is the union firms catching up with the non-union firms. There are two hypotheses as to why this change occurred:

a) The changes in legislation under the 1979 Conservative government weakened the union's ability to pursue effective industrial action. This led to a decisive shift in power towards management and hence a higher level of bargained effort.

b) The deep recession of 1979-81 'shocked' both firms and workers into a sudden realisation of the precariousness of their position (the much quoted 'new sense of realism on the shopfloor'). In such a climate restrictive practices were seen as indefensible.

We tend to prefer the second explanation to the first. This is largely because of timing considerations. It is hard to believe that the 1980 and 1982 Employment Acts changed the climate of industrial relations overnight. It seems much more sensible to regard these acts as becoming effective only after 1983. The worst of the recession was then over and the unions felt able to challenge the new laws. Even then it may be argued that were it not for the change in police tactics towards picketing, the outcome of, e.g. the miners strike, may have been different, no matter what was decided in the civil courts. We would argue that it was the economic, not the legalistic, climate that provided the spur to productivity. Union members were not interested in action that could threaten their jobs. Managements had to obtain productivity increases to survive. The new legislation played its part by making unions considerably more circumspect about embarking upon industrial action and much less inclined towards a *laissez-faire* approach to unofficial disputes.

(3) The evidence suggests that, by 1985-86, TFP growth in union firms was no faster than that in non-union firms. This suggests that if it was the anti-union legislation that boosted productivity, it does not appear to have had a permanent effect on productivity growth. Union firms have now 'caught up' with non union firms and there no more simple opportunities to increase productivity.

(4) Firms with increases in debt-equity ratios experienced significantly faster productivity growth over our sample period. This evidence is supportive of the notion that debt helps discipline managers, and may be relevant to an evaluation of the recent wave of leveraged buy-outs.

Footnotes

* We are extremely grateful to Bill Callaghan, Richard Jackman, Richard Layard, Steve Machin, David Metcalf, Richard Freeman and participants at the unemployment seminar for their useful comments. Steve Machin kindly allowed us to use the results of his questionaire. Bertrand Kan and Savvas Savouri provided research assistance. We are grateful to the Department of Employment, the Economic and Social Research Council and the Esmee Fairburn Trust for financial support.

1 We follow Muellbauer in defining 'Utilisation' as the number of hours worked by a fixed number of employees and 'Effort' as the intensity of work within each hour.

2 Thus, for example, it would be difficult to envisage a situation where union negotiations occured every time additional employees were hired or workers who had left were not replaced.

3 We do not define 'union power' here explicitly. It is unlikely to be a one dimensional variable. In the text it is more or less implicitly defined as a function both of the union's ability to wage effective industrial action and to discipline it's members, and of the individuals worker's rights to claim unfair dismissal and to go to arbitration to obtain the 'union rate'. The complexity of this issue is clearly seen by the 'backfiring' of several of the governments actions to reduce union power. The union position is supported in 90 per cent of the ballots on strike action for example (figures from Towers (1988)). Also the requirement in the 1984 trade union act that unions keep accurate membership records has considerably helped unions in expanding membership services and becoming administratively more efficient.

4 Section 29(1) of TULRA 1974 contains the list of subjects that a trade dispute must be connected with to be legitimate.

i) Terms and conditions of employment, or the physical conditions in which any workers are required to work.

ii) Engagement or non-engagement or termination or suspension of employment or the duties of employment of one or more workers.

iii) Allocation of work or the duties of employment as between workers or groups of workers.

iv) Matters of discipline.

v) The membership or non-membership of a trade union on the part of a worker.

vi) Facilities for officials of trade unions.

vii) Machinery for negotiation or consultation, and any other procedures relating to any of the foregoing matters, including recognition by employers or employers' associations of the right of a trade union to represent workers in any such negotiation or consultation or in the carrying out of such procedures.

5 This reform possibly led to the least desirable outcome of the Conservative's reforms. Most of the other changes are confined to the civil law. However because of the difficulty of ascertaining whether picketing qualified for immunity and, if it didn't, pursuing civil actions against pickets, the criminal law and hence the police quickly became embroiled in industrial disputes. This ended the principle of keeping the police as neutral. This outcome was forseen by the government's green paper in 1981 (para 174).

6 Machin and Wadhwani (1989) found that firm size had a significant effect on the likelihood of 'organisational change' during the eighties. Multi-unionism had no significant effect. This would suggest

that using size as a proxy for multi-unionism can give misleading results.

7 The only measure of union power available on both samples was union coverage. It is given by the answer to question 8 (a) on our questionaire and of question 6 on Steve Machin's.

8 This is a very simple model. In a more standard model c_1 would depend on other variables, in particular the interest rate. In the context of our rather short time series we assume that it may be treated as a constant, or, alternatively, variations in c_{1t} may be subsumed into the common time effects after linearisation.

Table 5.1

Sample Size by Year and Union Status

Year	Union Coverage > 50%	Union Coverage < 50%
1972	81	18
1973	82	19
1974	82	19
1975	83	19
1976	91	22
1977	94	25
1978	94	26
1979	97	26
1980	99	26
1981	100	27
1982	89	24
1983	63	19
1984	57	21
1985	51	20
1986	41	14

TABLE 5.2

Characteristics of Sample

VARIABLE	"HIGH" Unionisation Firms	"LOW" Unionisation Firms
Median Employment	1858	709
Median ln (Real Sales)	6.2	4.96
ln (Output/Employment)	-1.44	-1.51

Notes:- (i) "High" unionisation = firms with union coverage > 50%.

(ii) All figures refer to 1980.

TABLE 5.3

Estimates of Production Function (Equation 34)

Independent variables	(1) Basic equation	(2) Balanced panel	(3) Relaxing CRS	(4) Excluding lagged dependent variable
ΔIn (Employment)$_{it}$*	0.525 (13.53)	0.096 (0.89)	0.473 (11.42)	0.512 (12.17)
ΔIn (Capital Stock)$_{it}$*	0.084**	0.317**	-0.013 (-0.39)	0.118 (3.06)
ΔIn (Average Hours)$_{it}$	0.190 (0.75)	0.695 (1.12)	0.459 (1.90)	0.297 (1.52)
Δ(Borrowing * Ratio)$_{i,t-1}$	0.065 (6.91)	0.064 (1.43)	0.051 (5.22)	0.042 (4.28)
ΔIn (Market Capitalisation)$_{it}$	0.043 (7.31)	0.090 (1.95)	0.018 (2.38)	0.042 (4.23)
UNION EFFECTS				
Union cov· *75-78 dummy	0.003 (0.45)	-0.066 (-2.14)	-0.003 (-0.37)	-0.008 (-0.83)
Union cov. *80-84 dummy	0.029 (3.87)	0.043 (1.43)	0.039 (4.54)	0.044 (4.88)
Union cov. *85-86 dummy	0.001 (0.05)	-	-0.008 (-0.41)	0.014 (0.63)
ΔIn (Real Sales)*$_{i,t-1}$	0.391 (12.10)	0.587 (4.18)	0.257 (8.70)	-
Sample period	1975-86	1975-84	1975-86	1975-86
Number of firms	107	39	107	107
No of observations	953	390	953	953
Sargan test for validity of instruments	69.47 (60)	5.59 (5)	67.87 (59)	68.60 (58)
m_2	-0.23	1.44	-0.64	-0.95

Notes:

(i) All equations include time dummies.

(ii) t-ratio in parentheses.

(iii) * denotes variables are treated as endogenous.

(iv) Additional instruments used are:

in Column (1): all the valid moment restrictions from lags on employment and market capitalisation, lagged capital stock (t-2, t-3), lagged sales (t-2, t-3).

Column (2):- those from colum (1), but only includes lags (t-2, t-3) of employment and capitalisation.

Column (4): those from column (1) excluding lagged sales (t-2, t-3).

(v) ** denotes that the coefficient is restricted - i.e. long-run constant returns to scale is imposed.

(vi) m_2 is a test against on AR(2)/MA(2) error process (~N(0,1) under the null).

TABLE 5.4

Further Estimates of Production Functions

Independent Variables	(1) 'Shock' effect	(2) More Union Effects	(3) Effects of Decentralisation	(4) Effects of Size
$\Delta \ln$ (Emp.)$_{it}$*	0.517	0.489	0.572	0.716
	(14.70)	(13.87)	(5.88)	(18.52)
$\Delta \ln$ (Capital Stock)$_{it}$	0.093**	0.090**	0.127**	0.005
				(0.12)
$\Delta \ln$ (Average Hours)$_{jt}$	0.287	0.325	0.543	0.44
	(1.15)	(1.22)	(1.53)	(2.22)
$\Delta \ln$ (Sales)$_{i,t-1}$	0.390	0.421	0.301	-
	(11.99)	(14.49)	(4.09)	
Δ(Borrowing Ratio)$_{i,t-1}$	0.066	0.071	0.047	0.045
	(6.89)	(7.72)	(2.62)	(7.40)
SHOCK$_{it}$	0.102	0.106	0.056	0.007
	(6.47)	(6.84)	(1.75)	(0.52)
$\Delta \ln$ (Market Capitalisation)$_{it}$	0.029	0.029	0.039	0.016
	(4.82)	(4.34)	(2.02)	(2.85)
UNION EFFECTS				
Union cov· *75-78 dummy	0.001	0.013	-0.015	-0.004
	(0.07)	(0.88)	(-1.37)	(-0.41)
Union cov. *80-84 dummy	0.029	0.059	0.014	0.029
	(3.85)	(7.76)	(0.98)	(2.69)
Union cov. *85-86 dummy	-0.014	-0.083	-0.087	-0.048
	(-0.56)	(-2.27)	(-1.50)	(-2.56)
Union recog. *75-78 dummy	-	-0.018	-	-
		(-1.43		
Union recog. *80-84 dummy	-	-0.039	-	-
		(-4.42)		
Union recog. *85-86 dummy	-	0.114	-	-
		(3.72)		

TABLE 5.4 (cont.)

Further Estimates of Production Functions

Independent Variables	(1) 'Shock' effect	(2) More Union Effects	(3) Effects of Decentralisation	(4) Effects of Size
Decentr.dummy *75-78 dummy	-	-	0.015 (1.90)	-
Decentr. dummy *80-84 dummy	-	-	-0.029 (-2.56)	-
Decentr. dummy *85-86 dummy	-	-	-0.032 (-0.59)	-
SIZE dummy *75-78 dummy	-	-	-	-0.009 (-1.56)
SIZE dummy *80-84 dummy	-	-	-	0.034 (5.01)
SIZE dummy *85-86 dummy	-	-	-	0.138 (6.13)
Sample period	1975-86	1975-86	1975-86	1975-86
Number of firms	107	107	75	107
No of observations	953	953	715	953
Sargan test for validity of instruments	70.05 (60)	70.95 (60)	25.92 (25)	64.63 (58)
m_2	-0.24	-0.23	0.78	-0.93

Notes:

(i) All equations include time dummies.

(ii) t-ratio in parentheses.

(iii) * denotes variables are treated as endogenous.

(iv) **denotes coefficient restricted to satisfy constant returns to scale.

FIGURE 5.1

The Disutility of Observed Effort (e_1)

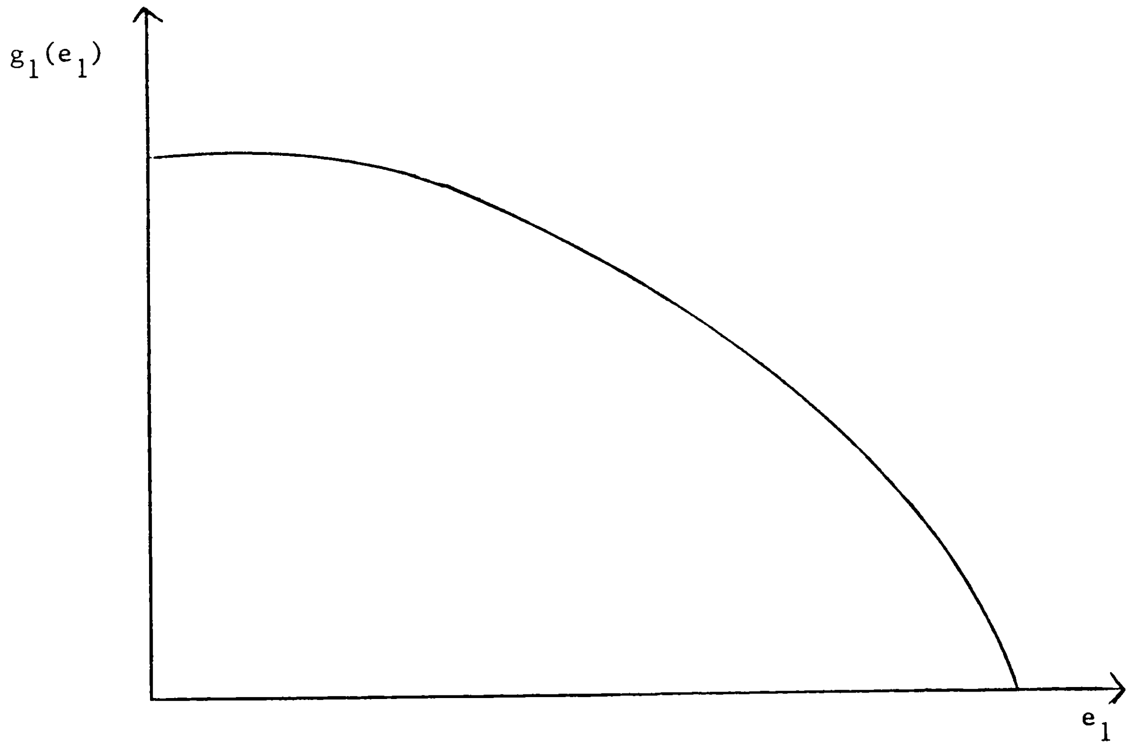


FIGURE 5.2

The Impact of "Shock" on the Utility of Effort

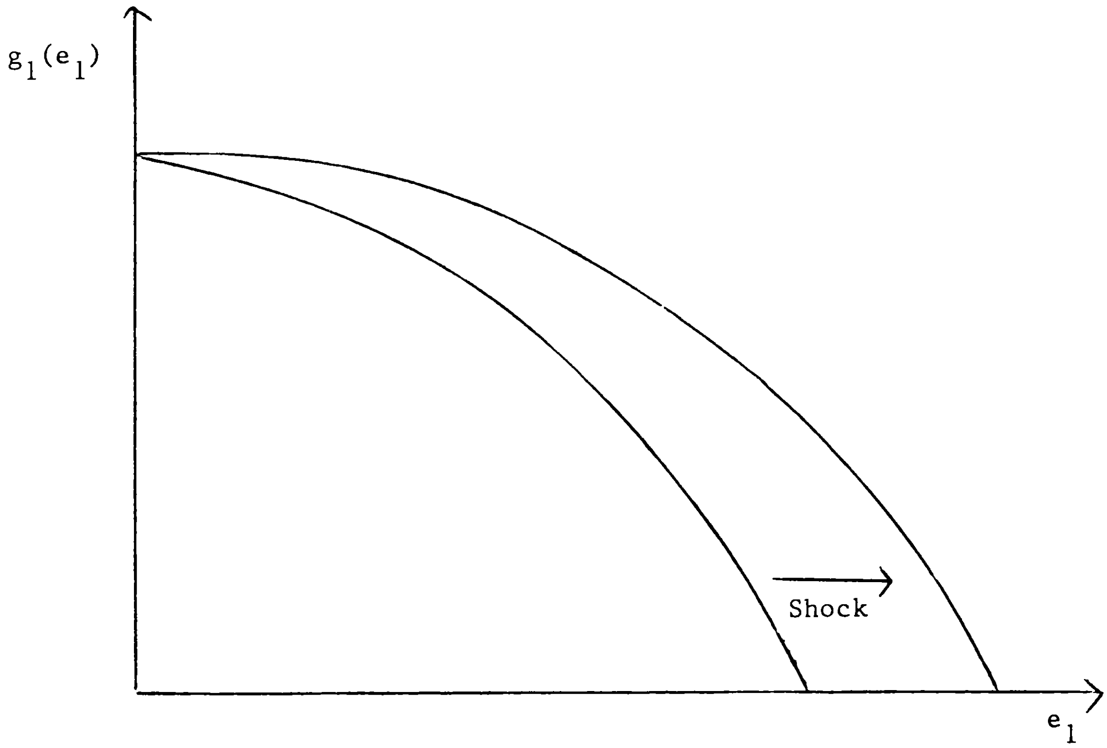
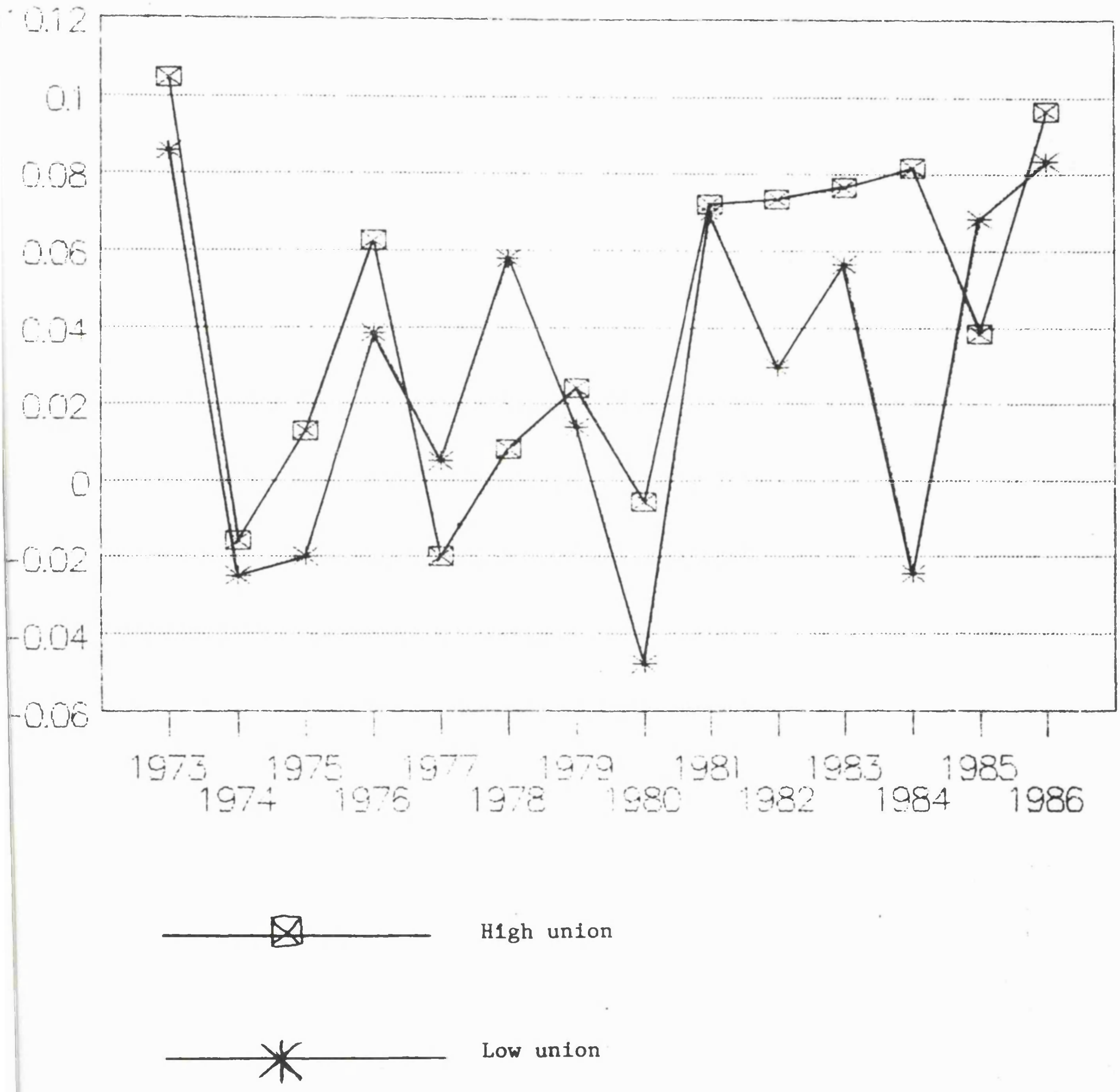


FIGURE 5.3

Productivity Growth, Union vs. Non-Union



Chapter 6: The Effects of Unions on Corporate Investment 1972-86

6.1 Introduction

In this chapter we assess whether unionisation has an effect on the long term economic performance of the firm by acting as a deterrent to investment. There are two channels through which it is suggested such an effect could operate:

i) Once the investment is made and the equipment is installed, the costs involved are 'sunk'. An investment project is not easily reversible. Unions will realise this and will be able to appropriate the rents earnt by such equipment. This will act as a deterrent to investment since rational investors will forsee this possibility and will not carry out the project. This insight was originally due to Simons (1944) and has been presented in more formal models by Baldwin (1983), Grout (1984) and Van Der Ploeg (1985).

ii) New investment will usually require some re-organisation of working practices. Nickell (1988) has suggested that unionised workers are more likely to be resistant to such change than non-unionised. This would mean that unionised firms face higher adjustment costs associated with investment.

There has recently been some evidence based on US data, that unionised firms *do* have lower investment to capital ratios (see Hirsch (1988a)).

In the British context we are also interested in whether the 'change of climate' in industrial relations in the 1980s, perhaps caused by the anti-union legislation or the shock of the recession, has led to an abandonment of restrictive practices and an increase in the rate of investment in unionised firms.

Our econometric results are based on the same panel data set as was used in the last chapter. We attempt to deal with the above issues by estimating two types of equations. Firstly we estimate an investment equation to assess whether union recognition or density directly effects investment and if any such effect changes across the sample period. Secondly we estimate a wage equation with capital intensity on the right hand side. This allows us to assess whether unionised workers are more successful at capturing the quasi-rents from capital than their non-unionised counterparts.

Section 6.2 is concerned with theory, 6.3 covers data and methodological issues. The results of estimating the investment equation are contained in 6.4 and the wage equation in 6.5. Section 6.6 contains our conclusions.

6.2 Unions and Investment: Some Theory

6.2.1 Unions expropriate quasi-rents

Simons (1944) contained the two insights that provided the basis for the rent seeking models:

i) Rents from durable capital are vulnerable to expropriation by an organised, i.e. unionised, workforce. The firm will stay in business so long as it can cover it's variable costs. The union will then set the wage such that the variable cost is just less than the price. Thus the firm will stay in business but all the rents earnt from capital go to the workers.

ii) Because this possibility is forseen by rational investors this vulnerability will ultimately act as a deterrent to investment and new capital formation.

These insights have been put into a more formalised setting by Baldwin (1983), Grout (1984), Van Der Ploeg (1985) and Manning (1987). All these models predict that where unions can expropriate the returns on capital the optimum level of investment cannot be reached, i.e. at any feasible outcome there will be levels of investment preferred by both firm and union. This problem arises because the union's optimal policy is time inconsistent. Before the investment is made it is in the union's interest to encourage a high level of capital accumulation by demanding only a low wage. After the equipment is installed and the costs are sunk the union has an incentive to re-optimize, to increase wages so as to capture the return on the capital, knowing that the firm will carry on producing so long as it covers variable costs. Therefore even if it is in the union's long term interests to stick to it's original contract this contract is not 'credible' because the firm knows that the union has an incentive to renege.

Credible wage contracts will be characterised by the union having no incentive to re-optimize after investment takes place. The contracts are therefore self-enforcing. In Baldwin's model a credible outcome has the feature that the firm will maintain inefficient capacity. The firm and union both know that if the union reneges on it's contract and demands a high wage then the inefficient capacity will no longer cover costs and be closed down with the loss of employment. The degree of inefficient capacity needed will be so as to equate the marginal gain to the union of the higher wages with the marginal loss through the associated redundancy. Obviously enforcing wage contracts through operating inefficient capacity is sub-optimal.

There are several ways out of this dilemma:

i) Binding contracts. If unions could pre-commit themselves to a wage contract then a pareto superior point could be achieved. In the US labour contracts are usually legally enforcable, whereas in the UK, in general, they are not (The 1971 Industrial Relations Act made collective agreements legally binding unless otherwise specified in the agreement. Virtually all the agreements concluded under this act contained specific clauses stating that they were not to be legally binding). Binding contracts bring their own costs in the form of less flexibility.

ii) 'Reputational' equilibria. This model gives greater bargaining power to the union when capital is installed. The reason for this is that capital is irreversible. It cannot be quickly or costlessly removed from the industry[1]. The asymmetry of power is a result of the firm having a longer planning horizon than it's workforce. As the durability of the machines decreases and the planning horizon of the workforce increases the 'temptation' to cheat (the short term rent appropriation) becomes outweighed by the associated 'punishment' (the fact that the firm will no longer invest). In such situations 'reputational' equilibria could evolve. Here the gains to co-operation are within the unions planning horizon and so it will not renege on it's agreement.

Note that the ability of workers to capture the increased returns from investment is not restricted to a union-non union model. In the 'shirking' variant of efficiency wages (Shapiro and Stiglitz (1984) see 4.2.1), there is the same result. As the plant become more capital intensive the costs to the firm of inefficient operatives will increase. The firm will then pay a higher relative wage to it's workers to maximise it's profit function. If firms pay higher wages for this reason, or if they share rents for any other reason, this could attenuate any negative effect that unionisation has on investment.

6.2.2 Unions, work rules and investment

Firms and unions bargain over a variety of issues, not only pay but also manning ratios, demarcation lines and other 'custom and practice' issues which to some extent allow employees to control the way their work is directed and utilised. New capital investment will often require work to be organised differently and resistance to this change may be greater in unionised firms or plants. This could be modelled as adding to the adjustment costs involved with new investment (along the lines of Nickell and Denny (1989)). This might be a special problem in Britain because here workplace unions are often defined by the crafts that their members possess. New technology can often directly threaten the skills that provide the separate identity of the union and hence will be strongly resisted. Some of the most high profile disputes in British labour history have been associated with such resistance. In 1972, dockworkers resistance to containerization led to a dispute in which five shop stewards were imprisoned and the effectiveness of the 1971 Industrial Relations Act was severely tested. Another example was the introduction of new technology into the printing industry in the 1980s. The introduction of Computer typesetting meant that anyone who could operate a keyboard could send text directly to be printed without any need for a specialised print room. The skills threatened by this new technology belonged to members of the National Graphical Association. The strategy adopted to resist the introduction of this technology was firstly either flat refusal to allow it into the workplace or acceptance with the 'double key-stroking' proviso. This meant that all text meant for printing must ultimately be typed in by an NGA craftsman, thus retaining a notional skill gap. This resistance eventually led to 'blacking' work done by non-union shops and the mass picketing of such shops (as in the *News International* dispute). Less well publicised has been the NGA's agreements with the British Printing Industry Federation that accomodates the new technology but attempts to minimise the adjustment costs faced by the NGA's members.

In general the evidence suggests that these high profile disputes have had an effect on the popular perception of the trade union's behaviour with regard to the introduction of new technology but are untypical of industry as a whole. Daniel (1987) and Machin and Wadhwani (1989), both using data from WIRS, found that there was a positive relationship between unionisation and organisational change over the 1980s. Clearly we require more evidence with respect to this issue.

6.2.3 Some Empirical Evidence

In the last few years there have been a number of studies in this area, mostly on US data. Many of these are plagued by data difficulties and econometric problems and none could be referred to as 'definitive'. Connolly, Hirsch and Hirschey (1986) investigated the effect that unionisation had on investment in *intangible* capital (R&D, advertising etc..). They used a cross-sectional dataset of 367 US firms matched with *industry* level union density data. They found that R&D expenditure adds less to the market value of unionised firms than to equivelent non-union firms. They also found that unionised firms spent less on R&D and other intangible assets. This result ties in with the results of a survey of 315 US firms carried out by Hirsch and Link (1984). They found that 'innovative activity' was significantly less important for unionised firms than non-unionised. These results taken together would suggest that union firms have shorter planning horizons than their non union counterparts. Bronars and Deere (1986) used an unbalanced panel of 715 US companies over 1972-76 to estimate the effects of unionisation. Again their density variable is obtained by matching industry level data. They found that higher density led to lower investment in both tangible and intangible assets, and also to a lower capital labour ratio. A weakness of their approach was that they did not include any other industry controls. Hirsch (1988a) includes industry controls and also has firm level unionisation data for 315 companies. When he ran a cross sectional regression he found a significant negative effect of unionisation on investment but a positive effect on the capital labour ratio.

The British evidence is surveyed in Metcalf (1988a). We have already mentioned that Daniel (1987) and Machin and Wadhwani (1989) both using WIRS data found that unions had a positive effect on organisational change over the eighties. Daniel has argued from these results that unions stimulate investment. Some preliminary results from Denny and Nickell (1989), using industry level data matched to WIRS, seems to point the other way. They found that recognition had a negative effect on investment and density a positive effect. However, density can never become high enough to outweigh the initial recognition effect. Machin and Wadhwani (1989) also explicitly estimated some investment equations and argued that there was no evidence that unionisation had a negative effect on investment. As can be seen the evidence is far from conclusive and much more work needs to be done in this area.

6.2.4 A Model of Investment

We shall initially consider a rather standard setting where the firm chooses its capital stock to maximize net present value, i.e. the firm maximises

$$V_t = E_t \sum_{j=0}^{\infty} \Pi_{t+j}/(1+r)^j \qquad (6.1)$$

where

$$\Pi_t = p_t A_t(Un_t)\ F\ (K_t,\ N_t) - p_t\ G(I_t, K_t, Un_t) - W_t\ (K_t)\ N_t - p_t^I\ I_t \qquad (6.2)$$

$$K_t = (1-\delta)\ K_{t-1} + I_t \qquad (6.3)$$

i.e. Π_t denotes profits at time t, and is defined by (6.2), E_t denotes expectations formed on the basis of information known at time t, $F(K_t, N_t)$ is a constant returns production function, A_t represents technical progress and is, in general, a function of unionization, K_t is the capital stock, N_t is employment. $G(I_t, K_t, Un_t)$ is the adjustment cost function, where I_t is investment, and, once again, unions might have an effect. The wage is written as $W_t(K_t)$, to allow for the possibility that, as discussed in section 6.2.2 it rises with investment. Of course, $\partial W_t/\partial K_t$ may be a function of Un_t. Further, p_t^I denotes the price of investment goods, r is the discount rate, δ is the rate of depreciation, and (6.3) is just the standard capital accumulation constraint.

In postulating the above model of investment, we have made the assumption that investment is not the subject of a bargain between unions and firms - this does not seem grossly at odds with 'reality', in that Daniel and Millward (1989) found that, at most, 25 per cent of manufacturing establishments bargained over investment.

However, firms and workers may well bargain about wages and effort, where we assume that the latter affects A_t. We have deliberately not specified the details of the wage bargain, but it suffices for our purpose that this bargain occurs after the capital stock is chosen, and that the wage outcome might depend on union power (see Manning (1987) for a rigorous justification for the procedure followed here).

The maximisation problem may be written as

$$\text{Max } V_t = E_t \left[\frac{1}{1 + r_t} \left[(\Pi_t + V_{t+1}) + \lambda_t^k \, (I_t + (1-\delta)K_{t-1} - K_t) \right] \right] \tag{6.4}$$

Where λ_t^k is the lagrange multiplier on the constraint (6.3)

so, the first-order conditions are

$$E_t\left\{\frac{\partial \Pi_t}{\partial I_t} + \lambda_t{}^K\right\} = 0 \qquad (6.5)$$

$$E_t\left\{\frac{\partial \Pi_t}{\partial K_t} - \lambda_t{}^k + \frac{(1-\delta)}{(1+r)}\lambda_{t+1}{}^k\right\} = 0 \qquad (6.6)$$

There are several ways to proceed at this point. We follow Bond and Meghir (1989)and eliminate the unobservable $\lambda^k{}_t$. From (6.5) we can write:-

$$E_t\left\{\frac{\partial \Pi_t}{\partial I_t} - \left[\frac{1-\delta}{1+r_{t+1}}\right]\frac{\partial \Pi_{t+1}}{\partial I_{t+1}} + \lambda_t{}^K - \left[\frac{1-\delta}{1+r_{t+1}}\right]\lambda^k{}_{t+1}\right\} = 0$$

substitute this into 6.6 gives us,

$$-\frac{\partial \Pi_t}{\partial I_t} = E_t\left\{-\left[\frac{1-\delta}{1+r_{t+1}}\right]\frac{\partial \Pi_{t+1}}{\partial I_{t+1}} + \left[\frac{1-\delta}{1+r_{t+1}}\right]\frac{\partial \Pi_t}{\partial K_t}\right\} \qquad (6.7)$$

Now, (6.7) may be re-written as (assuming $r_{t+j}=r\forall j$),

$$-\frac{\partial \Pi_t}{\partial I_t} = \sum_{j=0}^{\infty}\left[\frac{1-\delta}{1+r}\right]^j E_t\left\{\frac{\partial \Pi_{t+j}}{\partial K_{t+j}}\right\} \qquad (6.8)$$

To get rid of the expectations term we assume that, in steady state, there is an optimal level of $\partial \Pi_{t+j}/\partial K_{t+j}$ (call it $(\partial \Pi_{t+j}/\partial K_{t+j})^*$) and that it grows at the rate g, we may then write

$$-\frac{\partial \Pi_t}{\partial I_t} = \left[\frac{\partial \Pi_t}{\partial K_t}\right]^*\left[\frac{1+r}{r+\delta-g}\right] \qquad (6.9)$$

If we now assume that the adjustment cost function is

$$G(I_t, K_t, Un_t) = \frac{b(U_{nt})}{2} \left[\frac{I_t}{K_t} - c\right]^2 K_t \tag{6.10}$$

and also assume that,

$$N_t \frac{\partial(W_t/P_t)}{\partial K_t} = \alpha_0 + \alpha_1 \, Un_t \tag{6.11}$$

(i.e. the degree to which ***real*** wages rise with capital per head may be a function of unionization). We also define ***net*** output as Y=AF(.)-G(.) and assume that the firm faces a demand curve $Y = P^{-\varepsilon}$, where ε is elasticity of demand. Then assuming that F has constant returns to scale and labour is hired up until it's profit maximising level, we obtain:-

$$\left[\frac{I_t}{K_t} - c\right] \left[\sigma - \frac{I_t}{K_t}\right]$$

$$= \frac{1}{b(Un_t)} \left[\frac{Y_t}{K_t} - \frac{W_t \, N_t}{P_t \, K_t(1 - 1/\varepsilon) A_t(Un_t)} - \frac{\sigma P_t^I}{P_t} - \frac{\alpha_0}{P_t} - \frac{\alpha_1 Un_t}{P_t}\right] \tag{6.12}$$

where $\sigma = \dfrac{r + \delta - g}{1 + r}$

By log-linearising this equation we obtain

$$\ln\left[\frac{I}{K}\right]_t = \text{const.} + \gamma_1 \ln\left[\frac{Y_t}{K_t}\right] - \gamma_2 \ln\left[\frac{W_t}{P_t}\right] - \gamma_3 \ln\left[\frac{Nt}{K_t}\right] - \gamma_4 \, \sigma$$

$$- \gamma_5 \ln Un_t + \gamma_6 \ln\left[\frac{P_t^I}{P_t}\right] + \gamma_7 \, A_t \tag{6.13}$$

where γ_5 is driven by the possibility that unionisation might raise the adjustment cost parameter, b, and the possible rent-seeking activity by the union ($\alpha_1 > 0$).

We should emphasise that all the determinants of γ_5 are, themselves, ambiguous. If there are "voice" effects, such that a unionised workforce is able to exhibit some control over it's work enviroment, this might make it more willing to accept change - so, b could be lower in a unionised setting. Similarly, efficiency wage considerations imply $\partial W_t/\partial K_t>0$, and there is therefore, no necessary presumption that $\alpha_1>0$. Further, the coefficient of Un in an equation like (6.13) would only capture some of the effects of unions on investment. In particular, unions can be expected to affect, at least, the wage and total factor productivity (A_t).

Equation (6.13), though, is just the appropriate investment equation in steady-state. If we return to equations (6.8a) and (6.8b), and, instead, assume that agents form expectations about the future variables that determine $\partial \Pi_{t+j}/\partial K_{t+j}$ by looking at current and lagged information on the same variables, we may replace (6.13) by its dynamic equivalent,

$$\gamma_0(L) \ln \left[\frac{I}{K}\right]_t = \text{const.}\ \gamma_1(L) \ln \left[\frac{Y_t}{K_t}\right] - \gamma_2(L) \ln \left[\frac{W_t}{P_t}\right] - \gamma_3(L) \ln \left[\frac{N_t}{K_t}\right] - \gamma_4 (r+\delta) + \gamma_5 \ln Un_t - \gamma_6(L) \ln \left[\frac{P_t{}^I}{P_t}\right] + \gamma_7 A_t \qquad (6.13a)$$

This equation forms the baseline for our empirical work. We shall, though, also discuss and report some experiments where we imposed Rational Expectations and attempted to estimate equation (6.7) directly.

Note, though, that in our discussion above we have not considered the possibility that union pressure on wages will lead firms to invest *more* heavily in order to reduce their reliance on expensive labour. This would emerge from our model had we considered a somewhat more general production function (see Denny and Nickell (1989) for further discussion). Fortunately, this does not affect the empirical specification that we estimate - it would merely manifest itself as a positive coefficient on the real wage.

6.3 Data, methodology and results

6.3.1 Data

The data set used was the same as that used in the last chapter. Slightly fewer observations are available for each firm because for the work reported below we require data on wages. Table 6.1 provides information on the number of firms available to us in each year. The variables used are (numbers refer to locations in the data appendix where full details of sources and methods etc. are provided):-

i) I : The total value of new fixed assets (variable 16).

ii) K : The capital stock (variable 4).

iii) Y : Total sales (variable 5), deflated by the wholesale price index (variable I1).

iv) W : Average remuneration per employee (variable 3).

v) N : Employment (variable 1).

vi) UN : Our firm specific measure of coverage (variable 12) is only available at one point in time. However coverage might not be the appropriate measure of union power in this context. We instead use data on industry level union density (variable I7) and assume that the power of the union within firm i will vary with the density in the specific industry. We are in effect assuming:-

i) Firm union power = f(firm union density,.....)

ii) Firm union density=(firm specific constant)

$$+ \gamma \text{ (industry union density)}$$
$$+ \text{ common time effects}$$
$$+ V_{it} \qquad\qquad V_{it} \sim N(0, \sigma^2)$$

i.e we are assuming that the measurement errors involved with proxying firm union density with it's associated industry density are subsumed in the fixed effect, the time dummies and noise. We have written union power above as a function of union density. However, in general it will be a function also of changes in the enviroment in which industrial relations are conducted. We have argued in the previous chapter that in the second part of our sample period, 1980-86, there was a marked change in the legislative background to industrial relations, compared to the period prior to 1980. We have already provided some detail as to the actual changes in the laws relating to industrial relations over the sample period (see section 5.3.2) so here we just re-iterate the conclusions that we drew from this discussion:-

i) The legislation enacted over the period 1975-78 tended to favour the growth of unions and encouraged the more widespread use of collective bargaining in wage determination. However, this was not particularly at odds with the trend in labour law over the previous seventy years.

ii) With the change in government in 1979 there was a marked 'change of climate' at Westminster. Virtually all legislation enacted since that date has been concerned to reduce the power of the unions through limiting their ability to wage effective industrial action, through discouragment of collective bargaining and recognition of unions and through controlling the internal organisation of trade unions. The justification for this series of actions was that unions acted as a hindrance to the workings of a free labour market.

Freeman and Pelleiter (1989) have attempted to assign a quantititative index to the extent to which labour law was favourable to unionism. The 1974-79 period saw this index increase from 15 to 20. By 1982 the changes in the law initiated by the Conservative government had reduced the index to 10.5. By 1986 the index had fallen to 9, it's lowest level since 1946. Although this is an interesting exercise and a confirmation of our qualitative conclusions, we do not adopt this approach. We allow firm specific unionisation to interact with the time dummies and this should pick up the effects of the legislative changes on investment.

The above discussion indicates that some care needs to be taken when interpreting our results. If we find that unionised firms invested more than non-unionised over the 1980-84 period then this could mean ***either*** that unionism, as such, boosts investment, ***or*** it could mean that the anti-union legislation of the '80s has led to the abandonment of the restrictive practices that caused low investment in the unionised sector. Unionised firms would than be 'catching up' over this period. Evidence for this hypothesis is discussed in Machin and Wadhwani (1989) and in the previous chapter.

One important point to note is that, because of the degree of unobservable heterogeneity we believe exists between the firms in our sample, we remove firm specific fixed effects before estimating. This controls for differences in managerial ability, accounting conventions used in calculating the capital stock, product market power, process specific technical change etc. However this also means we cannot test for a union effect on the ***level*** of the investment-capital ratio, as is conventional in previous studies (see Hirsch 1988a and references therein). Instead we try to infer the sign of γ_5 by assessing what effect the ***change*** in Un (union power) has on the ***change*** in investment. We proxy changes in Un both by using industry specific union density and firm specific coverage interacted with time dummies. To explain the procedure we use somewhat more fully, we represent investment differences between union and non union firms as depending on

$$-\varphi_2\ (b_t^{UN}-b_t^{NU})\ -\ \varphi_3\ N_t\ \left[\left[\frac{\partial W_t}{\partial K_t}\right]^{UN}\ -\ \left[\frac{\partial W_t}{\partial K_t}\right]^{NU}\right] \qquad (6.14)$$

relative movements in b_t and $(\partial W_t/\partial K_t)$ will occur because of changes in union power both through changes in union density and in union legislation. Changes in density (proxied by changes in industry density) should provide an estimate of γ_5. The coefficients on the time dummies interacted with union coverage will be a mixture of φ_1 and φ_2 as well as actual movements over time in b_t and $(\partial W_t/\partial K_t)$ due to, say, changes in legislation. This distinction will be of some help in interpreting the results. If unions *do* effect investment then we would expect both the density and the time dummies to enter.

vii) In our simple model the relative price of investment, the real interest rate and the time trend do not vary across firms. Because these are not parameters of interest in the current model we simply omit them. We control for the ommission of all such 'aggregate' variables by including time dummies.

viii) A_t : We originally intended to obtain a series for technical progress from a production function. However it was realised that A_t obtained in this fashion would be a function of (Y/K) and (L/K), variables that are already included in the model. Thus the variable is already implicit in our model but we are unable to estimate an independent effect.

Table 6.2 contains some statistics on the particular sample that we use. Unionised firms, on average, have greater employment, investment and sales than non-union firms. Furthermore unionised firms are more capital intensive. On the other hand, firms with high union coverage have low I/K ratios as compared with low coverage firms. If we estimate a simple cross section of I/K on union coverage we find a significant negative effect. This result accords with much of the empirical work in this area. We feel though that this result could easily be caused by the ommision of fixed effects from the regression.

6.3.2 Estimation method

In our model we have assumed that there are firm specific fixed effects. This leads to a less efficient use of the data than the altenative of assuming random effects but we feel this is essential to control for the unobserved heterogeneity between firms. A standard technique for removing fixed effects is to use the within groups estimator. This, in effect, just involves transforming the equation such that each variable is replaced by it's deviation from it's firm specific mean. This method has two disadvantages.

i) Unless the regressors are strictly exogenous the within groups estimator will biased of the order 1/T (see Nickell (1981)). This is because in eliminating the fixed effects we have introduced a 1/T correlation between the explanatory variables and the transformed error term. Since in our case T=13 we cannot afford to ignore this bias.

ii) If explanatory variables are correlated with present and past shocks but not with future shocks then lags of these variables will be valid instruments. However, again as a result of using the within groups transformation, lags of these variables will now be correlated with the transformed error term so are no longer valid.

One way round this is to remove fixed effects by differencing and use lagged differences as instruments (the Anderson-Hsiao estimator). Although this is econometrically valid there is often a lot of noise in differences and good instruments are difficult to obtain.

Instead we use an alternative transformation proposed by Arellano (1988). This involves taking the deviation of each variable from the mean of all ***future*** realisations of this variable. i.e we replace x_t with $\bar{x}_t$ where $\bar{x}_t$ is given by:

$$\bar{x}_t = x_t - \sum_{j=0}^{T-t} x_{t+j}$$

This allows us to use pre-determined variables as instruments since they will not be correlated with future shocks. This will referred to as the ***orthogonal deviations*** transformation. The program we used was DPD written by Manolo Arellano and Stephen Bond. This has the additional feature of exploiting all the available moment restrictions in the data, i.e. for each successive time period further lags are available as valid instruments. DPD uses all available instruments in every time period. Furthermore residuals from the first stage are used to obtain a second stage GLS type estimator.

6.3.3 Results

Our estimates of equation (6.13a) are presented in column 1 of tables 6.3 and 6.4. Table 6.3 contains the one-step estimates and 6.4 the two-step GLS estimates. The long run coefficients on the explanatory variables are correctly signed and significant. A high output to capital ratio encourages investment whilst high real wages and a labour to capital ratio discourage it.

The coefficient on industry union density is positive and significant[2]. This would suggest that γ_5 is also positive. We re-iterate that this estimate must be treated with caution because of the measurement error involved with proxying the change in firm union density by using industry level density. Turning to the union time dummy interactions, ***none*** of these are negative and those for 1976 and 1977 are strongly positive. Hirsch (1988b) found that, using US data, there were large differences in performance between non-union and union companies but that ***given*** recognition, the extent of coverage within a company did not greatly effect investment. We estimated a variant of our preferred equation interacting time dummies with a union recognition dummy instead of coverage. The results were extremely similar and if anything re-enforce the positive effect of unionisation. Specifically the results were:-

Years	**Union Recognition**	**Union Coverage (from table 6.4)**
1976	0.80 (2.85)	0.73 (3.55)
1977	0.51 (5.64)	0.46 (4.83)
1978	0.20 (2.41)	0.02 (0.31)
1979	-0.005 (0.04)	0.42 (0.61)
1980-84	0.23 (3.13)	0.12 (1.94)

Following the discussion leading to equation (6.14) and the fact that we take orthogonal deviations, we suggest that the coefficients on the coverage-time dummy interactions reflect movements in:-

$$-\varphi_2 \overline{(b_t^{UN}-b_t^{NU})} - \varphi_3 N_t \overline{\left[\left[\frac{\partial W_t}{\partial K_t}\right]^{UN} - \left[\frac{\partial W_t}{\partial K_t}\right]^{NU}\right]} \qquad (6.14a)$$

(where $\bar{x}_t = x_t - \sum_{j=0}^{T-t} x_{t+j}$)

which are *not* associated with changes in union density but rather depend on aggregate effects on union power, e.g. the changes that occurred in the legislative background and the rise in unemployment. Can these coefficients on the time dummies be explained by the legislative changes? If, as we have argued, the legislation acted so as to strengthen unions in the 70s, and has gradually weakened unions in the 80s, we might expect $\overline{(b_t^{UN}-b_t^{NU})}$ to be high in the 70s, and gradually diminishing through the eighties. Therefore, $\overline{(b_t^{UN}-b_t^{NU})}$ would be positive in the seventies, and would be gradually falling towards zero from 1980 through until the end of the sample as the legislation becomes more effective. So, on this view, noting the inclusion of a constant term in the regression, $\overline{-\varphi_1(b_t^{UN}-b_t^{NU})}$ would show up in the coefficients on union-time-dummy interactions as negative effects in the 70s, and positive effects in the 80s. This simple pattern, though, is not found here. We find strong ***positive*** effects in 1976 and 1977 and a weaker positive effect over 1980-84. The absence of a negative effect over the seventies is consistent with the findings of the last chapter that the pro-union legislation of this period was not associated with a relative decline of productivity growth in unionised firms.

The positive effect in the 80s could be rationalised as in the last chapter. That is, the rise in unemployment led to a fall in $\overline{(b_t^{UN}-b_t^{NU})}$, as unions agreed to do away with restrictive practices. (There was, of course, no significant rise in unemployment during 1975-8.)

Our main result is then that there is ***no evidence*** in our data that unions deter investment through the capture of quasi-rents. If anything higher union density is associated with ***higher*** investment (we shall consider more direct evidence in this regard below). Also we do not believe that the change in the legislative background against unions led to improvements in the relative investment performance of unionised firms. This is because of the absence of negative union effects in the relatively pro-union seventies and the weakness of the positive effects in the eighties. We feel that on the basis of this evidence it is unlikely that the presence of unions in the workplace inhibits investment.

6.4 Some Further Explorations

6.4.1 Financial Considerations

Our estimating model is based on the assumption that managers maximise the expected present value of future cash flows. The stock market valuation of the firm does not impinge on our model in any way. This might be considered too restrictive in the light of the current popularity of 'q' theories of investment.

If, when we had the first order conditions (6.5) and (6.6), we had chosen to 'measure' $\lambda^k{}_t$ using stock market data then we would have had a 'q' model of investment. However, it seems likely that the stock market value fluctuates for reasons unconnected with future cash flows (as in the 'crash' of 1987) For this reason we have, so far, followed Bond and Meghir (1989) in substituting out this variable and expressing the model in terms of current observables.

That being said, there are several reasons why rational managers might still look at the stock market when planning investment, even if it was perceived to be inefficient.

i) If they ignore the share price when taking investment decisions they might be disciplined by their shareholders, e.g. through takeovers.

ii) If the share price is 'too high' then this will act as an incentive to invest because there is an opportunity to secure 'cheap' money (see Mullins and Wadhwani (1989) and especially the discussion by Fischer (1989)). This opportunity would be limited if managers cared about future shareholders.

In the absence of a well specified model of managerial behaviour when the stock market is perceived to be inefficient, we include the above considerations in our model by replacing (6.9) with:-

$$-\frac{\partial \pi_t}{\partial I_t} = \varphi \frac{\partial \pi_t / \partial K_t}{\sigma} + (1-\varphi)\, \lambda^{sk}{}_t \qquad (6.9a)$$

where $\lambda^{sk}{}_t$ will be measured using stock market data and as before

$\partial\pi_t/\partial K_t$ will reflect the underlying 'fundamentals'. If we assume F and G are linearly homogeneous then using the well known result of Hayashi (1982) we can approximate the theoretically correct concept of 'marginal q' ($\lambda^{sk}{}_t/P^I$) with the observable 'average q' (V/P^IK) where V is the market value of the firm .

In terms of estimation this simply leads to us adding Tobin's 'q' (variable 15) to the RHS of our investment equation. The resulting estimates are contained in column 2 of tables 6.3 and 6.4. Both q_t and Δq_t appear to boost investment *in addition* to the underlying variables included previously, though the latter become less significant. These results are therefore in line with the views of previous authors who have argued that 'q' is not a sufficient statistic for investment (see Hayashi and Inoue (1988) and references therein). The union density effect is driven out by the inclusion of 'q' but there is still no sign of a negative effect. The coefficients on the time dummy interactions are largely unchanged.

6.4.2 Rational Expectations

It is becoming increasingly common when specifying empirical models of investment, to assume the existence of rational expectations (RE). We chose not to follow this path when deciding on an empirical specification and assumed instead an adaptive expectations structure with unrestricted coefficients on lags. The reasoning for this was partly based on the fact that, in recent years, the assumption of RE has been questioned both on theoretical and empirical grounds (see Arrow (1982), Frydman and Phelps (1983) and Frankel and Froot (1986)). However it is clear we are ignoring much of the informational content of the model by not imposing RE. For this reason we attempted some experiments where RE was imposed. The estimating equation becomes (cf Bond and Meghir (1989)):-

$$\left[\frac{I}{K}\right]_t = \text{const.} + \delta_0 \left[\frac{I}{K}\right]_{t-1} + \delta_1 \left[\frac{I}{K}\right]^2_{t-1} + \delta_2 \left[\frac{Y_{t-1} - W_{t-1} L_{t-1}}{P_{t-1}\, K_{t-1}}\right]$$

$$+ \delta_3 \left[\frac{Y_{t-1}}{K_{t-1}}\right] - \delta_4\, Un_t + \ldots \qquad (6.15)$$

where prior theoretical considerations require that $\delta_0>1$, $\delta_1<-1$, $\delta_2<0$ and $\delta_3>0$. However, on estimating (15), we obtained,

$$\hat{\delta}_0 = \underset{(11.08)}{0.283}, \quad \hat{\delta}_1 = \underset{(-12.41)}{-0.602}, \quad \hat{\delta}_2 = \underset{(2.81)}{0.937}, \quad \hat{\delta}_3 = \underset{(-2.02)}{-0.609}$$

so δ_0 is significantly less than 1 and both δ_2 and δ_3 are of the wrong sign. These results are rather puzzling and we defer further investigation of this issue to future work.

6.5 Is There any Evidence for Additional Expropriation of Quasi-Rents in Unionised Firms

Unions might deter investment if firms anticipate that they will expropriate quasi-rents (i.e. $W_t'(K_t)>0$). The idea is that this quantity is positive for unionised firms and zero for non-union firms. However, apart from rent-seeking, there are other reasons why this should be non zero.

(i) As was noted above, $W_t'(K_t)>0$ is also possible in non union settings, e.g. in efficiency wage models (Shapiro and Stiglitz (1984)) or monopsony models (Nickell and Wadhwani (1989) etc.). Thus the issue might be whether the presence of unions enables the workforce to capture an ***extra*** share of the quasi-rents. This can only be decided empirically.

(ii) It is also possible that, in union settings, with appropriate technical assumptions, $W_t'(K_t)<0$. Lawrence and Lawrence (1985) argue that, if technology is putty-clay then the labour demand curve is more inelastic and a monopoly union will set a higher wage. Of course, were this valid, (and this is basically a declining industry story) then the presumption that unions induce underinvestment is reversed.

The evidence from the investment equations in the previous section suggests that union rent-seeking does not inhibit investment. In this section we briefly consider some direct evidence as to unions rent-seeking using wage equations. Specifically we estimate:

$$w = \mu_1 w_{-1} + \mu_2 (k-n) + \mu_3 \Delta n + \mu_4 Un + \mu_5 \bar{w}_a \qquad (6.16)$$

where w, k and n are logs of the firm's wage, capital stock and employment, U_n is union coverage and $\bar{w}_a$ is the outside wage. An equation like (6.16) can be derived from both union and non-union models of the labour market (cf. Nickell and Wadhwani (1989)). It is quite general in that it includes both internal ((k-n), Δn) and external ($\bar{w}_a$) factors in wage determination.

Most theories of wage determination will be special cases of (6.16). The hypothesis we are interested in is whether the the response of wages to changes in (k-n) is greater in union firms - as asserted by the union rent-seeking school. To test this we interact the coefficient on (k-n) with the union dummy when estimating the wage equation.

The results are presented in table 6.5. The equation has been estimated by both OLS and two-step general method of moments. In the instrumental variables specification all the variables are treated as endogenous. This is because the included transformed variables will be correlated with current and future shocks so they cannot act as their own instruments. These variables are instrumented by using their current levels. For some variables (those marked with an asterisk), we believe that the current level is correlated with the shock so these are instrumented using lagged levels. The estimates are largely consistent with prior expectations in that both inside and outside factors are relevant. For our purposes we find that the overall effect of the capital labour ratio is significantly lower in union firms. So the standard theoretical presumption that unions deter investment ***because*** wages rise more with the capital stock does not appear to be consistent with the evidence.

6.6 Conclusions

Our substantive conclusions are:

(1) There is no evidence that union rent-seeking behaviour inhibits investment. Specifically, increases in the union density rate have no effect on, or even *increase* investment. Also, contrary to the rent-seeking model, increases in the capital labour ratio do not have a larger effect on wages in union firms (in fact, we find the opposite effect).

(2) There is some evidence that union firms invested more over 1976-77 and 1980-84. We find it difficult to believe that this pattern could be explained by the changes in the union laws enacted over the 1980s. The fact that investment seems independent of the trade union legislation would also point to the conclusion that union rent-seeking was not inhibiting investment in the first place.

We do not claim that our dataset is perfect, a brief glance at table 6.1 will show the weaknesses in the sample. However we believe that the evidence presented here is certainly sufficient to question the prevailing wisdom that unions inhibit investment through the implied threat that they will capture the quasi-rents.

Footnotes

* We are again grateful to Steve Machin for the use of his questionaire. Helpful comments were received from Barry Hirsch, Stephen Bond and participants in seminars at the department of Employment and the LSE. Financial assistance from the Economic and Social Research Council and the Esmee Fairburn Trust is gratefully acknowledged.

1 If capital is, in fact, short lived but workers have to undergo long training periods in order to aquire the job-specific human capital they need then all of the arguments are reversed. This is discussed in Klein, Crawford and Alchian (1978), pp313-315. Workers are now vulnerable to expropriation of their human capital. Baldwin (1983) suggests that this situation might also lead to self-enforcing contracts but, unlike the case discussed in the text, these would not entail inefficient production.

2 Note that Hirsch (1988b) also failed to find a significant negative effect from *changes* in union coverage on changes in investment. He accords greater weight to the cross-sectional relationship between the levels of these variables.

Table 6.1

1. Sample Size for investment sample

We have an unbalanced panel:

Year	Union Coverage > 50%	Union Coverage < 50%
1973	74	15
1974	77	16
1975	77	16
1976	83	17
1977	87	19
1978	88	20
1979	88	21
1980	89	22
1981	90	22
1982	81	19
1983	34	13
1984	28	13
1985	24	12
1986	9	4

TABLE 6.2

Characteristics of Sample

Variable	Mean of "High" Union Firms	Mean of "Low" Union Firms
Investment	6.952	5.493
Employment	1858	709
Real Sales	6.609	5.204
Inv/Capital Stock	-2.73	-2.64
Cap. Stock/Employment	1.67	1.37

Notes: (i) All variables except employment, are in logarithms and refer to 1980.

(ii) "High" union implies union coverage ≥ 50 per cent.

(iii) The employment figures refer to the ***median*** firm (not the mean.

TABLE 6.3

Investment Equations

One step estimates

Independent variables	(1) Basic equation	(2) Equation Including 'Q'
$\ln(I/K)_{i,t-1}$	-0.219	-0.156
	(4.05)	(2.27)
$\ln(I/K)_{i/t-2}$	-0.169	-0.376
	(3.73)	(2.86)
$\ln(Y/K)_{it}{}^{*}$	0.09	1.45
	(0.13)	(1.64)
$\ln(Y/K)_{i,t-1}$	2.37	0.09
	(3.62)	(0.09)
$\ln(Y/K)_{i,t-2}$	0.45	0.58
	(2.44)	(2.67)
$\ln(W/P)_{i,t}{}^{*}$	-0.51	-1.72
	(0.66)	(1.53)
$\ln(W/P)_{i,t-1}$	-1.8	-0.51
	(3.02)	(0.68)
$\ln(N/K)_{i,t}{}^{*}$	-0.16	-0.55
	(1.27)	(0.64)
$\ln(N/K)_{i,t-1}$	-1.64	-0.03
	(2.41)	(0.04)
Union Effects		
$(\text{Industry Union})_{it}$	0.041	0.01
$* (\text{Firm Union Coverage})_{it}$	(2.25)	(0.01)
Time Dummy Interactions		
1976	0.75	0.17
	(2.08)	(0.63)
1977	0.52	0.44
	(2.6)	(1.88)
1978	0.09	0.13
	(0.45)	(0.56)
1979	0.08	0.48
	(0.44)	(2.50)
1980–1984	0.09	0.22
	(0.56)	(0.97)

cont.

TABLE 6.3 (cont.)

Independent variables	(1) Basic equation	(2) Equation Including 'Q'
1985	0.12	-0.01
	(0.47)	(0.03)
Q_t	-	1.06
		(3.89)
Q_{t-1}	-	-0.66
		(3.00)
Sample Period	1976-85	1976-85
No. of firms	106	106
No. of Observations	781	781
Sargan's test for Validity of Instruments	76.568 (63)	80.91 (62)

Notes: (i) t-ratios in parentheses.

(ii) All equations include time-dummies.

(iii) Variables marked * treated as endogenous in the sense that their current levels are not included in the instrument set. All variables are endogenous in the sense that the equation is estimated on transformed variables that are instrumented using their contemporary levels.

(iv) Additional instruments used are:-
All valid moment restrictions are from (Y/K) in column 1.
All valid moment restrictions from (Q_t) as well in column 3.

(v) All variables (except time dummies) are enclosed as orthogonal deviations.

TABLE 6.4

Investment Equations

Two step estimates

Independent variables	(1) Basic equation	(2) Equation Including 'Q'
$\ln(I/K)_{i,t-1}$	-0.258	-0.181
	(10.31)	(7.17)
$\ln(I/K)_{i/t-2}$	-0.156	-0.412
	(8.87)	(11.96)
$\ln(Y/K)_{it}^{*}$	0.264	1.34
	(1.17)	(4.16)
$\ln(Y/K)_{i,t-1}$	2.50	0.49
	(12.42)	(1.48)
$\ln(Y/K)_{i,t-2}$	0.47	0.56
	(6.54)	(7.01)
$\ln(W/P)_{i,t}^{*}$	-0.35	-1.17
	(1.11)	(2.28)
$\ln(W/P)_{i,t-1}$	-1.88	-0.72
	(9.03)	(2.38)
$\ln(N/K)_{i,t}^{*}$	-0.34	-0.33
	(1.23)	(1.05)
$\ln(N/K)_{i,t-1}$	-1.82	-0.36
	(8.61)	(1.08)
Union Effects		
$(\text{Industry Union})_{it}$	0.03	-0.00004
* $(\text{Firm Union Coverage})_{it}$	(4.27)	(0.01)
Time Dummy Interactions		
1976	0.73	0.20
	(3.55)	(1.36)
1977	0.46	0.42
	(4.83)	(4.16)
1978	0.02	0.002
	(0.31)	(0.03)
1979	0.42	0.40
	(0.61)	(4.05)
1980–1984	0.12	0.26
	(1.94)	(2.91)

cont.

TABLE 6.4 (cont.)

Independent variables	(1) Basic equation	(2) Equation Including 'Q'
1985	0.10	0.08
	(0.89)	(0.49)
Q_t	-	0.95
		(9.59)
Q_{t-1}	-	-0.61
		(11.63)
Sample Period	1976-85	1976-85
No. of firms	106	106
No. of Observations	781	781
Sargan's test for Validity of Instruments	76.568 (63)	80.91 (62)

Notes : see table 6.3

TABLE 6.5

Firm-Level Wage Equation
Dependent variable : ln w_{it}

Independent Variables	w_{it}	w_{it}
	OLS (levels)	IV (orth.dev.)
$(k-n)_{i,t-1}^*$	0.023	1.72
	(4.57)	(4.20)
Δn_{it}^*	-0.078	-0.42
	(3.08)	(2.95)
$\bar{w}_{jt}$	0.14	0.55
	(4.13)	(1.13)
Industry Union Density_{it}	0.04	-4.39
	(1.07)	(2.39)
$w_{i,t-1}^*$	0.94	1.43
	(82.0)	(4.46)
Union Interactions		
Union Coverage * $(k-n)_{i,t-1}^*$	-0.008	-1.61
	(1.54)	(3.28)
Union Coverage * Industry Union Density_{it}	-0.01	8.60
	(0.24)	(4.20)
Sample Period		1975-86
Number of Firms		123
Total No. of Observations		1013
Sargan's test for the Validity of Instruments		53.81
		(48)

Notes: (i) The equation includes time dummies and union coverage interacted with time dummies.

(ii) Column 2 is estimated using transformed variables. These are instrumented using their contemporary levels. In addition variables that are asterisked are treated as endogenous.
Additional instruments used are:-
$w_{i,t-2}$, $w_{i,t-3}$, all valid moment restrictions on n_i, starting with t-1, all valid moment restrictions on k_i, starting with t-2, and $(k-n)_{i,t-2}$, $(k-n)_{i,t-3}$ interacted with union coverage.

(iii) A wald test against including $(k-n)_{i,t}$ and $(k-n)_{i,t}$ interacted with union coverage in equation (2) gave a value 1.837 with 2 d.f.

Chapter 7: Summary and Conclusions

This thesis has been concerned with the empirical testing of several hypotheses about the behaviour of the labour market over the 1970s and 1980s. In particular we have been interested in isolating the determinants of labour productivity over this period.

To accurately measure labour productivity we need first to obtain an accurate measure of the capital stock. This was the objective of chapter two. This is interesting in itself because there has been a great deal of discussion on the 1970s having been a period of high 'economic' scrapping. Several authors have suggested the price rise in both energy and raw materials that occurred in 1973 might have rendered a proportion of the capital stock uneconomic to operate. Such equipment would be scrapped or retired before it reached the end of it's physical life. This would not be reflected in the official estimate of the capital stock, based, as it is, on fixed assumptions about the service lives of capital equipment. Our estimate of each firm's capital stock was calculated from information that the firms themselves provided in their accounts. The problem that this chapter was devoted to solving was how to convert the assets valued in the accounts at 'historic' cost into the economically more meaningful 'replacement' or 'current' cost. To do this required adjusting the 'historic' cost figure for inflation and this in turn required us to make some assumption about the average age of disposed of assets. The important aspect of our approach is that we were able to ***validate*** our assumptions because, for a sub-sample of firms and for three years, we had data on the firm's ***own*** valuation of it's assets at 'replacement' cost. We firstly presented these figures, without altering them at all, as direct evidence on economic scrapping in the 1980s. We found that, in our firms, the average capital stock fell by 2.37 per cent over 1981-82 compared with a fall in the official figure of 1.1 per cent. Hence the CSO's figure understated scrapping and overstated the level of the capital stock at the end of this period. However several other authors have also attempted to estimate the fall in the 'true' value of the capital stock over this period and have come up with much larger figures than ourselves (see table 2.1). Our results indicated that the CSO's overstatement is not as drastic as was previously thought.

The next step was to inflation adjust the historic cost figures. This required some assumption about the distribution of asset lives over disposed of assets. We had to adopt one of a number of reasonable assumptions, none of which were ***a priori*** superior. Therefore we attempted to converge on a preferred assumption by comparing the results obtained using each adjustment with the 'true' figures for current cost assets drawn from the accounts. By choosing the method that gave the closest 'fit' between ***changes*** in our adjusted series and ***changes*** in the true figure we have some check on the validity of our underlying assumptions. We arrived at an adjustment where assets are assumed to be disposed of after eight years. Using this adjustment we derived a replacement cost value for the capital stock based on the accounts of 333 firms from 1973 to 1982. This sample contains something like 26 per cent of total manufacturing employment in 1980. The results of this exercise are presented in table 2.3. We found that, from 1976 onwards, the CSO overestimated the growth rate in the capital stock and so cumulatively overestimated the UK's productive capacity. This overestimate varies considerably over the sample period (see table 2.4). We estimated that the capital stock grew by .83% over 1974-82 as opposed to the CSO's 13.3% growth. However once again our results are much less extreme than those of other authors in the sense that we found much less evidence for substantial unobserved scrapping.. We feel the strength of this approach was that we could ***test*** whether or not our underlying assumptions are valid. This is not done by any of the other authors we review in this chapter.

In chapter 3 we assessed whether the claims made for benefits of profit related pay had any empirical validity. At a microeconomic level profit sharing is said to lead to higher productivity partly through it's direct incentive effect and partly through inducing a sense of common purpose amongst workers and managers. We tested for this effect. At macroeconomic level Martin Weitzman has claimed that profit sharing can provide a cure for stagflation. It is difficult to test this claim directly since profit sharing schemes were rare in this country before 1978 and still far from widespread at the end of the sample period. Therefore we developed tests based on the condition necessary for Weitzman's claims to prove correct. This condition is that firms must regard the base wage (that part of the wage that is independent of profits) and ***not*** total remuneration as the relevant marginal cost of hiring extra labour. We showed that this had implications for the empirical implementation of employment and stock returns equations derived from standard theory. We also tested the effect that profit sharing had on wage setting. Proponents of profit sharing have argued that it could reduce wage pressure. Others have argued that the profit related bonus will be simply regarded as an 'add-on' payment and hence will prove inflationary. Our results, based on data drawn from both company accounts and from a special survey of profit sharing schemes, showed that the necessary condition for profit sharing to provide a cure for stagflation did not hold. Both the employment and stock returns equation indicate that UK firms do not behave in the way predicted by Weitzman. They regard the marginal cost of labour as being equal to the total remuneration of the marginal worker. Behaviour in the British labour market needs to change in this regard before profit sharing can 'work'.

The results of estimating the wage equation also indicated that profit sharing could be, of itself, inflationary. However there is some evidence that profit sharing leads to higher productivity. This result seems to make little sense in the context of the large firms of our sample. A share in the profits of the company would ***a priori*** seem to be a very indirect incentive for the average employee to redouble his efforts when compared to, say, a productivity bonus. The fact that our firms do obtain higher productivity from profit sharing points to there being returns to cooperation between workers and management. Gains have accrued because the work enviroment, the workplace 'culture', has been made more conducive to higher productivity.

We investigated further these sort of considerations in the next chapter where we implemented a direct empirical test of the efficiency wage hypothesis. Efficiency wage models predict that higher wages will lead to higher productivity. This is because more highly paid jobs attract better applicants, people do not quit such jobs so readily and incumbents of these jobs will be more highly motivated because they do not wish to be sacked. Thus, because firms are setting wages above the market rate in order to induce greater productivity from their workers, wages will not be bid down by high unemployment and involuntary unemployment will persist.

We attempted to estimate whether high internal wages ***relative*** to expected outside earnings led to higher productivity. Also we attempted to refine such a result so that we could discriminate between models in the 'efficiency wage' catagory and competitive models that also could explain such a positive wage-productivity relationship (e.g. unobserved human capital). We found a positive effort elasticity of 0.4 and a positive unemployment elasticity of 0.05. We believe these results are favourable to efficiency wage models. In such models high unemployment reduces outside opportunities and so increases the workers valuation of his current job. Such an effect is not often found in competitive models.

We went on to further claim that our results favoured the sociological variant of efficiency wages, e.g. the 'partial gift exchange' model of Akerlof. In this model workers reciprocate the 'gift' of fair or good treatment by the firm (i.e higher than necessary wages) by the 'gift' of higher than necessary effort. However the psychological theory of adaptation suggests that people will become accustomed to their relative position and, what yesterday was a high relative wage, today is regarded as the 'norm' and no reason for turning in higher than normal effort. Such a model predicts that only a ***change*** in the relative wage will boost productivity. We found some evidence that this was the case, that the effect of a wage premium decays by a factor of about .2 every year. We would find it hard to reconcile this result with a competitive model of why higher wages lead to higher productivity.

In the final two chapters we looked at the roles that unions play within firms. It has been common for quite some time for politicians and journalists to lay the blame for Britain's poor economic performance at the door of the unions. Only recently, however, have academics argued along the same lines. Our work was intended to examine the empirical evidence for the claims of Metcalf and others that unions adversely affected the economic performance of the firms in which they were recognised. This adverse performance is usually regarded as a result of unions defending restrictive work practices, resisting technical change and generally preventing the manager from allocating resources in a manner that he thinks fit.

We were also interested in the effect of the anti-union legislation of the 1980s. The Thatcher government, motivated by many of the same arguments that we have paraphrased in the last paragraph, have enacted a whole program of legislation that has progressively weakened the union's power to wage effective industrial action or to usefully represent their members interests. If it is true that, in the 1970s the path of union legislation led to greater union power and hence a higher incidence of restrictive practices, then union firms should have lower productivity growth than their non-union counterparts over this period. If it is also true that the anti-union legislation of the 1980s led to the abandonment of these restrictive practices then union firms should grow faster than non-union firms over the 1980s. The Conservatives contend that this has led to an 'industrial relations breakthrough' that has been a major cause of the 'productivity breakthrough' of the 1980s, the high recorded growth in labour productivity since 1981. We attempted to deal with both these issues.

For this study we extended our sample to 1986 and also incorporated the results of two special surveys of the union status of our firms. We then estimated a production function and allowed TFP growth to differ between union and non-union firms. Our results showed no significant difference in the growth rates of union and non-union firms over the 1975-78 period. From 1980 to 1984 union firms had significantly higher rates of TFP growth. For 1985 and 1986, again there was no significant effect of unionisation. Thus our results suggest a 'catch-up' effect for union firms over the early 1980s, indicating that unions did indeed abandon restrictive practices over this period. As to the cause: We feel this is more likely to be the shock caused by the deep recession of 1979-81 rather than the change in legislation. There are several reasons for this. Firstly the recession was so deep that it caused widespread unemployment among 'core' workers.

Previously these had been reasonably insulated from economic fluctuations. These workers realised that they had come very close to redundancy and cooperated, or at least did not resist, the necessary productivity enhancing changes introduced by managements. Secondly, there was no evidence of a negative effect of unionisation over the 1975-78 period. This period was characterised by pro-union legislation. Thirdly, the anti-union legislation of the eighties probably did not begin to 'bite' until at least 1983, and possibly was most constraining on union behaviour towards the latter end of the sample. Instead our union-productivity effect unwinds in 1985-86. This would indicate that union firms have now caught up and there are no more 'easy' productivity gains to be made.

Finally we looked at whether unions acted as a deterrent to investment. This would occur because capital, once installed, is largely irreversible and cannot be switched easily out of the industry. The firm will continue to operate as long as it covers variable costs. Labour faces no such constraints and a rational union can capture the quasi-rents on capital simply by setting a wage such that the firm only just covers it's variable costs. Rational investors, however, will foresee this possibility and refrain from investing in such firms. This is another channel in which unions can stunt the economic performance of the firms which recognise them. Furthermore union's resistance to technical change could act as a further deterrent to unionised firms undertaking investment projects by increasing the adjustment costs associated with such projects..

We estimated a standard investment equation. Unionisation enters this equation in two ways. Firstly we assessed whether union power directly effects investment. This is done by proxying for firm level union power by using industry level union density. We also investigated whether union firms and non-union firms differed in investment behaviour and whether this difference changed over the sample period as a result of the change in the legislation. We found no evidence that union power (union density) deters effects investment. We also found that the differences in the investment records of union and non-union firms do not seem to depend on the legislative background. That is, there is no significant evidence that union firms invested less than non-union firms in the seventies or that they invested more in the eighties.

We then went on to directly investigate whether unionised workforces are more able at capturing the quasi-rents from capital. We did this by estimating a standard wage equation where the capital labour ratio and the capital-labour ratio interacted with union status are explanatory variables. We found no evidence that unionised workers were any more succesful at expropriating quasi-rents than non-unionised workers.

The work reported in this thesis covers a variety of subjects. In all of the work reported we have attempted to devise tests that effectively discriminate between our null and alternative hypotheses. This was often a major problem. Many of the hypotheses that we tested provide few in the way of testable predictions. The efficiency wage model for example, proved very difficult to empirically distinguish from alternatives. We hope that we have done this in an effective fashion and shown that our results are robust and point to the conclusions that we draw.

We have relied throughout on published company accounts as our primary data source. This has constantly provided problems of consistency and interpretation. We feel that we have dealt with these problems in the most suitable way but that we have pointed out in the text where the use of accounting data has led to problems of inference. The most common problem was the use of 'sales' instead of value added output. We have attempted to control for discrepancies between the accounting variables and the underlying 'economic' variables in various ways but this will always weaken any inferences drawn.

One advantage that this work possesses is that it relies on panel data. This is superior to time series data in that it gives much larger amounts of data over critical time periods. It is also superior to cross sectional data in that it allows us to control for ommitted unobservable variables. Since this work was begun it has become much more simple computationally to analyse panel data sets (Largely due to the DPD program of Arellano and Bond) and the econometric analysis correspondingly becomes more robust in the later chapters.

The final conclusion of this thesis is then that such hypotheses as we have tried to analyse require a great deal of discriminatory power in order to acheive substantive results. Such discriminatory power is only likely to exist in panel data.

Data Appendix

Note: The main source for data is the EXSTAT data tape. The version used is the January 1988 release from the ESRC data archive at the University of Essex. DATASTREAM is used to supplement the EXSTAT information. DATASTREAM has information on variables that are not contained in EXSTAT and has data for the period 1983-86 that EXSTAT regards as not comparable with previous years.

Firm Specific Variables

1) EMP : Employment;
Exstat item C15 'Domestic Employees'
Datastream item 216 'UK employees'

2) REM : Remuneration
Exstat item C16 'Domestic Employees Remuneration'
Datastream item 214 'Remuneration UK'

3) AVW : Average Wage
calculated as log (REM)-LEMP

Note: Until June 1982 companies were required to disclose the number of UK employees and UK remuneration only. As from this date the requirement is for group totals only. For the period 1983-86 we have a considerable fall off in the availability of LEMP and REM. *Exstat* do not report these figures at all for these years and *Datastream* report figures only for those firms that do not have overseas subsidiaries.

4) CAPITAL STOCK : For the empirical work we calculated this series using two methods. Method 1 is only slightly different to that employed in chapter two. Method 2 is used for the (few) firms for which we do not have sufficient data to use method 1. It is adapted from Bundell, Bond, Devereux and Schianterelli (1987).

Method 1

The data for the capital stock is constructed using the identity

$$\frac{\text{current cost depreciation}}{\text{historical cost depreciation}} \equiv \frac{\text{gross capital stock at current cost}}{\text{gross capital stock at historic cost}} \quad \text{(A1)}$$

where,
current cost depreciation = CCAD
historic cost depreciation = DEP
(all definitions of the data used are included below)
gross capital stock at historic cost = GTAS calculated from *Exstat* data
gross capital stock at current cost = IGTAK is solved for using (A1)
GTAS is calculated from *Exstat* data using the formula

$$GTAS_t = NTA_t + ADPR_t + ADTA_t - GCCUR_t - GCRV_t \quad \text{(A2)}$$

NTA = net tangible assets
ADPR = accumulated depreciation on property
ADTA = accumulated depreciation on tangible assets
GCRV = gross cumulative revaluations
GCCUR = gross cumulative currency changes.
The latter two terms are subtracted because of the unsystematic way in which firms dealt with them.
GTAS can be calculated for all firms in the sample.
CCAD is available from 1979 onwards. However complete data on CCAD for all years 1979-82 is available for only a small number of firms.

The procedure, then, is to calculate IGTAK exactly for all firms and for all years in which CCAD is available and to use data on additions and disposals to estimate IGTAK for the remaining years.

When CCAD is not available, we use

$$IGTAA_t = IGTAA_{t-1} + IATAD_t + ADISP_t + \Delta ICPHR_t \qquad (A3)$$

where
ΔICPHR is the change in the value of leased assets
IATAD is additions (see below)
The basic disposals series is

$$ATDISP_t = DISPP_t + DISPA_t + SUBDP_t + SUBSDA + (TOTH_t | TOTH_t < 0) \qquad (A4)$$

DISPP = disposals in property
DISPA = disposals in tangible assets
SUBDP = disposals of subsidiaries: property
SUBSDA = disposals of subsidiaries: tangible assets
TOTH = total other movements in property or assets.
added to disposals only if negative.
Then

$$ADISP_t = ATDISP_t \times \frac{PIPM_{1972}}{PIPM_{t-8}} \qquad (A5)$$

I.e., the disposals figure for period t is deflated by the price index for period t-8 and multiplied by the price index for 1972. We calculate an alternative series on disposals, BDISP is calculated in exactly the same fashion using the price index for t-16. These time periods were chosen as the extreme points of possible length of life of capital equipment. This was done to see how sensitive the capital stock series and the regressions were to changes in this assumption.

The additions series is

$$IATAD_t = ADDA_t + ADDP_t + SUBSA_t + SUBSP_t + (TOTH_t | TOTH_t > 0) \qquad (A6)$$

ADDA = additions to tangible assets
ADDP = additions to property
SUBSA = acquisitions of subsidiaries: assets
SUBSP = acquisitions of subsidiaries: property
This is expressed in 1972 prices

The *Datastream* and *Exstat* items used in this calculation are:-
CCAD : *Datastream* item 221 'Current cost additional depreciation'
DEP : *Exstat* item C52, 'Depreciation and Amortisation'.
NTA : *Exstat* item C91, 'Total net tangible assets'. This excludes leased assets under construction.
ADPR : *Exstat* ITEM C85, 'Accumulated depreciation and amortisation on property'.
ADTA : *Exstat* item C89, 'Accumulated depreciation and amortisation on other tangible assets'.
GCCUR: 'Gross cumulative currency changes'. This is calculated from two other variables.
CURCHA: *Exstat* item CC16, 'Currency changes,other tangible assets'.
CURCHP: " " CC8, ' " " , property'.
GCCUR is these two items added together and cumulated over the sample period. So GCCUR in 1980 will be the sum of CURCHA and CURCHP over 1972 to 1980.
GCRV : 'Gross currency revaluations'. This is calculated in exactly the same way as GCCUR except that that it is the sum of:
RVTA : *Exstat* item CC15, 'Revaluations, other tangible assets'.
RVP : " item CC7 , ' " " , property '.
ICPHR: is the capitalised value of leased assets. We use
PHR : *Exstat* item C66, 'Plant hire'

$$ICPHR_t = PHR_t \times \left(\frac{PIPM(1972)}{PIPM(t)}\right) \times 20 \qquad (A7)$$

This capitalises plant hire assuming a 5% interest rate and puts the figure into 1972 prices
DISPP: *Exstat* item CC4, 'Disposals in property'.
DISPA: *Exstat* Item CC12, 'Disposals in other tangible assets'.
SUBDP: *Exstat* Item CC6, 'Property of subsidiary companies disposed of'.
SUBSDA: *Exstat* CC14, 'Assets of subsidiary companies disposed of'.
TOTH: 'Total other movements in assets', this is the sum of *Exstat* Item CC17 'other movements in tangible assets' and *Exstat* item CC9, 'other movements in property'.
ADDA: *Exstat* item CC11, 'additions, other tangible assets'.
ADDP: *Exstat* item CC3, 'additions, property'.
SUBSA: *Exstat* item CC13, 'new subsidiary companies other tangible assets'.
SUBSP: *Exstat* item CC5, 'new subsidiary companies, property'.

Method 2

This method is used for firms for which ***Exstat*** does not have the data to allow us to use method 1.

The data used is taken from ***Datastream*** and is
item number 328 Gross historic cost of plant and machinery (GFP)
" " 327 " " " " buildings (GFB)
" " 435 Total new fixed assets (NFA)
" " 136 Depreciation of fixed assets (DEP)

"   "   221 Additional depreciation (current cost) (CCAD)

PIB and PIPM are price indices used to revalue assets to current cost. PIB is used for buildings and PIPM for plant and machinery. The method uses changes in the gross fixed assets of plant and machinery to estimate what proportion of new investment is in plant and machinery. To do this we calculate a variable PMRT so that we have:

$$NFApm_t = NFA_t * PMRT_t \qquad (A8)$$

$NFApm_t$ is the proportion of new fixed assets in plant and machinery.

For the first time period $PMRT_t$ is calculated as:

$$PMRT_t = \frac{GFP_t}{GFP_t + GFB_t} \qquad (A9)$$

For the subsequent time periods if both ΔGFP_t and ΔGFB_t are positive then:

$$PMRT_t = \frac{\Delta GFP_t}{\Delta GFP_t + \Delta GFB_t} \qquad (A10)$$

if $\Delta GFP > 0$ and $\Delta GFB < 0$ then PMRT=1. If the opposite is true then PMRT=0. This loop was inserted to avoid PMRT taking implausible values. The next step is to obtain a benchmark measure of the capital stock to backcast or forecast from (This may not be very important because with a fixed effects model, the choice of an accurate benchmark will be largely irrelevant to the estimation of other coefficients. We calculated a variable KRT such that:

$$KRT_t = \frac{CCAD_t + DEP_t}{DEP_t} \qquad (A11)$$

which uses the fact that the ratio of current cost to historical cost assets is equal to the ratio of current cost to historic cost depreciation. To obtain the plant and machinery component of the above we use the same assumption as above i.e.

$$RKPM_t = CCAG_t * [GFP_t / (GFP_t + GFB_t)] \qquad (A12)$$

The replacement cost of capital in current prices is then forecast using

$$RKPM_t = [1 + IPPM_t] * RKPM_{t-1} * [1 - DEPP] + NFAP_t \qquad (A13)$$

or backcast using:

$$RKPM_t = [RKPM_{t+1} - NFAP_{t+1}] * [1 + DEPP] * [1 - DPPM_t] \qquad (A14)$$

(A14) is just the inverse of (A13) where NFAP is investment in Plant and Machinery, DEPP is depreciation (fixed at 8 per cent p.a. for P&M) IPPM is the increase in prices $IPPM_t = (PIPM_t - PIPM_{t-1})/PIPM_{t-1}$ and DPPM is the decrease in prices $DPPM_t = - \{(PIPM_{t+1} - PIPM_t)/PIPM_{t+1}\}$. A similar calculation is done for buildings using 2.5 per cent as the annual rate of depreciation. For firms for which we do not have data on DEP or CCAD a sample average of KRT_t is used. The series of the replacement value of buildings is called RKB. Once these series are calculated they are put into constant 1972 prices using the price indices PIPM and PIB respectively. The estimated replacement value of the capital stock for each company is then: $RK_t = RKPM_t + RKB_t$. We define a variable KDUM that is set to unity if the capital stock is calculated using our preferred method and zero if the method outlined above was used. This variable was included in several regressions to see if the method used was sensitive to the calculation of K. We found that the method used to compute the capital stock did not have a significant effect on our results.

5) OUTPUT : The series we used was 'Total Sales/Turnover' (*Exstat* item C31). To obtain the firms actual output would require information on changes in inventories and work in progress. However, the data on these latter variables proved impossible to obtain in any quantity. Whether or not this will systematically bias our results is be discussed in the text.

6) PROFIT SHARING BONUS: The variable form *Exstat* is C72 'Profit sharing schemes' . This is supplemented by the variable PROF from the LSE-Stock Market 'Employee Share Ownership Survey'. These variables represent the amount of money the firm transfers to the scheme in a given year. The variable PROF has to be multiplied by the firms after-tax profits in order to make it comparable with C72. This variable is also used to define PSDM, the profit sharing dummy, and the 'scheme-on', 'scheme-off' dummies.

7) DEBT-EQUITY RATIO: *Datastream* item 733 'Borrowing ratio'. Defined as:-

$$BR = \frac{\text{total loan capital + borrowings repayable within 1 year}}{\text{total equity capital and reserves + deferred tax - goodwill}} \qquad (A15)$$

8) MARKET VALUE: *Datastream* item HMV

9) INCOME GEARING : expressed as a percentage, defined as:

$$IG = \frac{\text{interest charge}}{\text{(Operating profit + total non-trading income + associates dividend)}} \times 100 \qquad (A16)$$

Datastream Item 734

10) CASH RATIO : defined as,

$$CASHR_t = \frac{\text{Total cash and equivalent}}{\text{Total current liabilities}} \qquad (A17)$$

Datastream item 743

11) REAL RETURN ON EQUITY : defined as,

$$RET = \frac{\dfrac{(V_{i,t+1} - V^N_{it})}{P_{t+1}} - \dfrac{V_{it}}{P_t}}{\dfrac{V_{it}}{P_t}} + \frac{\dfrac{D_{it}}{P_{i,t+1}}}{\dfrac{V_{it}}{P_t}} \qquad (A18)$$

Where:
V_{it} = Market capitalisation of equity at the end of the firm's financial year. (Market value see above).
V^N_{it} = Total value of rights issues between period t and period t+1. Calculated by adding RGSI - rights issues, ordinary capital, *Exstat* item CD10, and SHPS - share premiums, *Exstat* item CD21.
P_t = retail price index, see aggregate variables below.
D_{it} = is the tax-adjusted dividend paid by the firm and is given by,

$$D_t = \frac{\left[\dfrac{DDIV_t}{P_t}\right] \times (1-m_t) \times \theta_t}{(1-z_t) * (1+\Delta P_t)} \qquad (A19)$$

Where m_t is the average of marginal tax rates on dividend income, θ_t is the opportunity cost of retained earnings, z_t is the average of the *effective* tax rate on capital gains and $DDIV_t$ is *Datastream* item 434 'Ordinary and Preference dividends paid during the period' (cf. Nickell and Wadhwani (1987b)).

12 MUD : Percentage of manual workers covered by collective agreements. This is given by the answer to question 8 (a) in our questionaire and by question 5 in Steve Machin's. In our questionaire, as opposed to Machin's, we did not ask for an exact percentage of workers covered by collective agreements but rather asked firms to specify what range their coverage fell within; 0%, 1-10%, 10-25%, 25-40%, 40-60%, 60-75% and 75-100%. We then assigned to each firm the figure corresponding to the midpoint of the range they had indicated.

13 RUD : Are there any unions, as distinct from staff associations, recognised by management for negiotiating pay and conditions for manual workers? this will just be a 1,0 dummy. It is obtained from the answer to 3 (a) in our questionaire and question 6 in Machin's.

14 DCD : Decentralised bargaining dummy. This is set to zero if the firm indicates that pay is bargained nationally. This is question 10 in our questionaire. It is not contained in Machin's questionaire.

15 'Q' RATIO: Again we follow Blundell, Bond, Devereux and Schianterelli (1987). The 'Q' ratio is defined as:-

$$BQ_t = \left\{ \left[\frac{mv_t + lco_t}{(1-.08) \times nvk_t} \right] - 1 \right\} \times \frac{pipm_t}{wp_t} \qquad (A20)$$

Where:-
mv_t = market value (variable 8, above).
lco_t = 'total loan capital' *Datastream* item 321.
$pipm_t$ = price index for deflating plant and machinery. This is drawn from ***Price Indices for Current Cost Accounting*** HMSO.
nvk_t = capital stock in current prices. This is simply our constant price capital stock series put in nominal terms by using the pipm index.
wp_t = The 'wholesale' or 'producer' price index. See variable I1, below.

16 INVESTMENT : this variable is IATAD (above) for those firms for which this is available. For the remaining firms this is *Datastream* item 435, 'total new fixed assets'.

17 PIAT : Profits after Tax: *Exstat* item C43.

18 DR : Director's Remuneration : *Datastream* item 126.

Industry Specific Variables

The industrial classifications that our firms have are those allocated by the Stock Exchange and the Institute and Faculty of Actuaries. Because most industry data is available classified according to the Department of Trade and Industry's Standard Industrial Classification (SIC) we matched the *Exstat* classes to the SIC as follows:-

EXSTAT	SIC (1968) SIC (1980)
26 Manufactures of wire, rope and mesh 33 Steel manufactures, processors and stockholders	Metal Manufacture (Order VI) Metal Manufacturing Class 22
12 Brick and Roofing tile manufactures 15 Cement and Concrete 14 Building Materials	Bricks, Pottery, Glass Cement etc. (Order XVI) Manufacture of Non-Metallic Mineral Products Class 24
16 Paint, Dyes 67 Pharmaceutical products 68 General chemicals 37 Carpets, floor coverings 66 Plastic and Rubber fabrications	Chemicals and Allied industries (Order V) Chemical Industry class 25
20 Cold formed fastenings and farmed parts 21 Founders and Stampers 28 Machine and other tools 32 Metallurgy 34 Misc. Metal farming	Metal Goods not elsewhere specified (Order XII) Manufacture of Metal Goods not elsewhere specified Class 31

EXSTAT		SIC(1968) SIC(1980)
22	Industrial Plant, Engines and Compressors	
23	Mechanical Handling	Mechanical Engineering (Order VII)
24	Pumps and Valves	
25	Steel and Chemical Plant	Mechanical Engineering Class 32
27	Misc. Mechanical Engineering	
29	Misc. Engineering Contractors	
19	Electrical Goods exc. radio and TV	Electrical Engineering (Order IX)
36	Radio and TV	Electrical and Electronic
39	Household appliances	Engineering Class 34
41	Motor Components	Vehicles (Order XI)
43	Motor Vehicles	Manufacture of Motor Vehicles and Parts Thereof Class 35
31	Instruments	Instrument Engineering (Order XI) Instrument Engineering Class 37
49	Cereal Food	
50	Milling and Flour Confectionary	Food, drink and Tobacco (Order III)
46	Wines Spirits	Food, Drink and Tobacco
45	Breweries	Class 41/42
63	Tobacco and Cigarettes	

EXSTAT	SIC(1968) SIC(1980)
60 Cotton and Sythetic 61 Wool 62 Misc. Textiles n.e.s.	Textiles (order XIII) Textile Industry Class 43
59 Clothing 64 Footwear	Clothing and Footwear (Order XV) Footwear and Clothing Class 45
38 Furniture and Bedding	Timber, Furniture etc. (Order XVII) Timber & Wooden Furniture Class 46
52 Newspaper and Periodical Publishers 53 Publishing and Printing 54 Packaging and Paper	Paper, Printing and Publishing (Order XVIII) Paper & Paper Products, Printing & Publishing Class 47
65 Other Manufacturing	Other Manufacturing (Order XIX) Other Manufacturing Class 49

The above table shows how the *Exstat* classifications are matched to the SIC. The matches are not exact, the *Exstat* numbers do not correspond exactly to SIC groups and the 1968 SIC is not related to the 1980 SIC in a simple fashion. All published Industry-level data is available until 1982 on the 1968 SIC but thereafter it is only available dissaggregated according to the 1980 SIC. For the chapters where our sample stops in 1982 this was not a problem. For later chapters, where the sample extends until 1986 the data available on the new basis had to be spliced to the old. Fortunately, our 'industry' level is quite aggregated. Each of our industries corresponds quite closely to an 'order' in the 1968 classification, or a 'class' under the 1980 classification. Further disaggregation would have been pointless since our firms are usually multi-product. whilst it could be assumed that their range of outputs would lie within a certain 'order' or 'class', it is unlikely that all their products would lie within a 'minimum list' or 'activity' heading, the most dissaggregated level at which data is available. *Datastream* provide a percentage breakdown of 'sales by SIC group' for each firm and this was used as a check. We carried out this cross check for the 150 firms for which we had gathered the SIC information off *Datastream* The vast majority of firms are 100% within their order, i.e. they may be diversified out of their specific product group but, in general, they do not venture outside their industry. That being said, some firms have diversified into separate industries. The minimum proportion of a firm in the industry for which it is classified, is 60%. Even then the majority of this sort of diversification is between Metal Goods N.E.S and Mechanical Engineering, two industries that are fairly closely related. A problem with this validation exercise is that the sample period is 1972-82 or 1972-86, the 'sales by SIC' information was taken off *Datastream* in 1989. Thus the results of any such exercise must be regarded with caution.

<u>I1 WP</u> One variable for which it was required to go to the most dissaggregated level was the ***wholesale price***. We have no firm specific data on prices so we had to obtain as closely defined a series as possible from published sources.

The sample is divided into 43 different industrial classifications which are specific to *Exstat*. The *Exstat* classifications were matched with the nearest Minimum List Heading (MLH) or group of MLHs.

Published information was augmented by data purchased from the Business Statistics Office.

Producers Price indices were constructed for 25 of the 43 classifications (e.g., *Exstat* classifications 28 is Manufacturers of Machine and other Tools. This we constructed as a weighted average of the series for MLH 332 Metal Working Machine Tools, MLH 390 Engineers Small Tools and MLH 391 Hand Tools and Implements. The weights used were the relative Home Sales in 1980). For the 18 classifications for which we were unable to construct a series at MLH level the price index for the order was used instead. The data is published in ***Trade and Industry*** until 1979 and ***British Business*** from 1980. The weights are given in ***Wholesale Price Index: Principles and Procedures*** studies in official statistics No.32 CSO 1980. The data was updated to 1986 by Bertrand Kan.

I2 WG : Industry Wage, source: ***Department of Employment Gazette.*** Average weekly Earnings for Male, Manual workers on full time rates. Various indices spliced together. Normalised so that the average is 100 in 1980.

I3 PM : Price of materials and fuel purchased by manufacturing industry. These are drawn from the price indices used to put stocks of materials and fuel into current cost and are contained in ***Price Indices for Current Cost Accounting***.

I4 UR : Unemployment rate. Until 1982 this is available from the ***Department of Employment Gazette***. For 1983 to 1986 data was obtained from the ***Labour Force Survey***. The two series were spliced together. We thank Johnathan Wadsworth and the Department of Employment for help with obtaining this data.

I5 OH : Overtime hours. (from Muellbauer (1984)) given by:

$$OH_t = \frac{\text{Weekly overtime hours per operative on overtime}}{\text{normal hours}} \times \text{fraction of operatives on overtime}$$

All three series are available, by industry, from the ***Department of Employment Gazette***.

<u>I6 AH</u> : Average Hours, source : ***Department of Employment Gazette***

<u>I7 UDEN</u> : Industry Union Density, source:

<u>1972-79</u> From Bain, G.S., and Price, R., (1982), 'Union Growth in Britain: Retrospect and Prospect' in ***British Journal of Industrial Relations***. and ____________ and ____________, (1980), ***Profiles of Union Growth: A Comparative Statistical Portrait of Eight Countries***. Oxford, Blackwell.

<u>1980-86</u> We are grateful to Kevin Denny for providing data on industry specific density from the Workplace Industrial Relations Surveys of 1980 and 1984. For intervening years and for 1985-86 we interpolated using the change in aggregate density.

<u>I8 CONC</u> : Concentration ratio: Defined as percentge of total sales and work done by the 5 largest enterprises in each particular industry, Source ***Census of Production***, summary tables PA1002, table 13. As mentioned above, *Datastream* provides information on the percentage of each firm's sales lying within any SIC group. We then calculated the Concentration ratio facing each firm as a weighted average of the reported concentration ratios in each of the SIC groups where it had positive sales. The weights were given by the percentages in *Datastream*. There are several problems with this approach to measuring a firm's market power. For example we have no guarantee that our firm is within the top five in the industry, even if it is a large firm. A large firm could have small divisions in many industries. None of these might be in the top five in their particular industry. This might explain why our CONC variable does not work very well. A better measure of market power might be the ratio of our firm's sales in any group to the total sales for that group. This latter figure is also available in the *Census of Production*. We thank John Gruber and Jan Duesing for help in obtaining

this variable.

I9 INDQ : Index of industrial output, sectoral. Source: ***Monthly Digest of Statistics*** table 7.1. This data was originally collected for use in Pissaredes, C. and MacMaster, I., (1984), ***Sector Specific and Economy Wide Influences on Industrial Wages in Britain.*** London School of Economics, Centre for Labour Economics, Working Paper No. 572.

I10 NH : 'Normal' hours. Source : ***Department of Employment Gazette.***

Aggregate Variables

A1 BEN : Benefits, obtained from Layard, R. and Nickell, S., (1985), *Unemployment in Britain*.

A2 LNW : Aggregate wage, source: Layard, R. and Nickell, S., op.cit.

A3 UNEMPLOYMENT : Percentage of male manual workers seeking work.
source : ***Department of Employment Gazette***.

A4 MLR : Minimum lending rate, source: ***Economic Trends***

A5 LUM : Union Mark Up. Source : Layard, R. and Nickell, S. op.cit.

A6 RTP : Retail Price Index. source: ***Economic Trends***.

This is a copy of the quetionaire carried out by the CLE

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Q U E S T I O N N A I R E

INTRODUCTION

Please complete Section 1.

Section 2 is to be completed by those who answer YES to either Question 3(b) or Question 4(b).

SECTION 1: GENERAL INFORMATION

1. Person to contact Name ....

Position ....

Address ....

....

....

....

Telephone No. ....

2. How many people are employed by your firm (i.e. the enterprise) in the U.K. (approximately)?

Under 500	500-1,000	1,000-5,000
☐	☐	☐
5,000-10,000	**10,000-50,000**	**Over 50,000**
☐	☐	☐

3. (a) Are any of your manual workers (full-time or part-time) members of unions? YES/NO ☐☐

(b) Are there any unions that are recognised by management for negotiating pay and conditions for manual workers? (If pay and conditions are discussed only with staff associations or their equivalent - as distinct from trade unions - please answer NO to this question). YES/NO ☐☐

4. (a) Are any of your non-manual workers (full-time or part-time) members of unions? YES/NO ☐☐

(b) Are there any unions that are recognised by management for negotiating pay and conditions for non-manual workers? (If pay and conditions are discussed only with staff associations or their equivalent - as distinct from trade unions - please answer NO to this question). YES/NO ☐☐

5. (a) Do you regard your company's last pay award(s) as (please tick appropriate box)

Too high ☐ About right ☐ Too low ☐

(b) Do you regard the current level of pay awards generally in the economy as (please tick the appropriate box)

Too high ☐ About right ☐ Too low ☐

6. To what extent has the level of pay award(s) in your company been influenced by (please score each in importance on the scale 0-5)

	Not Applicable	Not Important	Less Important		More Important	
The need to match pay rates set in unionised firms	0	1	2	3	4	5

7. If you do not recognise any unions (i.e. you answered NO to Question 3(b)) was the decision on the pay of manual workers made

(a) By a Statutory Wages Council ☐

(b) By an employers association or national joint negotiating body ☐

(c) By management alone ☐

(d) By management after consultation with the employees ☐

If you answered NO to Question 3(b) and Question 4(b), please sign and return this questionnaire (space for your comments and signature is provided on the back page).

If you answered YES to Question 3(b) or Question 4(b), please complete Section 2.

SECTION 2

To be completed by firms who answered YES to either Question 3(b) or Question 4(b).

8. (a) What proportion of your manual workforce is covered by collective agreements with trade union(s)?

0%	0-10%	10-25%	25-40%	40-60%	60-75%	75-100%

(b) What proportion of your non-manual workforce is covered by collective agreements with trade union(s)?

0%	0-10%	10-25%	25-40%	40-60%	60-75%	75-100%

9. How many people are employed in the largest bargaining group which you recognise as a separate unit for purposes of negotiating pay and conditions (approximately)? ....

10. At which of the levels shown are there negotiations with this bargaining group which either form the basis for subsequent negotiations or directly result in pay increases for this group of workers?

National/industry-wide but more than one employer ☐

This employer but more than 1 establishment/plant ☐

At establishment/plant level ☐

OTHER (please specify)

11. With reference to your <u>most recent</u> pay settlement affecting this group of workers, which was the <u>most important</u> level of negotiations which affected this group of workers?

National/industry-wide but more than one employer ☐

This employer but more than 1 establishment/plant ☐

At establishment/plant level ☐

OTHER (please specify)

This is a copy of the questionaire carried out by Steve Machin

ENTERPRISE LEVEL INDUSTRIAL RELATIONS SURVEY

SECTION 1

BACKGROUND

1. How many establishments with 25 or more employees does this enterprise have in the U.K. ?

Number in 1985 ______ Number in 1987 ______

2. Have there been any changes in the major business activities of the enterprise since 1980?

Yes ______

No ______

If yes give details and state when changes occurred ______________________

____

SECTION 2

UNION RECOGNITION : MANUAL WORKERS

3. How many manual workers are there in total (full and part-time) within this enterprise?

Number in 1985 ______ Number in 1987 ______

4. What percentage (to the nearest 5%) of manual workers employed in the enterprise are members of a union?

______ percent of the manual workforce were union members in 1985.

______ percent of the manual workforce are union members in 1987.

5. What percentage of the manual workforce are paid wage rates which are set by collective bargaining between unions and management ?

______ percent in 1985. ______ percent in 1987.

6. Are any unions recognised for negotiating the pay and conditions of any of the manual workers at the establishments in the enterprise ?

In 1985 Yes ______ In 1987 Yes ______

No ______ No ______

If the answer is yes in question 6.

7. Are manual unions recognised for negotiation in ALL establishments in which there are manual workers or only in some ?

In 1985 All ______ In 1987 All ______

Some ______ Some ______

8. Is there a closed shop for any manual workers in any of the establishments of the enterprise?

In 1985 Yes ______ In 1987 Yes ______

No ______ No ______

If the answer to 8 is Yes

9. Is there a closed shop in for the majority of manual workers in ALL the establishments of the enterprise ?

In 1985 Yes ______ In 1987 Yes _____

No ______ No _____

SECTION 3

UNION RECOGNITION : NON-MANUAL WORKERS

10. How many non-manual workers are there in total (full and part-time) within this enterprise?

Number in 1985 ______ Number in 1987 ______

11. What percentage of non-manual workers (to the nearest 5%) employed in the enterprise are members of a union ?

______ percent of the non-manual workforce were union members in 1985.

______ percent of the non-manual workforce are union members in 1987.

12. What percentage of the non-manual workforce are paid wage rates which are set by collective bargaining between unions and management ?

______ percent in 1985. ______ percent in 1987.

13. Are any unions recognised for negotiating the pay and conditions of any of the non-manual workers at the establishments in the enterprise ?

In 1985 Yes ______ In 1987 Yes ______

No ______ No ______

If the answer to question 13 is yes.

14. Are non-manual unions recognised for negotiation in ALL establishments in which there are non-manual workers or only in some ?

In 1985 All ______ In 1987 All ______

Some ______ Some ______

15. Is there a closed shop for any non-manual workers in any of the establishments of the enterprise ?

In 1985 Yes ______ In 1987 Yes ______

No ______ No ______

If the answer to 15 is Yes

16. Is there a closed shop for the majority of non-manual workers in ALL the establishments of the enterprise ?

In 1985 Yes ______ In 1987 Yes ______

No ______ No ______

SECTION 4

ENTERPRISE UNIONISM

17. How many full time shop stewards are there in the establishments in this enterprise ?

Number in 1985 ______ Number in 1987 ______

18. Has there been any change since 1980 in the way in which the enterprise deals with unions for manual and/or non-manual workers ?

Yes ______

No ______

If Yes

19. In what areas have these changes occurred ?

(a)Union recognition Year of change ______

(b)Shop steward facilities Year of change ______

(c)Number of shop stewards Year of change ______

(d)Others areas (describe and state year of change)__________________________

____

20. Do meetings occur between stewards/union representatives from different establishments within this enterprise ?

In 1985 Yes ______ In 1987 Yes ______

No ______ No ______

Thank you for your cooperation.

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