

**UNEMPLOYMENT IN THE OECD: A MACROECONOMIC
STUDY**

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This thesis is my own original work

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PREFACE

The thesis has benefited much from members of my committee which consists of Trevor Breusch, Bob Gregory and Raja Junankar. Trevor Breusch has been very helpful with the econometrics and has always been able to solve my econometric problems. Bob Gregory was involved in the initial and especially in the final stage of my work. Initially, he helped me to lead my topic in the right direction and in the final stage of my thesis his was extremely helpful in editing and discussing the content of my thesis. Raja Junankar has continually read the chapters, given me very skillful comments and has been of great support. Finally, I would like to thank Steve Dovrick for helpful discussions of some of my work.

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CHAPTER 1

1 INTRODUCTION

The purpose of this thesis is to test different theories of unemployment and to shed light on factors that may have contributed to the rise in the unemployment over the past three decades in 22 OECD countries. The thesis also attempts to explain why unemployment experiences have been so different across OECD countries. Although the chapters are interrelated they are written so they can be read independently.

Chapter 2 surveys the literature of unemployment. In contrast to other surveys, this chapter evaluates theories of unemployment in relation to the paths of key macroeconomic aggregates over time and across countries. The chapter also discusses the empirical multicountry models of unemployment.

The survey concludes; 1) that the most popular theories of unemployment cannot adequately explain the paths of unemployment in OECD countries and; 2) the empirical models of unemployment shed only limited light on factors that may have been responsible for the rise in unemployment and why of unemployment differs across nations. The greatest

problem for most empirical models seems to be a passionate focus on wage push factors and the neglect of labour supply factors. Moreover, to the extent to which output growth has been subject to a factor using bias has not been addressed adequately. All these elements, to a varying degree, are addressed in this study.

Chapter 3 tests the real wage gap theory, which suggests that the rise in unemployment in OECD countries has been caused by cyclical demand factors and excessive wages. The excess wage component, in these studies is measured by the real wage gap which is defined as the proportion of the real wage in excess of the marginal productivity of labour at full employment. I Use data for 22 countries for manufacturing and private services and a measure the real wage gap under the Cobb-Douglas technology assumption and find that the real wage gap has contributed modestly to the unemployment path in most countries. Moreover, the real wage gap is not able to contribute to the explanation of cross-country differences in unemployment or to the increase in the unemployment in the 1980s.

Most studies have estimated the wage gap under the assumption that the aggregate production function is Cobb-Douglas and occasionally under the assumption that the aggregate production function is of the more general CES type. Since the wage gap is likely to be sensitive to the underlying technology assumption it is important to test

which technology is the best one. **Chapter 4** derives and estimates the real wage gap under the Cobb-Douglas, CES and translog technology assumptions for 22 OECD countries. The models are compared in terms of nested and diagnostic tests. From the point of view of measuring the real wage gap the translog production function is found to give the best results and the real wage gap path in the 1980s, in particular, is sensitive to the underlying technology assumption.

It is a common finding in empirical studies that the estimate of the best technology depends to a large extent in the way to which the technology parameters are identified. In chapter 4 the technology parameters are identified from direct estimates of the production function in conjunction with an income share function. In **chapter 5**, however, I identify the technology parameters in a different way and test for the best underlying technology assumptions from the viewpoint of the labour demand functions. Since the data requirement in the estimations of the labour demand are quite different from the data requirements when the real wage gap is from a production and share equation it follows that the best technology is not necessarily the same for the two different approaches.

Chapter 5 derives neoclassical labour demand models under different identifying and technology assumptions and estimates the labour demand models for manufacturing and

private services for 15 OECD countries, a smaller subset of my 22 countries because capital stock estimates or investment data are not available on a sectoral basis for all countries. Cobb-Douglas, CES, translog and constant relative elasticity of substitution (CRES) technologies are considered. The chapter demonstrates which technology and identifying assumptions are likely to give the best results, in terms of statistical information criteria and diagnostic tests. Unlike the results of chapter 4 which suggest that the translog technology assumption is best when a production and share function are estimated chapter 5 finds, from the viewpoint of estimating a labour demand function, that the CES profit maximization gives better results.

Chapter 6 discusses the model used by Layard and Nickell to account for the unemployment path in the UK. I suggest that the model is incomplete as a result of unrealistic underlying assumptions and cross-equation constraints. It is also suggested that the estimation method they employ is inadequate. An alternative approach that circumvents some of the problems encountered by the Layard-Nickell model is suggested. Dynamic simulations with the model suggest that wage stickiness, decline in manufacturing employment and low GDP growth have all contributed to the rise in the UK unemployment from 1967 to 1983.

New Keynesian theories of unemployment have become popular explanations of unemployment and have now entered most modern economic textbooks. According to these theories OECD unemployment has increased as a result of reduced real wage flexibility, where wage flexibility refers to the degree of real wage response to unemployment or cyclical movements in macroeconomic activity.

Chapter 7 tests New Keynesian theories of unemployment. A wage equation is employed to test whether unemployment has exerted a decreasing downward pressure on real wages over the past three decades and especially after 1974, when the rate of unemployment started to increase in all OECD countries. The chapter also examines whether real wages are most sticky in those countries with the highest unemployment. A high proportion of the tests reject the New Keynesian theories of unemployment.

In **chapter 8** a small model to shed light on factors that may have contributed to the unemployment path and cross-country differences in unemployment is established, estimated and simulated. The novel feature of this model, compared to most other time series models of unemployment, is that 1) labour supply is explicitly considered; 2) income changes are decomposed into changes in factor usage and changes in productivity and 3) factors that may have contributed to the different unemployment paths across countries are analysed. The simulations of the model

indicates that the slow-down in the rate of growth of real GDP since 1973 has contributed much to the rise in the unemployment. The decline in manufacturing employment has also been an important contributing factor. In contrast to most other findings, wage push factors have only modestly contributed to the rise in the unemployment.

To conclude it is hoped that this thesis has made the following contributions. First, that the rise in unemployment is a vary complex phenomenon and cannot be explained exhaustively by few factors. Second, excessive wages cannot contribute much to the explanation of unemployment over time and across countries. Third, I have shown how the real wage gap under different technologies can be derived and that the wage gap is sensitive to the underlying technology assumption. Fourth, labour demand under different identifying and technology assumptions are derived and estimated. Fifth, the popular model suggested by Layard and Nickell is demonstrated analytically and empirically to give results one cannot have confidence in. Sixth, that New Keynesian theories of unemployment do not contribute much to our understanding of unemployment.

Overall the thesis suggests that much research is needed to give us a better understanding of the factors that may have contributed to the rise in unemployment. In my opinion contemporary research focus too much on factors that affect

labour demand whereas macroeconomic factors that affect labour supply are much neglected.

CHAPTER 2

UNEMPLOYMENT: A CRITIQUE OF THE THEORETICAL AND EMPIRICAL LITERATURE

Abstract. Theories of unemployment are evaluated in relation to key macroeconomic variables they assume unemployment to be related to. The theories cannot adequately explain the path of unemployment in OECD countries. Most empirical models suggest that a too low GDP growth and a too high real wages have been responsible for the rise in the unemployment rates in the OECD countries since the mid 1970s. Although this may be true these empirical models have not yet solved the paradox that the warranted real wages have declined mostly, and GDP in the private sector increased mostly, in the countries with the largest rise in the rate of unemployment since the mid 1970s.

1 Introduction

The two past decades have witnessed a strong rise in the unemployment rate in most OECD countries. This has provoked a growing bulk of theories on unemployment based on microeconomic foundations; most of which follow either the "New Keynesian" or the "New Classical" paradigm. In the "Old Keynesian" approach, sticky money wages and/or low demand may prevent full employment and the New Keynesian theories of unemployment try to explain the sticky nature of wages. In the New Classical approach, unemployment is assumed to be voluntary and caused by information misperception or expectational errors.

Both the New Keynesian and New Classical theories of unemployment make the implicit assumption that unemployment exists as a result of wages that are too high. The existence of a close link between real wages and unemployment is, as a rule, taken for granted. Although there is empirical evidence in favour of a negative correlation between employment and real wages, in my view it has never been demonstrated convincingly that the rise in the unemployment rate in the OECD countries over the past decade and a half has been caused by excessive wages. Nor has it been demonstrated that the differences in unemployment across OECD countries can be explained by the excess wage hypothesis.

The purpose of this survey is fourfold. First, to relate unemployment in most OECD countries to the path of important macroeconomic aggregates. Second, briefly to present the most popular theories of unemployment in the New Keynesian and the New Classical frameworks. Third, to discuss the link between real wage and employment in a theoretical and an empirical context. Fourth, to analyse the empirical multi-country models of unemployment. The emphasis of the survey will be on the empirical related unemployment literature, as theories of unemployment are covered in other surveys.¹

The chapter is organised as follows. Section 2 presents the macroeconomic aggregates relating to unemployment for four OECD country groups which have followed the same unemployment path. Theories of unemployment are discussed in section 3 and the disequilibrium wage hypothesis is theoretically and empirically reviewed in section 4. Section 5 deals with empirical models of unemployment. Section 6 briefly discusses the implications of the findings.

1. See Lindbeck and Snower (1986a), Nickell (1990), Katz (1988), Gordon (1976, 1990), Mankiw (1990) and Stiglitz (1986) for rigorous surveys of unemployment theories.

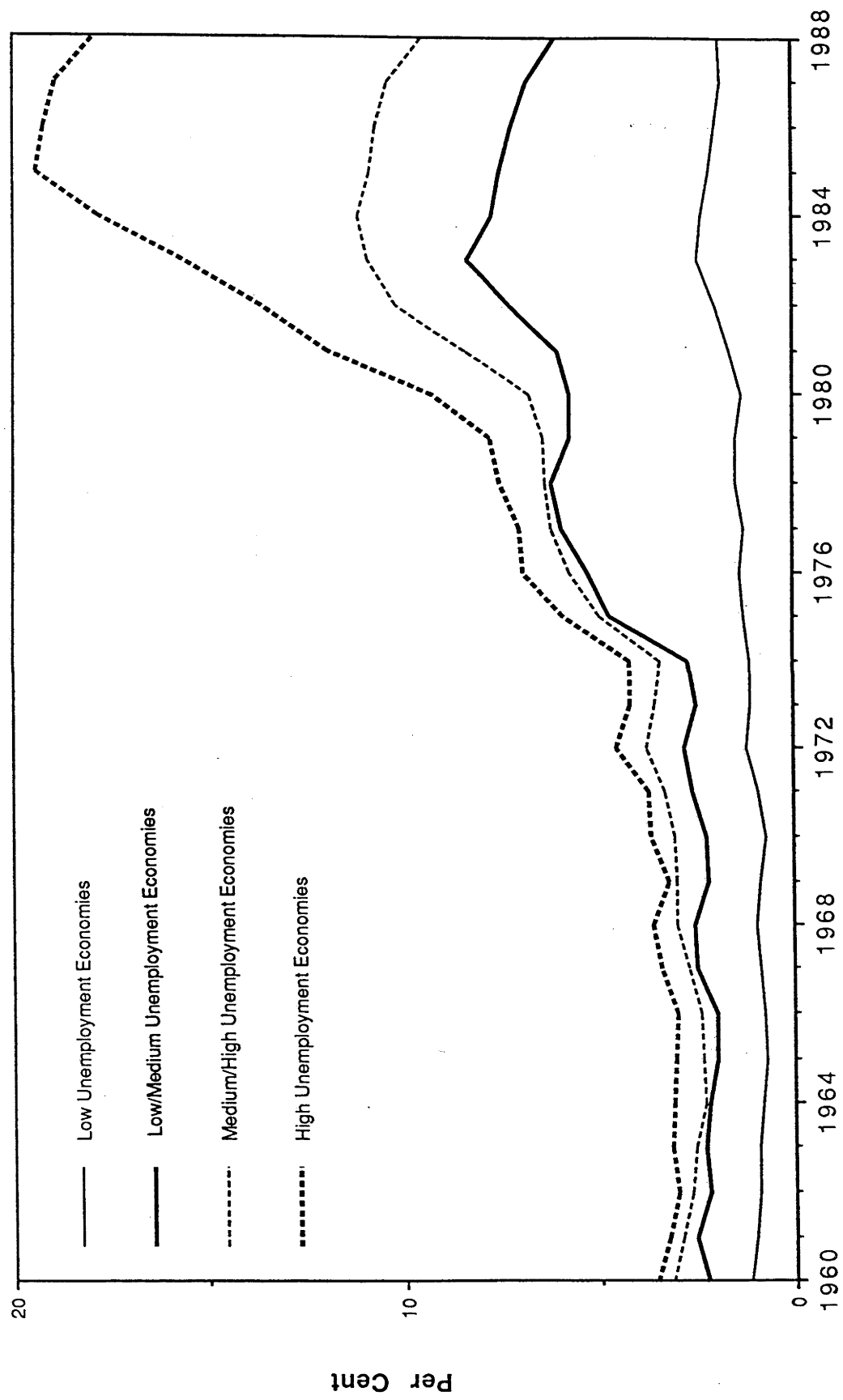
2 Labour Force, Employment and Unemployment and Their Relationship to Macroeconomic Variables

To get a clear picture of the different unemployment experiences, 19 OECD countries are divided into four groups according to the average unemployment rate over the period 1980 to 1988.² The low unemployment (L) group consists of Japan, Austria, Luxembourg, Norway, Sweden and Switzerland. The low/medium (LM) unemployment group is the US, Australia, Finland, Germany and Portugal. The medium/high (MH) unemployment group composes of Canada, Belgium, France, Italy, the Netherlands and the UK. The high (H) unemployment group encompasses Ireland and Spain. The arithmetic average is taken of all numbers that appear in the figures.

Figure 1 displays the unemployment rate from 1960 to 1988 with data from the OECD *Labour Force Statistics*. For the L group, the unemployment rate has increased slightly over the period. For the other three groups, unemployment increased to much the same extent over the 1973 to 1974 period but from 1978 to the mid 1980s the unemployment rates across these country groups moved apart from each other. In particular the H group experienced a strong rise in the unemployment rate over the period 1978-85. By 1988

2. My database consists of 22 OECD countries but the number of countries considered in the chapters vary according to the data requirement. This chapter consider 19 of the countries where the data is available from 1960 onwards.

Figure 1. Unemployment Rate



the L and the LM groups have managed almost to reach the unemployment rates existing before the 1980-82 recession. The MH and H groups have much higher unemployment rates in 1988 compared to their pre 1980-82 recession rates.

Figures 2 to 5 display the employment and labour force participation as a percentage of the population of working age (15 to 64 years of age). The figures suggest that both demand and supply of labour have been responsible for increased unemployment. In the low and the high unemployment countries, for instance, labour supply tends to mimic labour demand, whereas the supply and demand for labour in the LM and MH groups appear to move more independently. It is in this context that it appears striking that theories of unemployment usually consider either the demand side or the supply side of the labour market and not both.

Most New Keynesian theories of unemployment do not consider the factors that may affected the labour force participation rate. Supply of labour, however, plays a central role in most New Classical theories of unemployment, following the neoclassical paradigm. Assuming that the substitution effect outweighs the income effect in the labour supply decision neoclassical theories of labour supply predict labour supply to be a positive function of

Figure 2.
Employment and Participation Rate

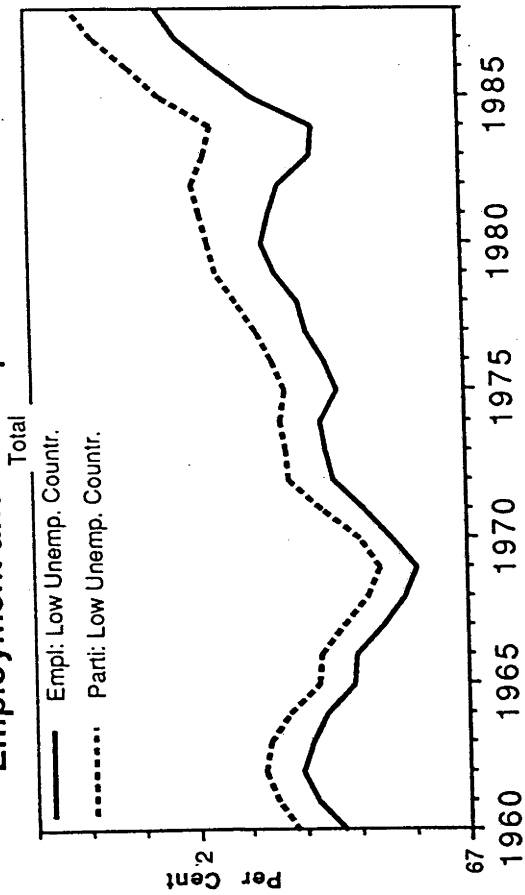


Figure 3.
Employment and Participation Rate

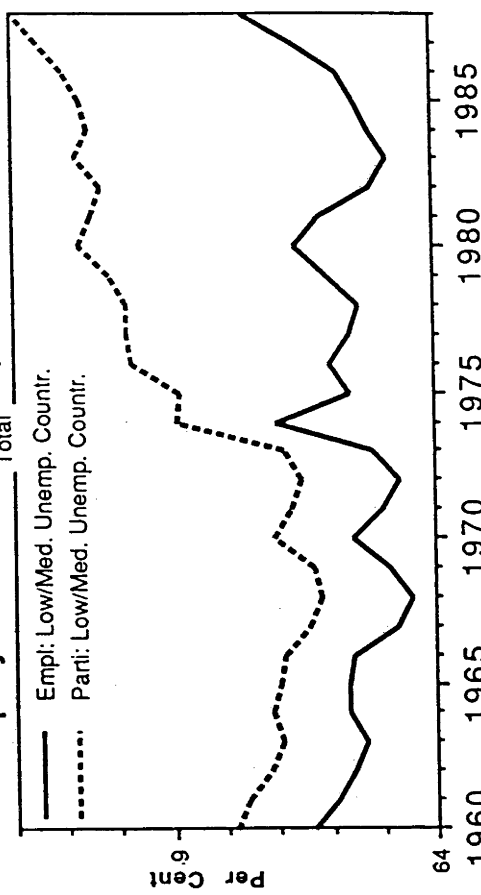


Figure 4.
Employment and Participation Rate

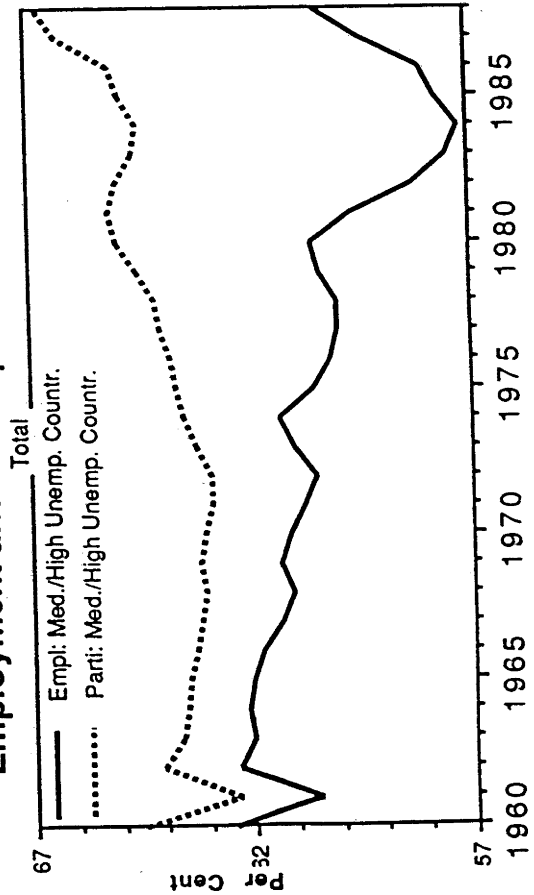
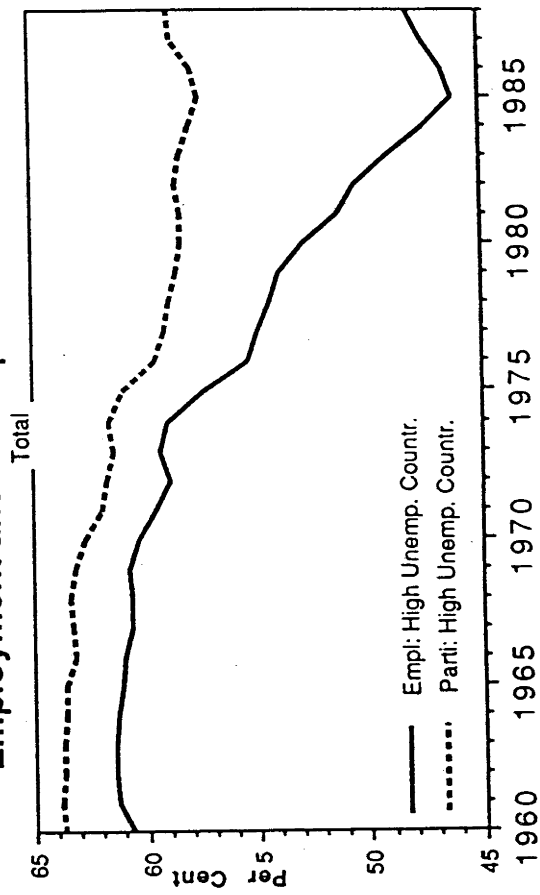


Figure 5.
Employment and Participation Rate



real after tax disposable income.³ Figure 6 displays the after tax real wage.⁴ From the onset of the first oil price shock, the participation rate has increased most in the LM countries that have experienced the slowest increase in the after tax real wage and declined in the H countries that have seen the strongest rise in the after tax real wage! These simple facts do not seem to support a simple model of labour supply that assumes that the substitution effect dominates the income effect.

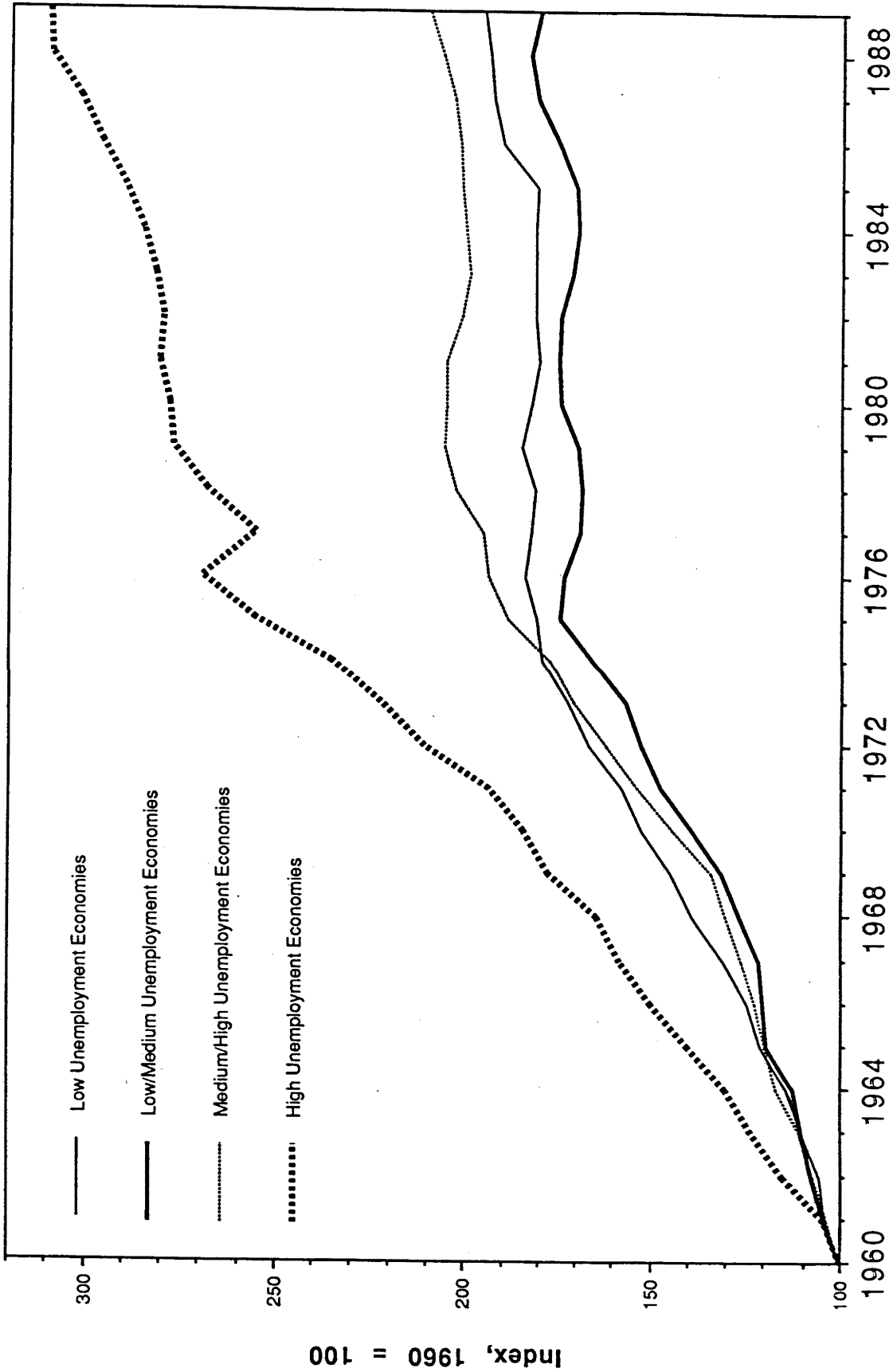
New Keynesian theories of unemployment assume unemployment exists as a result of excessive real wages. Comparison of the growth of real product wages across country groups is not without pitfalls since advances in labour productivity, factor ratios and factor augmenting technical progress dictate the warranted growth in the real product wage. Advances in labour productivity, for instance, have allowed a stronger warranted growth in real wages in Japan than in the US during past decades.

To allow for the contribution of differences in the rate of technical change and growth in capital stock across

3. Most cross-section studies find labour supply to be a positive function of (real) income or wages. See Keeley (1981), chapter 4, for a review on labour supply.

4. After tax real wage is calculated as $(1 - t)W/CPI$, where w is direct wages in services and manufacturing, CPI consumer prices and t the tax rate. t is calculated as General Government direct tax and other contributions receipts divided by GDP, from OECD's *National Accounts*, w is from ILO's *Year Book* and consumer prices IMF's *International Financial Statistics*.

Figure 6. After Tax Real Wage



countries the real wage gap, suggested by Sachs (1983) and Bruno and Sachs (1985), is used for comparative purposes. The real wage gap is defined as that part of the real wage in excess of the marginal productivity of labour at full employment. It provides a measure of the magnitude of the disequilibrium wage. Figure 7 and 8 display the real wage gap under the Cobb-Douglas and the translog technology assumption respectively.⁵ The average real wage gap is set to zero over the (full employment) period 1965-1969, and is measured as the excess wage as a per cent of the full employment wage.

All country groups experienced an explosion in the wage gap from the mid 1960s to the mid 1970s which may have been the triggering factor behind the unemployment rise in the wake of the first oil price shock. It is noteworthy that the wage gap rose *strongest* in the L and the LM groups up to 1976 even though they were subsequently to experience the *least* rise in the unemployment rate. Moreover, the real wage gap *declined* mostly in the H country group after 1976 although this group subsequently experienced the *strongest* rise in the unemployment rate. Finally, the unemployment rate *increased* after 1977 in all groups notwithstanding a *decline* in the real wage gap. This preliminary glance at the data suggests the real wage gap alone is not able to

5. The real wage gap under the Cobb-Douglas, the CES and translog technology assumptions are derived, estimated and compared in chapter 4.

Figure 7. Wage Gap Under Cobb-Douglas Technology

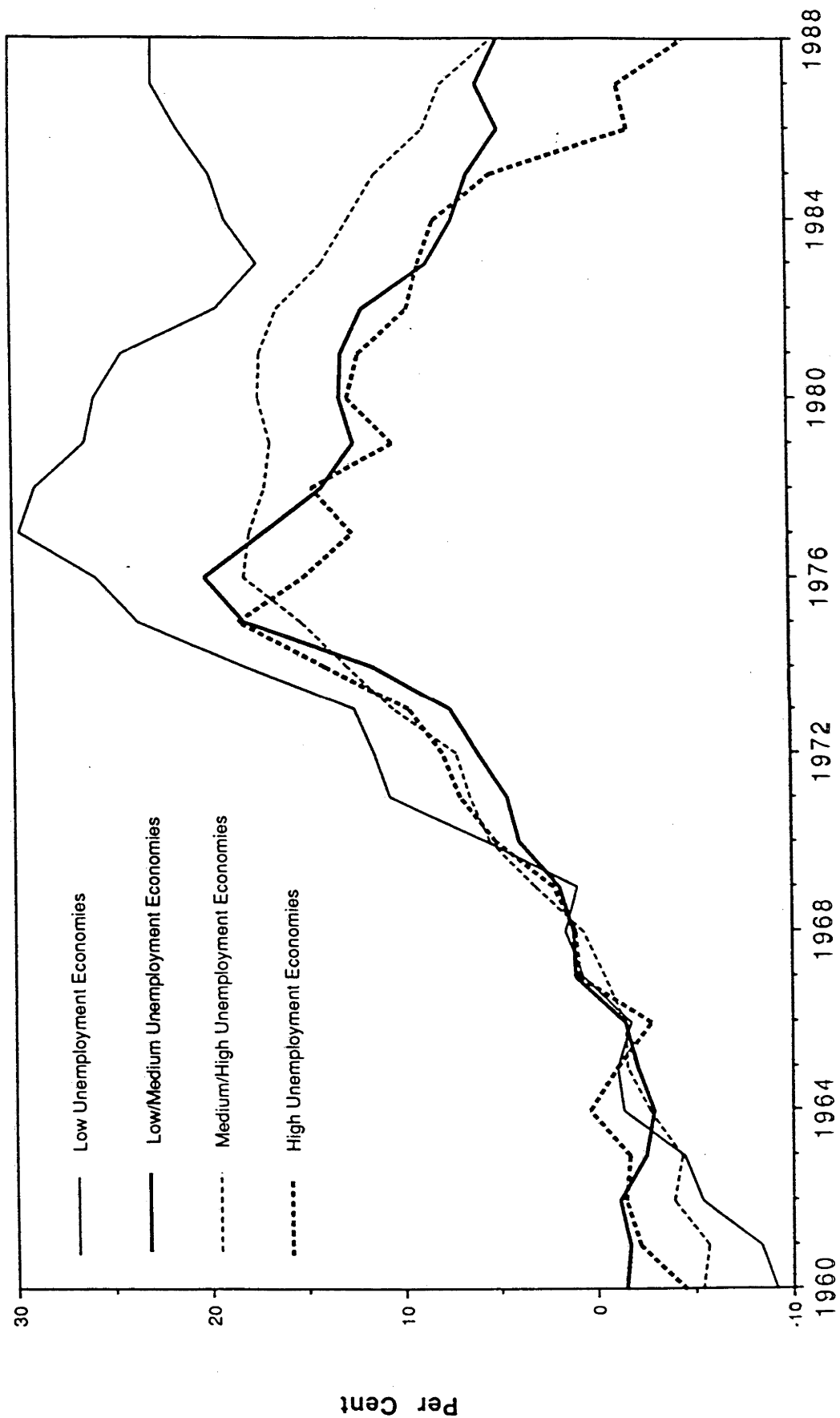
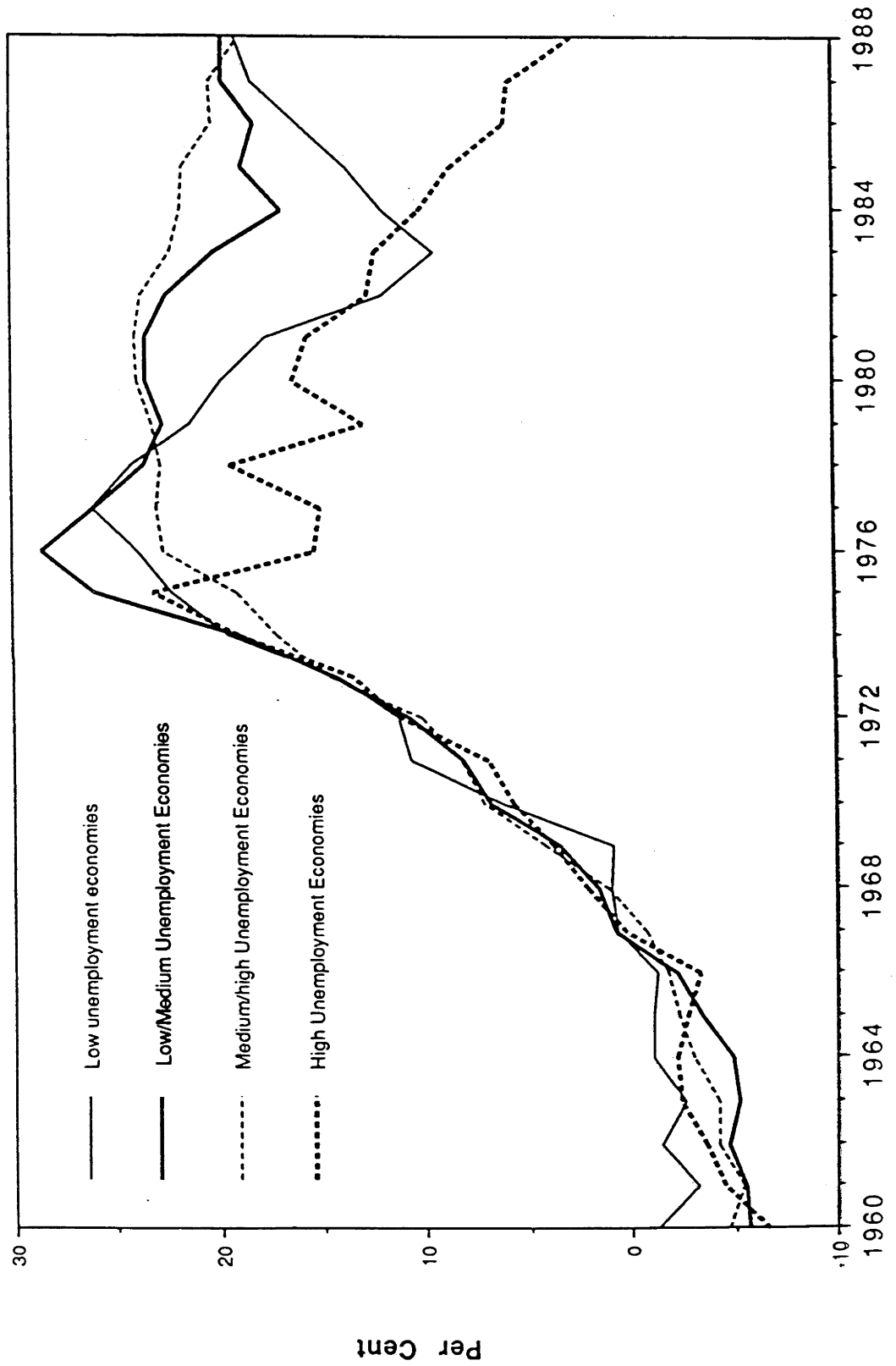


Figure 8. Wage Gap Under Translog Technology

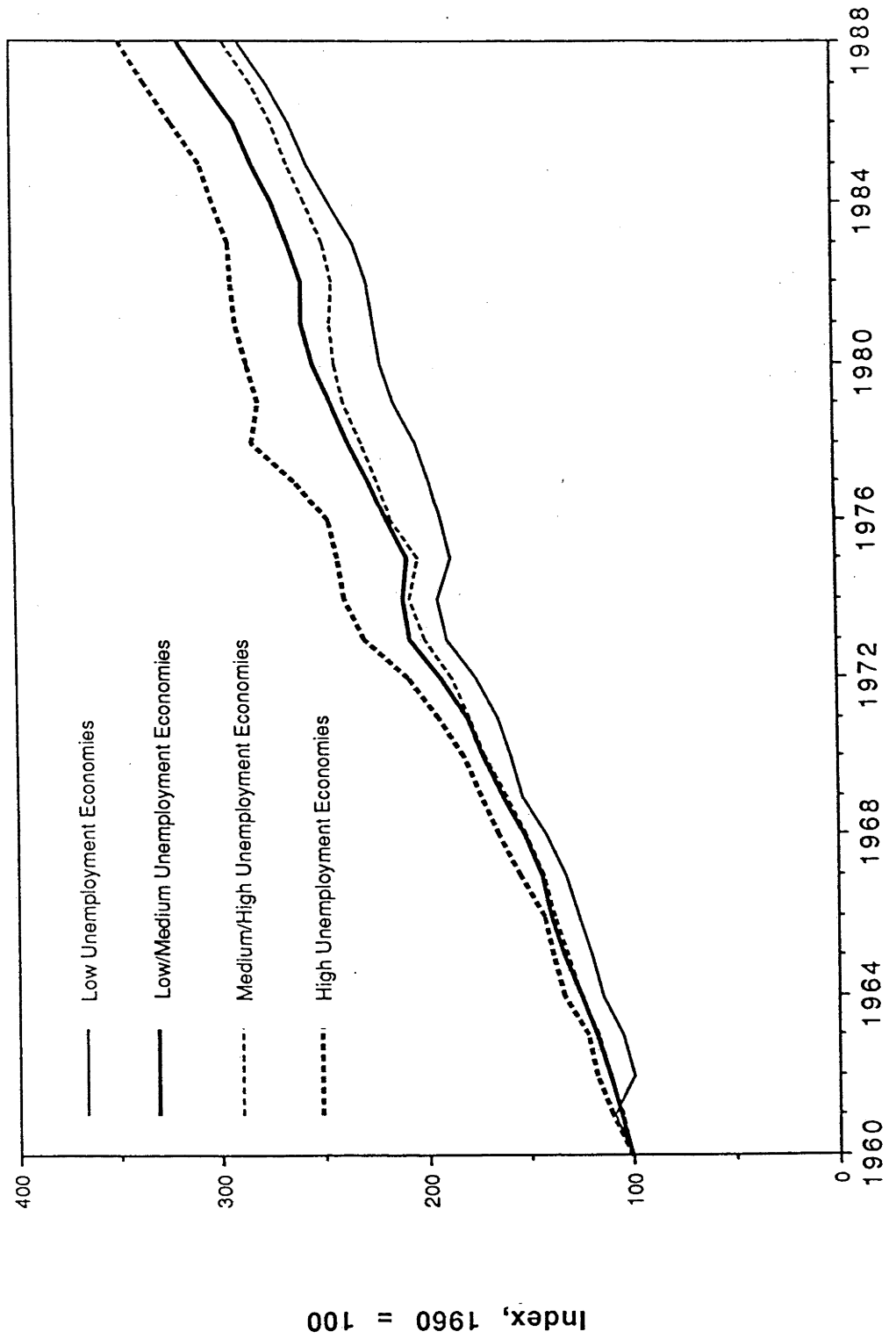


explain the different unemployment rates of the countries, or the different changes in unemployment through time.

According to the Old Keynesian theories of unemployment, the slow-down of GDP growth may have contributed to the increase in unemployment. Figure 9, however, shows that there is not a simple relationship between GDP growth and unemployment. Countries that have experienced the strongest GDP growth in private service and manufacturing also have faced the strongest rise in the unemployment rate over the period 1960-1988. The opposite holds true for the countries with the lowest increases in GDP. Additionally, the L group saw the greatest slow-down of GDP growth in the period 1973-1980 without experiencing higher unemployment, whereas the other country groups, over the same period, saw an approximate 4 per cent rise in the rate of unemployment. Note, however, that the impact GDP has on labour demand depends on the source of GDP change. Factor using increases in GDP and capital augmenting technological progress increase employment, whereas labour augmenting technological progress decreases employment via direct displacement of labour.

Finally, Glyn and Rowthorn (1988) have found that countries with the largest rise in the rate of unemployment have experienced the largest fall in manufacturing employment. The argument, discussed in more details later, is that blue collar workers displaced in manufacturing are not easily

Figure 9. GDP in Services and Manufacturing

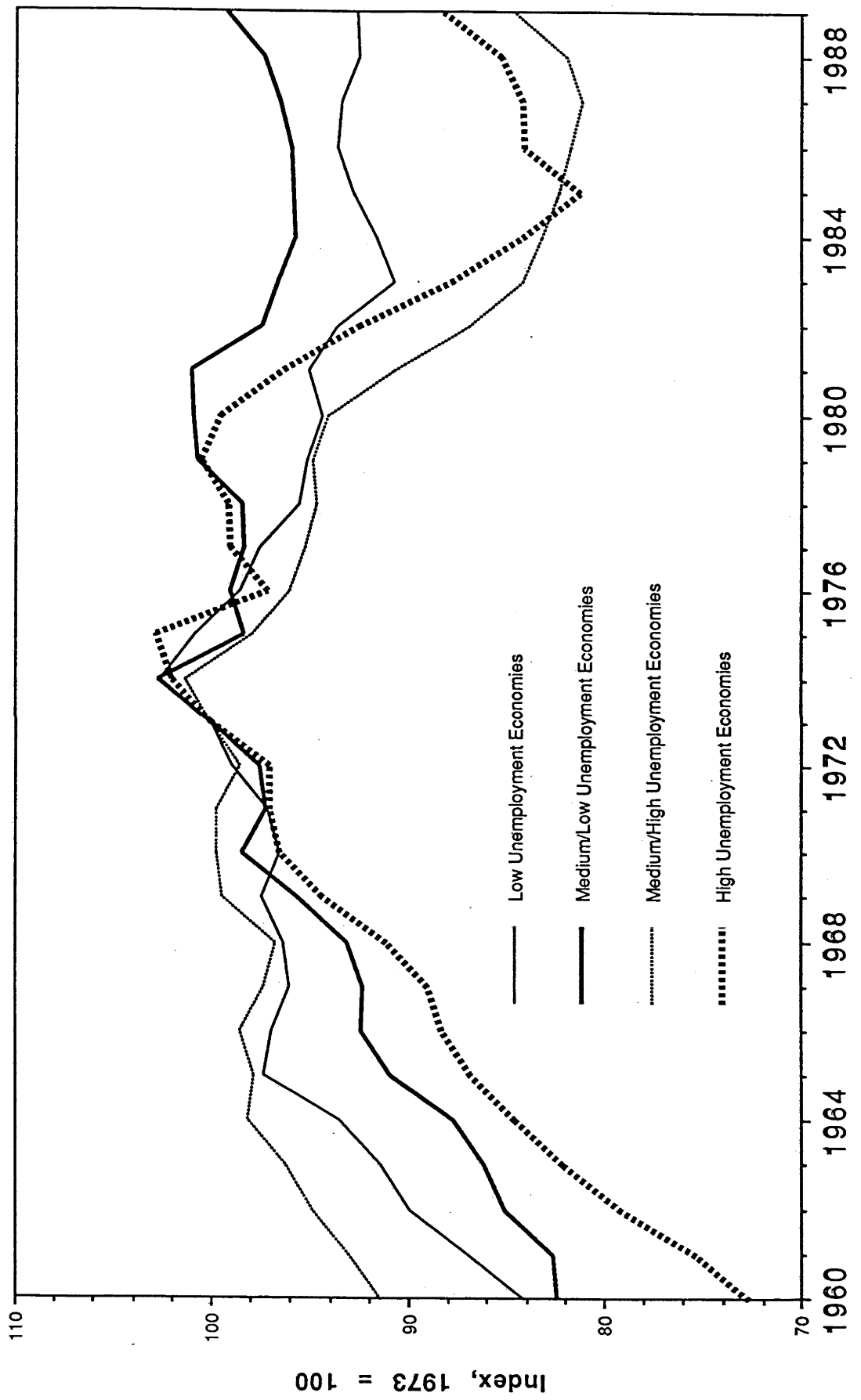


reemployed in the service sector. Figure 10 gives some support for this finding, especially after 1980. Comparing figures 1 and 10 suggests the relationship between decreases in manufacturing employment and increases in the rate of unemployment in the two country groups with the highest unemployment rate could be quite strong.

To summarize, the different unemployment rates for the OECD countries appear to be the result of a complex interaction between demand and supply of labour which makes it difficult to pin-point the causes of the unemployment differences across country groups. It is clear that an approach must be adapted that allows for a range of factors that have an impact on unemployment and that no single factor will be able to explain the unemployment data.

Concerning the supply of labour, the participation rate has increased most in countries that have experienced the slowest growth in the after tax real wage. This suggests that the link from increased real wages to increased labour supply to increased unemployment is incorrect. Concerning the demand for labour real wage gaps have declined least since the mid 1970s in countries that have experienced the largest increase in employment and smallest increase in unemployment. Furthermore, GDP in private services and manufacturing has not mostly increased in countries that have experienced the highest increase in employment. These findings suggest that the real wage gap and GDP growth are

Figure 10. Manufacturing Employment



not entirely able to explain cross country differences in unemployment rates. Finally, the decline in manufacturing employment since the mid 1970s may have contributed to the rise in unemployment, especially in countries with the highest rate of unemployment.

3 Theories of Unemployment

Before the late 1960s, theories of unemployment were dominated by Keynesian and Classical theories (Mankiw (1990)). According to Keynes, sticky money wages prevent real wage falls and hence the labour market from clearing when demand for labour is low. For the classical economists unemployment only occurs temporarily in unregulated and undistorted markets as a result of exogenous shocks in technology, tastes, trade and crop failures.

In regulated markets unemployment can exist because laws or tradeunions prevent wages from falling. The New Classical theories of unemployment assume labour to be on its notional labour supply scheme during unemployment periods, the New Keynesian theories assume that fluctuations in unemployment are associated with unemployed who want to work at the prevailing wage and therefore employment is not on the notional supply curve.

The role of money is another feature that distinguish the two frameworks. Money has no role in determine employment

and unemployment in the New Classical theories following the classical dichotomy. Real variables such as employment and output, are determined in the Walrasian system, whereas nominal variables, such as price level and wages, are determined in the money market (Mankiw (1989)). In the Keynesian model money demand and supply may affect employment and hence unemployment via changes in aggregate demand in the IS/LM framework and changes in the price level. If wages are not fully adjusted, or are slow to adjust, to a change in the price level changes in money demand or supply will affect employment via changes in real wages.

3.1 New Classical Theories of Unemployment

In the New Classical approach unemployment is a Pareto-efficient response of the labour market to changes in tastes and technology, and hence unemployment may be regarded as voluntary. Unemployment in these theories reduces to a rational reaction to changes in relative prices. An activist government which seeks to change unemployment distorts an otherwise equilibrating private sector and hence makes things worse. The most well known New Classical theories of unemployment are the following.

Imperfect Information. These models depart slightly from the Walrasian paradigm by assuming that the agent's expected consumer prices may deviate from realized consumer

prices (Friedman (1968)). An unexpected increase in prices, say due to an expansive monetary policy that is assumed to feed faster into price changes than wage changes, will lead firms to recruit more labour as the real product wage decreases. This will cause a temporary fall in the unemployment rate from its natural rate. In a slightly different version, suggested by Lucas (1972, 1973), producers are assumed to know the prices of their own products, but not the general price level. An unexpected increase in the price level hence leads to an output expansion since producers erroneously infer the relative price of the product they produce to be high. The higher output temporarily lowers the unemployment rate. Increases in the unemployment rate above the natural rate can result from the opposite effect.

These theories have been criticized on the ground that misperception of relative prices/real wages may not last over a prolonged period as in the 1930s and the past two decades (Gordon (1976); Mankiw (1990)). Moreover, monetary innovations in these models are assumed to have a temporary effect on employment. Nelson and Plosser (1982) have observed that most economic time-series appear to be non-stationary and do not follow a deterministic trend, implying that some fraction of innovations in output is permanent and alters the long-run trend in output.

Search theories. In the theories unemployment increases when workers refuse to take job offers. Unemployment will rise therefore when firms reduce wage offers relative to the acceptance wage, in periods of falling product demand (Alchian (1970); Mortensen (1970); Phelps (1970); Parsons (1973); Siven (1974)). Workers are by assumption able to search for new jobs only while being unemployed. Unemployment increases as a result of the misperception of workers of the wage distribution relative to the expected price level. Workers believe that the distribution of wage offers are more advantageous to them than is actually the case. Unemployment thus depends entirely on misinformation. In these models anything that influences the cost of job search affects unemployment. Government unemployment benefits, for instance, tend to stretch the length of unemployment spells and create unemployment because they subsidise the search process.

It is, of course, doubtful that the high and persistent unemployment in the 1930s and the past two decades are entirely due to the persistence of misinformation. The theory also cannot explain the fact that lay-offs increase and quits decrease during recessions.

Sectoral shifts. This theory is formally advanced in the paper by Lucas and Prescott (1974), but first became popular in the US in the 1980s due to papers by Lilien (1982) and Black (1987). According to this theory,

unemployment is initiated by stochastic shocks, which imply increased wage differentials between sectors via the labour demand schedule. The increased wage differentials lead workers to move from low-wage to high-wage sectors. Since, by assumption, active employment search is only possible while unemployed, the shock will lead to a rise in the unemployment.

The empirical evidence does not seem to support this theory. First, the movement of workers from one job to another is procyclical in contrast to the theory predictions (Murphy and Topel (1987)). Second, the theory implies a positive correlation between unemployment and vacancies which is not observed, that is, labour demand increases in some sectors and decreases in others at the same time. In the medium-term, however, a significant shift outward has been observed in the unemployment-vacancy (UV) schedule since 1975 which suggests that a larger fraction of unemployment may be due to structural factors but the outward shift is not a general phenomenon.

Real business cycles. According to this theory exogenous stochastic fluctuations in the rate of technological change lead to fluctuations in relative prices (Kydland and Prescott (1982); Long and Plosser (1983); Barro and King (1984); Prescott (1986)). Fluctuations in relative prices, in turn, lead rational individuals to alter their consumption and labour supply. If the price of leisure

increases (wage) relative to the price of goods, workers rationally reduce their labour supply and this affects unemployment.

Business cycle theories of unemployment have been subject to a large body of criticism. Since the rate of unemployment fluctuates markedly the theory implies large changes in technology. Summers (1986) and Mankiw (1989) argue that large changes in technology, and especially technological regress, are unlikely to occur. Stadler (1990) argues that most technological innovations are dependent on economic factors and therefore endogenous, rather than exogenous as suggested by business cycle theories. Empirical support of business cycle theories is also lacking. Stockman (1988) finds that most macroeconomic fluctuations cannot be ascribed to technological shocks alone. If the business cycle is primarily due to supply shocks, business cycle theories predict the marginal costs will move counter-cyclically. Bils (1987) finds evidence for the opposite.

3.2 New Keynesian Theories of Unemployment

Up to the 1970s conventional Keynesian macroeconomic analysis was mainly interpreted in the Hicksian IS/LM framework, without any attempt to construct the theory within an explicit disequilibrium context (Mankiw (1990)). In the seminal paper by Barro and Grossman (1971), which

built on the foundations laid down by Clower (1965) and Patinkin (1965), the Keynesian paradigm is interpreted in a general disequilibrium context where unemployment can arise either as a result of excessive wages and/or insufficient demand. The Barro-Grossman paper has initiated a growing bulk of New Keynesian theories of unemployment with the ambition of establishing microeconomic foundations to Keynesian macroeconomics. The mainstream New Keynesian theories of unemployment try to answer the following question; why are wages sticky when unemployment exists? The most popular New Keynesian theories of unemployment are the following.

Implicit contract theories. The early contributions by Azariadis (1975), Baily (1974) and D. F. Gordon (1974), share two common assumptions. First, workers are more risk averse than employers due to occupational selection and less opportunities of the workers to diversify their human capital; and second, the contractual arrangement between workers and employers is implicit and unwritten. Since workers are assumed to be more risk averse than employers, it becomes optimal for firms to minimize the income variability of their workers. The outcome is sticky money wages. Sticky money wages may translates into real wage rigidities which prevent the labour market from clearing. An adverse demand shock therefore results in worker layoffs and unemployment.

Implicit contract theories have been questioned on two grounds. First, why do reductions in demand result in layoffs rather than reduced hours (Gordon (1976)). Second, implicit contract theory is a theory of wage stickiness and not of employment (Stiglitz (1986)). Implicit contracts do not result in unemployment fluctuations, and insurance contracts in fact improve the functioning of a competitive market. Stiglitz (1986) has demonstrated that implicit contracts imply either full employment or overemployment and therefore it is difficult to justify them as theories of unemployment.

Efficiency wages. These theories hypothesize that worker productivity is a positive function of the wage paid (Shapiro and Stiglitz (1984); Weiss (1980); Phelps (1970); Salop (1979); Akerlof (1984)). Unemployment is an equilibrium response to information asymmetries and is triggered by wages in excess of market clearing levels. Keeping wages above the market clearing level is, from the firms' point of view, optimal as it encourages workers not to shirk, lowers labour turnover, attracts a high quality labour force and increases the workers morale.

Yellen (1984) has questioned efficiency wage models on the following grounds: Why do other types of labour contracts, which are Pareto-superior to unemployment, not arise in efficiency wage models? Why do workers, in the training costs-reduction of labour turnover model, not pay the firm

for training or post a bond for leaving prematurely? Why do firms, in the shirking model, not impose a penalty payable to the firm for shirking? Workers should be willing to purchase jobs if they provide rents. This act would allow wages to adjust to eliminate the disequilibrium wage.

The efficiency-wage theories have had some empirical success. The efficiency-wage premium may vary across firms due to different monitoring and turnover costs. Studies by Dickens and Katz (1987), Krueger and Summers (1988) and Murphy and Topel (1987) observe that wage differentials are positively related to monopoly power, profitability, and capital intensity and these are likely to be positively related to monitoring and turnover costs.

Insider-outsider theories. Wages are set by insiders (employed) whose interests are represented by the unions and the unemployed (outsiders) have become disenfranchised (Gregory (1982); Blanchard and Summers (1986, 1987); Lindbeck and Snower (1986b, 1987, 1988)). An unexpected negative shock raises unemployment, and the vicious circle which disenfranchises the unemployed is initiated. There are different mechanisms that cause a negative shock to have long-term unemployment effects: First, unemployed workers lose the opportunity to maintain and update their skills by working and over time they lose contact with the labour market (Blanchard and Summers (1986)). Second, the insiders have bargaining power over outsiders due to

turnover costs, hiring costs, training costs and firing costs, all of which make inside labour effectively cheaper than the outsiders (Lindbeck and Snower (1986)). On behalf of the insiders the unions role is to amplify the costs of hiring, training and firing and thereby ensure the labour market advantages of their members. The implication of the insider-outsider story is that once unemployment increases in response to a negative shock an even stronger positive shock is needed to reverse the process due to the human capital deterioration among the long-term unemployed.

The insider-outsider theories (and the labour turnover efficiency wage model) predict that firms with the highest turnover costs will have the least flexible wages. Using sectoral data for Canada and France, Campbell (1989) finds evidence for this. Moreover, in concurrence with efficiency-wage theories, the insider-outsider theory is consistent with the fact that the most profitable and capital intensive firms pay the highest wage premiums and have the lowest quit rates. Finally, Gregory (1986) finds wage growth to be influenced significantly by labour utilisation within the firm, measured as overtime hours worked, but not by the unemployment rate for Australia after 1977. This suggests that insiders possess a stronger power in the wage negotiation process than outsiders.

3.3 Can the Above Theories Explain the Macroeconomic Aggregates?

Common to all theories of unemployment discussed above is the implicit assumption that unemployment persists and is often caused by excessive wages. Moreover, unemployment is caused either by shifts in demand for labour or supply of labour, not both. The discussion in section 2 underscores the fact that factors that affect both supply and demand for labour have been responsible for the unemployment rise. Hence, none of the theories above can claim to be an exhaustive theory of unemployment. Moreover, New Keynesian theories fail to explain why labour demand, in proportion to the population of working age, has not increased strongest in the countries with the smallest increase in the wage gap. New Classical theories fail to explain why the labour participation rate has not increased most in countries with the strongest increase in the after tax real wage. It appears therefore that the search for an adequate theory of the OECD unemployment needs to continue.

4 Wages and Unemployment: The Disequilibrium Wage Hypothesis

The link between real wages and unemployment plays a pivotal role in unemployment theories. The theoretical and empirical links are discussed below and the real wage gap theory associated with Bruno and Sachs (1985) is evaluated.

4.1.1 The Theory of Real Wages and Employment

The negative relationship between real wages and employment is derived from the neoclassical system of perfect competition, where employment is set at the point where the real wage is equal to the marginal productivity of labour. A decrease in the real wage increases employment via the assumption of a diminishing marginal product of labour.

The assumption of imperfect competition does not change the principal hypothesis of a negative relationship between real product wages and employment. Assuming that the capital stock, the marginal user costs, and the marginal wage rate, are fixed, labour demand can be derived as follows. Given profit maximization as the firms objective

$$\max P^0 Y - W N - R K$$

where R is cost of capital, P^0 output prices, Y GDP, W wages and N employment the first order condition for profit maximization is $P^0 = \delta(W N + R K) / \delta Y$ under perfect competition. Under imperfect competition on the goods market and constant factor prices we get

$$P^0 = \mu \delta(W N + R K) / \delta Y = \mu W \delta N / \delta Y + \mu R \delta K / \delta Y,$$

where $\mu = 1 + 1/\eta$ and η is the price elasticity of demand. Assuming that $\delta K/\delta Y$ is zero and a homogeneous Cobb-Douglas production function, $Y = (AN)^a K^{1-a}$, then

$$P^0 = \mu W / (A^a a N^{a-1} K^{1-a}).$$

Isolating N on the left hand side, with lowercase letters in logs, gives

$$\begin{aligned} n = & -1/(a-1) \log a + 1/(a-1) \log \mu + a/(a-1) \log A \\ & + k + 1/(a-1) (w - p^0). \end{aligned} \quad (1)$$

Since $a < 1$ a negative relationship exists between real product wages and employment.

Since firms are never demand constrained in the neoclassical world, secondary demand effects of changes in wages are unimportant. If firms are demand constrained as a possibility allowed for in the Barro and Grossman (1971) model, in the sense that firms wish to produce more than they are able to sell at prevailing prices, an increase in wages in excess of value-added prices and productivity may affect employment via following channels: 1) A higher propensity to consume out of wages than profit, at least in the short-run, increases demand. 2) A capital loss on financial assets, when wages increase is announced and realized, curbs consumption via the wealth effect in the consumption function. 3) Malinvaud (1982) argues that real

product wages have an impact on employment via investments in the long-run. Lower profitability affects investments through the profitability constraint and the financing constraint. In the former, due to Tobin (1969), investment is undertaken if the stock capitalization is in excess of the replacement value of capital. The latter is due to Catinat et al. (1988) where internal financing of investments may be constrained by low profitability. This in turn, affects the external financing since a lack of internal funds is likely to hamper the access to external credit.

4.1.2 Empirical Evidence on the Relationship Between Real Wages and Employment

The real wage-employment relationship has been studied extensively. Most studies find a statistically negative relationship between employment and real wages (Hammermesh (1986)) but the evidence is mixed. Some studies, notably the study by Geary and Kennan (1982), however, fail to find a negative relationship between employment and real wages. Nickell and Symons (1990) show that this outcome is likely to be due to the use of an inaccurate price-deflator. Summers (1987) has pointed out that empirical studies with lagged real wages in the labour demand function may find a spurious negative relationship for the following reason: If firms increase prices, due to a surge in demand in the first period, but then increase the supply of goods and

demand for labour in the next period, a negative relationship is established since real wages have been falling in the first period. Anyadike-Danes and Godley (1989) demonstrating a similar point by finding a significant negative relationship between employment and real wages with generated data from a model without any causal link from real wages to employment. In order to avoid the possibility of a spurious employment-real wage relationship due to the possibility of a price rise ahead of a wage rise, chapter 3 of the thesis estimates the employment-real wage relationship using five and seven years differences in the variables to measure changes in employment and real wages for 22 OECD countries. Employment is found significantly to be negative correlated with real wages.

The secondary demand effects of an increase in the disequilibrium wage that I discussed in the previous section are hard to quantify and much influenced by the often intangible reactions of credit and financial markets. If firm profitability is "high" the impact of a wage rise on employment via credit and financial markets is likely to be low. Concerning investments, the impact of profitability has not been studied much empirically. Catinat et al. (1988) find profitability to be a statistically significant determinant of investment, but its quantitative impact on investments is low.

4.2 The Real Wage Gap Theory

As mentioned in section 2, the real wage gap is a summary measure of the excess component of the real wage. The real wage gap is set to zero in a full employment period. A positively wages gap then measures the per cent points the real wage has to fall to ensure full employment, adjusted for the influence on productivity of the business cycle. The real wage gap, together with cyclical shift parameters, is used by Sachs (1983), Bruno and Sachs (1985) and Bruno (1986) to explain the unemployment path in Europe and the US. They argue that demand factors lead to the unemployment rise in the periods 1973-75 and 1979-82, and an excessive wage increase that generated a real wage gap is responsible for the increase in unemployment between these two periods. Empirically, they find the real wage elasticity in labour demand to be negative and that the real wage gap-unemployment elasticity to be positive. These findings, however, are not sufficient to validate their assertions. For instance, comparing the Cobb-Douglas real wage gap for the whole economy in the US, the EEC and Japan Gordon (1987) demonstrates that the real wage gap in the 1970s and the 1980s was highest in Japan although it faces the lowest unemployment rate. Chapter 3 of the thesis shows that the results by Bruno and Sachs are due partly to a country selection bias and the real wage gap cannot explain the different levels of unemployment rates across countries.

5 Empirical Modelling of the Unemployment Path

The reduced form and structural form approaches have frequently been used to account for the unemployment path in the OECD countries. The former regresses unemployment on explanatory variables. In the latter, estimated structural parameters of wage, labour demand and, occasionally, price equations are employed to simulate unemployment due to shifts in "exogenous" variables.⁶

5.1 Reduced Form Approach

Bruno and Sachs (1985), McCallum (1986) and Bruno (1986) explain unemployment in a reduced form equation but the variables in the equation are derived from a structural model. Rowthorn and Glyn (1987), Glyn and Rowthorn (1988), Barro (1988) and Benjamin and Kochin (1979) go directly to the reduced form without being explicit about the structural equations. All these models are discussed below.

In the estimates of Bruno (1986) and McCallum (1986) the unemployment rate is regressed on the real wage gap and

6. Empirical estimates of macroeconomic rationing models by Sneessens (1983, 1987), Sneessens and Dreze (1986), Lambert (1990) and Coen and Hickman (1987, 1988) amongst others are not considered. Due to the complex estimation procedure of these models, their empirical validity is difficult to assess. More importantly, macroeconomic rationing models have, to my knowledge, not been applied in a multicountry context.

cyclical shift parameters, where lower-case letters refer to logs

$$\Delta U = \beta_0 + \beta_1 \Delta w^X + \beta_2 \Delta d^m + \beta_3 \Delta d^W + \beta_4 \Delta d^f + \beta_5 \Delta d^C + \beta_6 \Delta d^t + \beta_7 \Delta U^W + \varepsilon_1, \quad (2)$$

where U is the unemployment rate, w^X the real wage gap, d^m real monetary stock, d^W deviation of world trade from its trend, d^f the cyclical and inflation corrected fiscal balance in percentage of potential GDP, d^C the price competitiveness on export markets, d^t a terms-of-trade effect and U^W the weighted average of the unemployment rates in the country sample minus own country unemployment. To account for the rise in the unemployment rate, the estimated equation. (2) is used to simulate the contribution of each factor to the path of unemployment.

In Bruno's (1986) approach equation. (2) is estimated over the period 1962 to 1982 for eight countries with w^X , d^m and d^W as explanatory variables lagged one and two periods. He finds that the increase in the real wage gap explains much of the unemployment increase during the mid 1970s. The unemployment growth in the end of the 1970s and the beginning of the 1980s can primarily be attributed to aggregate demand factors but the continuous rise in the wage gap also played a role in some countries. Since single country estimates are not reported the credibility of the analysis is difficult to judge. Some information can be

extracted from a reported pooled cross-section and time-series estimate. These results show that the statistical significance of the parameter estimates in general are low and the model explains about the half of the variance in ΔU . Since the t-statistics in a pooled estimate are in general much higher than in single country estimates the significance of the parameters in the single country equations is likely to be quite low.

McCallum (1986) estimates equation. (2) with d^w excluded. He employs a pooled cross-section and time-series analysis over the annual period 1979 to 1984 for 14 OECD countries, with all explanatory variables lagged one period. The pooled cross-section and time-series estimate is then used to simulate the change in the unemployment rate for individual countries over the period 1979 to 1984. McCallum finds that cross-country differences in the change in the unemployment rate have been due largely to fiscal and monetary policy and that the real wage has played a minor role.⁷

7. McCallum implicitly assumes that the real monetary stock reflects the stance of the monetary policy. Due to increased capital mobility across borders and the abolition of quantitative ceilings on bank lending, monetary aggregates may not give much information on the stance of the monetary policy. The stance of monetary policy is also reflected in the exchange rate and interest rate movements, and they often give conflicting indications. See Stiglitz (1988) and Chouraqui et al. (1988) for further discussion of this aspect.

McCallum's study is particularly difficult to assess because he uses a wide range of variables constructed from combinations of data and parameters estimated from other studies.⁸ Moreover, the estimation period used by McCallum is too short to test the reliability of his model and whether the coefficients across countries can be assumed to be homogeneous.⁹ Finally, there are some measurement problems. The real wage is measured as the hourly wage in manufacturing deflated by manufacturing output prices. Since the unemployment rate refers to the whole economy, the real wage should do that too. He also make the classical error of deflating wages with output prices instead of the value-added price-deflator. Finally, the hourly wage does not encompass indirect labour costs which count for up to 50 per cent of total labour costs in OECD countries (Swedish Employers' Confederation (1989)).

Bruno and McCallum both fail to develop a thorough model of labour supply and as a result it is to judge the role labour supply as a contributing factor to the rise in

8. McCallum adjusts the demand variables as follows: The wage gap for each country is multiplied by the labour demand elasticity with respect to the real wage, estimated by Newell and Symons (1985), divided by the mean elasticity across countries. The demand shifts variables are multiplied by Okuns coefficient for individual countries divided by the means of the shift variables across countries, which again is multiplied by a constant and the relative openness of the economy (import-GDP ratio). Okuns coefficient is calculated as the sum of the estimates of $\bar{w}_1$ and $\bar{w}_2$ from the equation $U_t = \bar{w}_0 + \bar{w}_1 \text{GDP}_t + \bar{w}_2 \text{GDP}_{t-1} - \bar{w}_3 t + v_4 t^2 + \bar{w}_5 t^3 + e_t$, estimated over the period 1960 to 1984.

9. McCallum tests for structural stability, which, of course, does not make sense over a five year sample period.

unemployment. Equation (2) is the reduced form of the labour demand and supply, where labour supply is assumed to be a function of employment.

Glyn and Rowthorn (1988) and Rowthorn and Glyn (1987) explicitly take labour supply factors into account. These studies examine the diversity of the rise in unemployment across 19 OECD countries from 1973 to 1985. To serve this purpose they regress $U_{1985} - U_{1973}$ over the same period, on changes in variables, hypothesized to have an impact on the unemployment rate. The statistically most significant variables that explain the diversity of unemployment are the growth rate of working age population and industrial employment. The authors suggest that changes in industrial employment influences unemployment because workers skills tend to be industry specific and concentrated in particular geographical areas. GDP and the real wage change are found to be only weakly correlated with the change in the rate of unemployment.

The studies by Glyn and Rowthorn are important because they emphasise the need to incorporate labour supply explicitly into the analysis. Moreover, they highlight the merits of utilizing cross-country unemployment diversity in the estimations. Since only 19 observations are available, the authors run a double digit number of regressions with one explanatory variable in each equation in their 1987 paper. This estimation strategy renders their conclusions fragile.

Monte Carlo studies have shown that randomly generated variables after a sufficient number of replications always will be able to explain another variable significantly (Granger and Newbold (1974)). Finally, it is erroneous to use the change in the real wage across countries without adjusting it for advances in productivity as discussed in section 2. The real wage gap should have been used instead.

In the studies by Barro (1988) and Benjamin and Kochin (1979) they implicitly accept the hypothesis that an excessive real wage is the only factor responsible for the unemployment path. Since the empirical estimates referred to above have demonstrated that the real wage or the real wage gap alone cannot explain the unemployment path and diversity across OECD countries, these studies are of limited value.

5.2 Structural Approach

The structural approach suggested in the seminal papers by Layard and Nickell (1985a; 1985b; 1986) has gained wide popularity as a framework to account for the unemployment change in a single country (Bean et al. (1986); Pissarides (1991); Dolado et al. (1986); Pehkonen (1989); Huay and Groenewold (1989)). In the Layard and Nickell approach a labour demand equation, a price equation and a wage equation are estimated by three stage least squares. Although the real wage may have triggered the rise

in the unemployment it is not the causal factor since it is not truly exogenous. Therefore the wage equation is estimated to link wage changes to "exogenous" wage push factors. To account for the unemployment path the estimated system is simulated with the shifts in "exogenous" variables over periods where the unemployment rate has been rising. The change in the unemployment rate from the initial full employment period can then be traced back to the changes in the "exogenous" variables.

Bean et al. (1986) use a simplified version of the Layard and Nickell (1986) model to account for the rise in unemployment in 18 OECD countries. They find demand to be an important contributing factor behind the rise in the unemployment rate over the period from 1956-66 to 1980-83, especially in the EEC. Wage push factors, such as search intensity and higher taxes, also contributed significantly.

There are two major difficulties of the Layard and Nickell model which are associated with the role of the capital stock and the cyclical changes in the price mark-ups over marginal costs. The model is constructed in such a way that, on balance, changes in the capital stock and technological advances do not affect employment. This occurs because an increase in the capital stock and the technology are assumed to increase productivity and real wages proportionately so that unemployment does not change. These are strange restrictions since we have seen a secular

increase in demand for labour in response to changes in the technology and the capital stock. The point is analysed in details in chapter 6 of the thesis.

Another difficulty is related to the role of the price mark-ups over marginal costs which provides the only mechanism for the economic cycle to affect unemployment in the model. As a result the estimated effect of changes in the mark-up on labour demand and hence unemployment is often unreasonable large. An even more serious difficulty is that Layard and Nickell do not measure the mark-up directly but approximate it by cyclical variables. These cyclical variables are supposed to capture the economic cycle which in turn is assumed to capture the cyclical nature of mark-ups. The model assumes that increases in unemployment are associated with reductions in the mark-up. Other researchers, however, who have directly focused their studies on variations of the mark-up over the cycle, conclude that the mark-up behaves in the opposite way to that hypothesized by Layard and Nickell. Bils (1987), Rotemberg and Saloner (1986) and Price (1991) find that the mark-up typically falls during booms. These results suggest that the crucial variables included by Layard and Nickell are not measuring mark-up effects but are perhaps measuring Keynesian demand shifts. In other words, many of the cyclical variables should be included in the model in their own right.

The empirical results of Bean et al. (1986) do not seem to be plausible. For instance they find that a 9.68 percentage point increase in the Dutch unemployment rate in the period 1956-66 to 1980-83 is a result of a cyclical change in the price mark-up over marginal costs. They also estimate that changes in the mark-ups lead to an increase in unemployment of 5.33, 5.40 and 4.59 for the UK, Denmark and Canada respectively. These estimates seem to high. Another difficulty is that search intensity is estimated as the contribution of a time and a squared time trend to the outward shift in the UV relationship. It is far too simple to explain the outward shift in the UV relationship to a decrease in search activity as is shown by Blanchard and Diamond (1989) amongst others. In the Blanchard-Diamond model the following elements affect the position of the UV-curve: sectoral and cyclical shocks; autonomous changes in labour force participation; changes in the rate of capital accumulation; changes in the autonomous quit rate; and shifts in the matching function.

6 Concluding Remarks

Although the mounting number of theories of unemployment have given some insights into factors that may have caused the rise in unemployment in OECD countries they have not yet given an satisfactory account of the rise. The basic problem with the New Keynesian theories of unemployment is that they are theories of real wages. It is implicitly

taken for granted that unemployment exists as a result of excessive wages. This, however, is not what we observe. First, despite a falling real wage gap since the mid 1970s the unemployment rate has continued to increase in most OECD countries. Second, excess wages have decreased most in countries with the strongest increase in unemployment since the mid 1970s.

The New Classical theories of unemployment also face a number of difficulties. They for example are unable to account for the persistence of unemployment, unless one is willing to accept that information misperceptions and expectational errors can persist for decades.

Most empirical studies of unemployment also leave us with many unanswered questions. They have not been able to explain the paradox that the rate of unemployment has increased strongest in countries with the largest fall in the real wage gap since the mid 1970s. Nor have they been able to explain why the unemployment rate has increased mostly in countries with the largest rise in GDP. Although econometric and methodological problems are present in the studies by Rowthorn and Glyn (1987) and Glyn and Rowthorn (1988) it is interesting to note that they find that factors, other than those traditionally focused on, may have been responsible for the rise in unemployment in the OECD countries in the past few decades.

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CHAPTER 3

CAN THE REAL WAGE GAP EXPLAIN THE UNEMPLOYMENT PATH IN 22 OECD COUNTRIES?

Abstract. This chapter tests whether the real wage gap is able to explain parts of the unemployment path in 22 OECD countries by employing different time series models. Using pooled cross-section and time-series data it is furthermore tested whether the real wage gap has contributed to the explanation of cross-country differences in unemployment. Whereas the evidence suggest the wage gap has contributed to the increased unemployment since the first oil price shock for individual countries it has not contributed to the different paths of unemployment rates across countries.

1 Introduction

The persistently high rate of unemployment in many OECD countries over the past two decades has been a major puzzle in the economic literature. In some influential contributions, Sachs (1983), Bruno and Sachs (1985) (B&S) and Bruno (1986) suggest that wages above market-clearing levels and demand factors since 1973 have been responsible. This suggestion is supported by an analysis which involves regressing the unemployment rate on the real wage gap and cyclical shifts variables. The real wage gap is defined as the proportion of the real wage in excess of the marginal productivity of labour at full employment.

This chapter goes a step further than B&S in an investigation of the general ability of the real wage gap and cyclical demand variables to explain the unemployment rate over time and across countries. The 6 country sample considered by B&S and the 8 country sample considered by Bruno (1986), is expanded to 22 and the estimates are performed with the real wage gap in the private service sector in addition to the manufacturing sector. In the B&S estimates the real wage gap, estimated for manufacturing, is applied to the whole economy.¹ The effect of the real wage gap on unemployment is estimated using different models among which are models employed by B&S.

1. Gordon (1987) demonstrates the real wage gap in manufacturing show quite different time series behaviour compared to the path of the wage gap for the whole economy.

The empirical findings suggest the real wage gap has been a contributing factor to the unemployment path in the OECD countries. However, the real wage gap is not able to explain the strong rise in the OECD unemployment since the first oil price shock even though cyclical demand variables are included in the equations to allow for demand constrained situations. Finally, although changes in the real wage gap do not seem to be important contributors to changes in the unemployment rates they are more successful at explaining employment changes across countries.

The chapter is organised as follows. Section 2 briefly presents the derivation of the real wage gap under the Cobb-Douglas technology assumption. Section 3 describes the data and displays the path of the real wage gap in the manufacturing and the private service sector in the seven most important OECD countries. Section 4 outlines and estimates the models and further examines whether the wage gap models, estimated by B&S, are able to predict the turning points in the unemployment rates that occurred in the mid 1980s in most OECD countries. Section 5 calculates the zero wage gap unemployment rate in 1988. Section 6 sums up the main conclusions.

2 The Real Wage Gap

B&S (1985) and Sachs (1983) define the wage gap as the excess real wage over the full employment marginal product of labour. Under the Cobb-Douglas technology, the wage gap can be calculated as follows: Given the production function $Q = AL^\alpha K^{1-\alpha}$, with L as working hours and K capital services, the marginal productivity of labour is $dQ/dL = \alpha(Q/L)$, and the full-employment marginal product of labour is $\alpha(Q^f/L^f)$. With small letters denoting logs the real wage gap is then defined as

$$w^x = (w - p_Q) - (q^f - l^f + \log(\alpha)), \quad (1)$$

where w is direct and indirect labour costs per working hour and p_Q the value-added price-deflator. Analytically, B&S show labour demand to be a negative linear function of w^x under the assumption that firms are on their output supply schedules. In the empirical estimates, however, B&S relate unemployment rather than employment to the real wage gap. To support this approach B&S (1985) demonstrate a positive relationship between labour supply and employment via discouraged worker effects. Hence, the unemployment rate can be used as dependent variable in the reduced form of a demand and supply model. This requires, however, that the component of labour supply which is not explained by employment is fixed in the estimation period. This

assumption is not likely to hold and estimates below suggest that this is indeed the case.

3 Calculation of the Wage Gap

The real wage gap is calculated for manufacturing and private services excluding the agricultural sector and mining for the countries in which it accounts for more than 3 per cent of GDP (that is for Canada, Australia, the Netherlands and Norway). The government sector is excluded since labour productivity and the value added deflator are not easily measured in this sector. The agricultural and mining sector are excluded as their value-added price-deflators tend to fluctuate strongly in line with output prices as a result of the double deflating principle in national accounts. Compensation per working hour is the total labour compensation divided by working hours on a sectoral basis. Before 1970, employee compensation on a sectoral basis is not readily available. Hence compensation to employees for the whole economy is divided between the manufacturing and service sector according to the development in the hourly wage in the two sectors, weighted by sectoral person hours worked. Data availability dictated the use of annual data.

The trend-through-peak method used by B&S is employed to estimate the full employment labour productivity, $(q^f - l^f)$. We assume $(q - l)$ to be equal to $(q^f - l^f)$ at the cyclical

peaks years of 1960, 1973, 1979 and 1988, and to grow at a constant exponential rate between the periods. Since 1979 and 1988 are not full employment years, the estimated trend productivity growth rates may be biased. B&S (1985) and Burda and Sachs (1988), however, find the full employment productivity growth rates to be insensitive to alternative estimations of full employment labour productivity under the Cobb-Douglas technology assumption. The real wage gap on average is normalized to zero in the (full employment) period from 1965 to 1969 for all but two countries (1966-69 for Denmark and 1971 for New Zealand).

In the figures 1 to 7, the real wage gap in services and manufacturing are exhibited for the G7 countries (Canada, the US, Japan, France, Germany, Italy and the UK) over the period 1960 to 1988. For most of the countries, including those not displayed, the real wage gap rose sharply from the mid 1960s to the mid 1970s, and subsequently showed a declining trend.

Over the considered period the real wage gap has grown more in private services than manufacturing due to a weaker productivity growth and a firmer growth in compensation to employees per working hour. A stronger growth in the value-added price-deflator in private services, however, has worked in the opposite direction.

Figure 1. Real Wage Gap: Canada

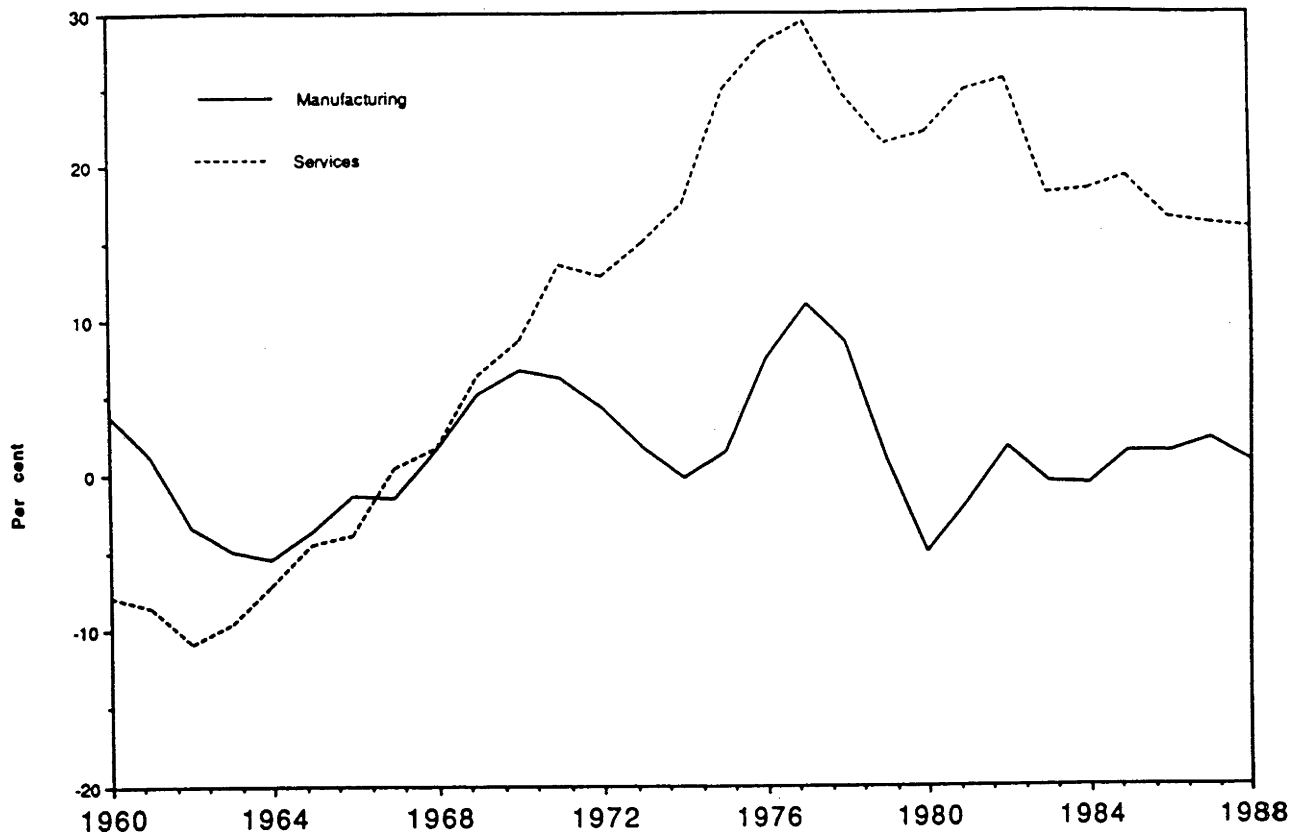


Figure 2. Real Wage Gap: USA

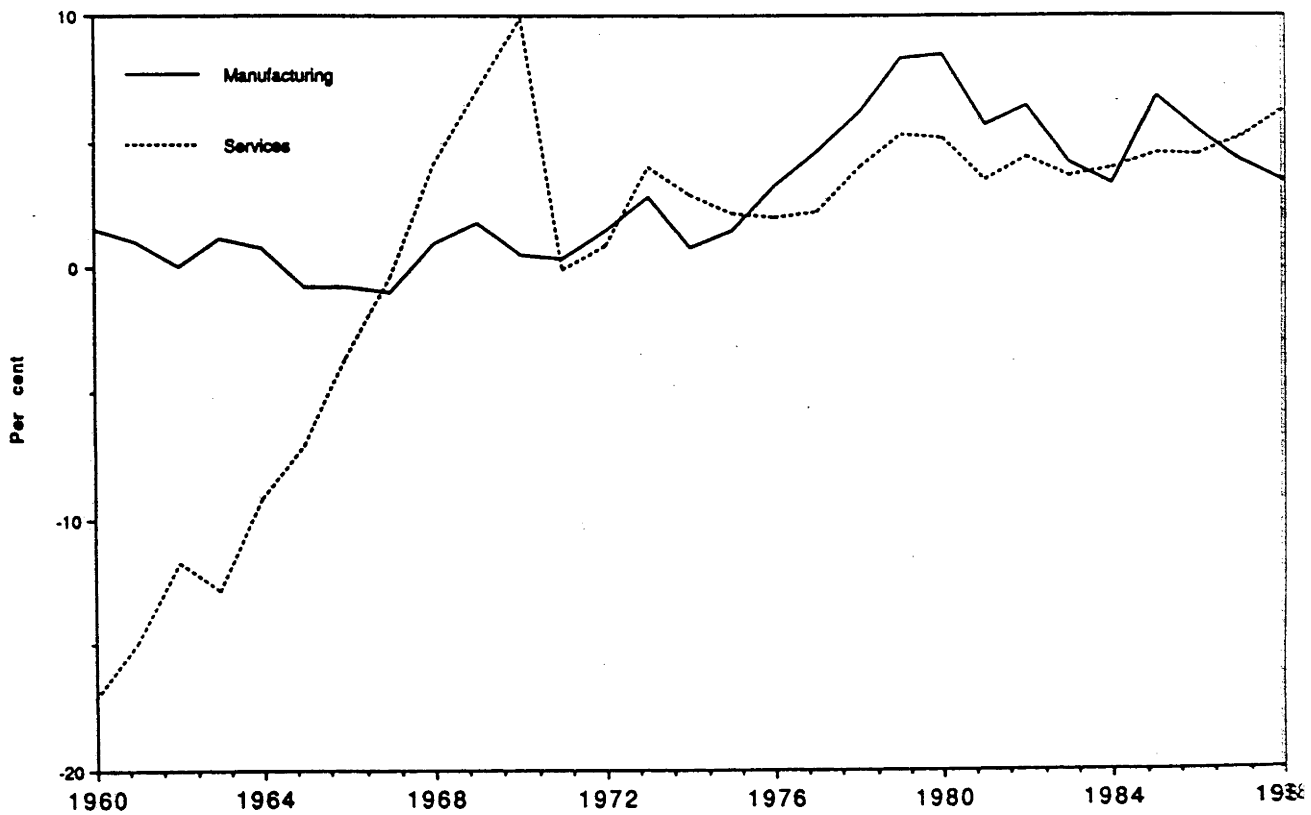


Figure 3. Real Wage Gap: Japan

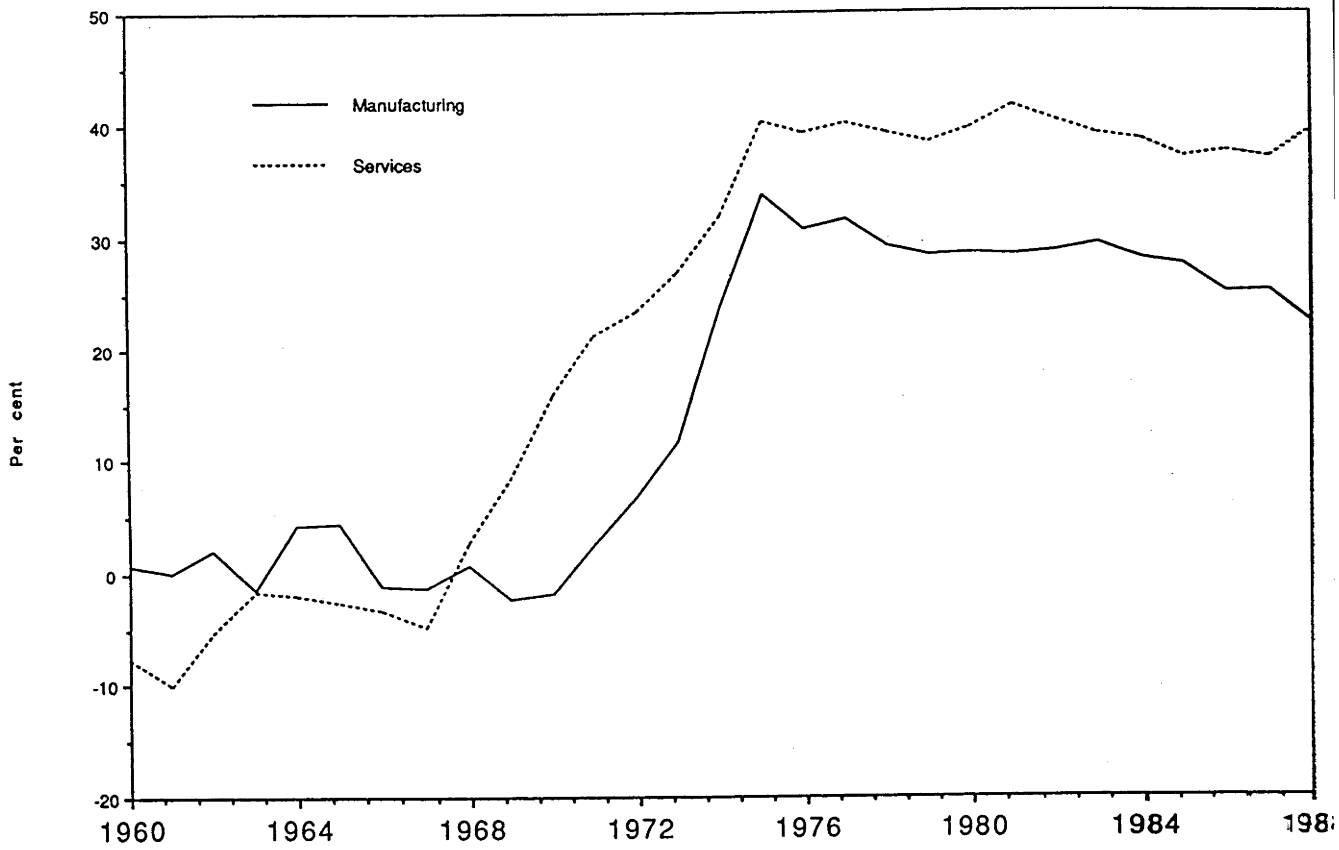


Figure 4. Real Wage Gap: France

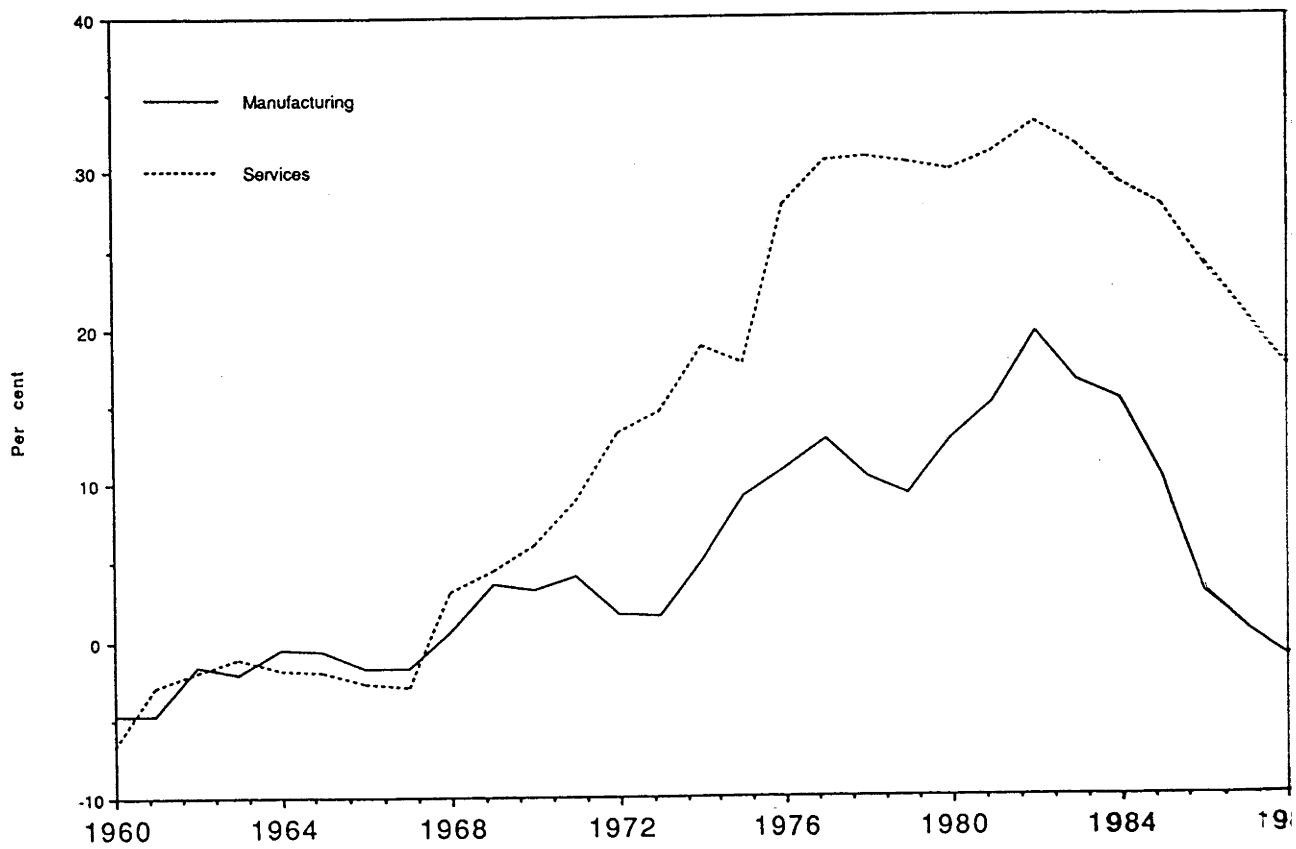


Figure 5. Real Wage Gap: Germany

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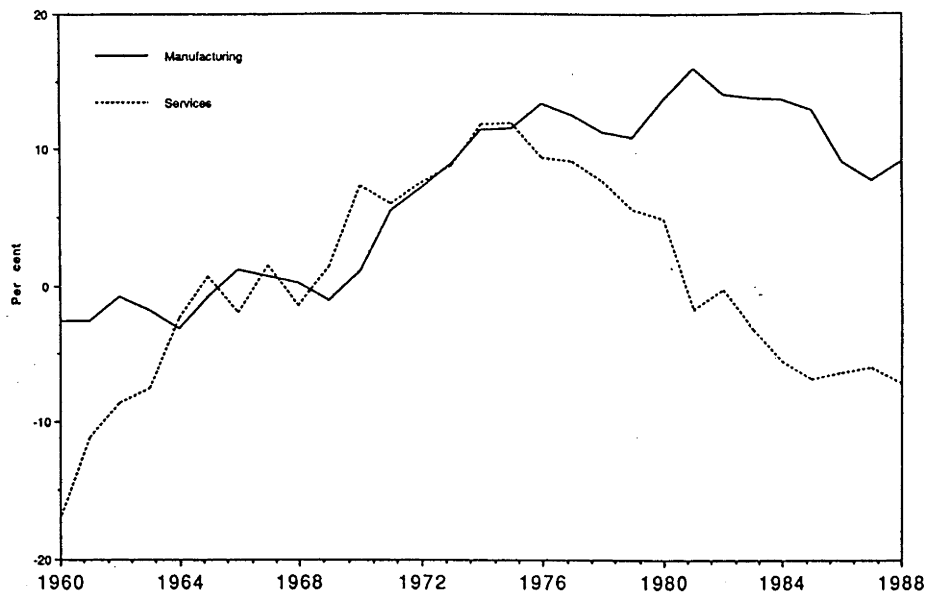


Figure 6. Real Wage Gap: Italy

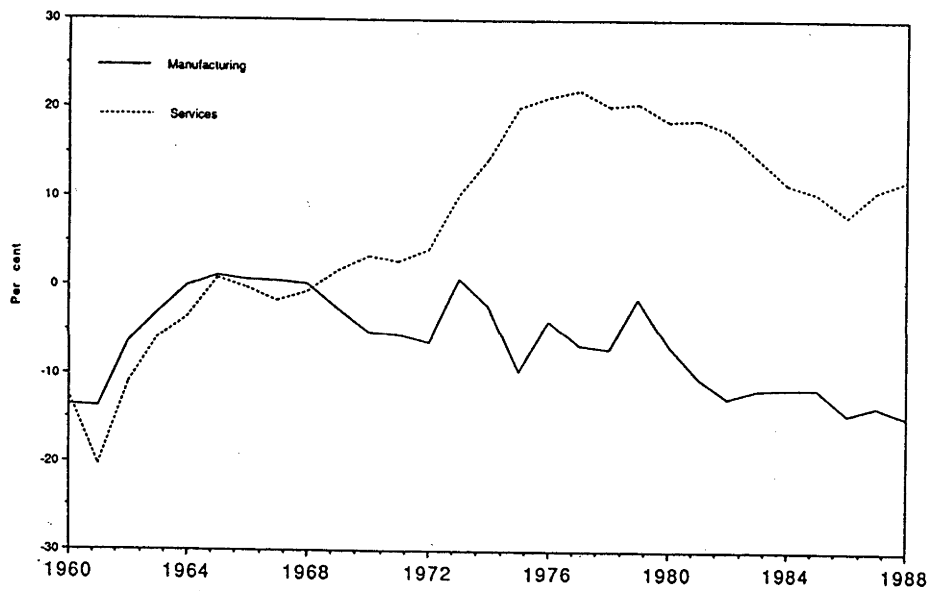
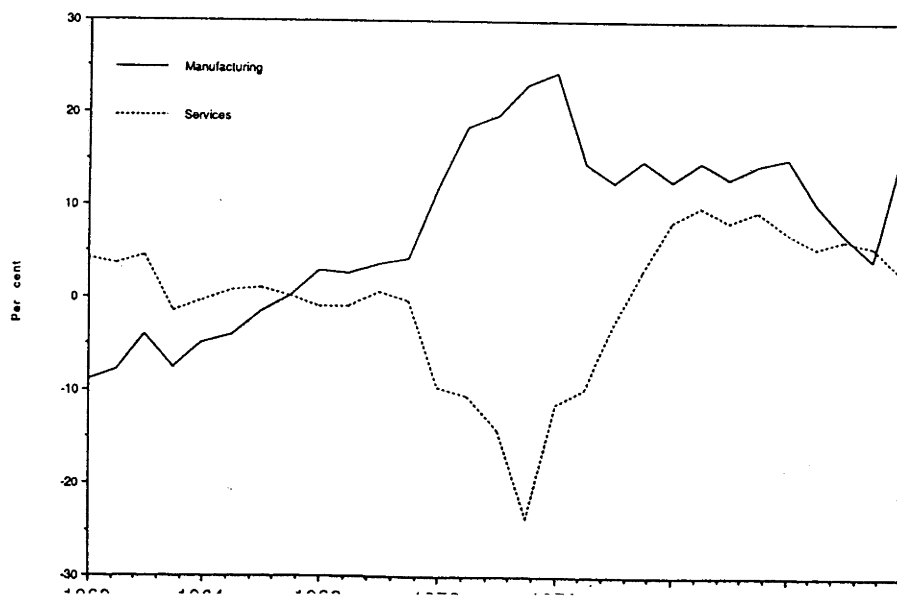


Figure 7. Real Wage Gap: UK



The different magnitude and path of the real wage gap in the two sectors show that an assessment of the magnitude of the disequilibrium wage on the basis of the manufacturing sector solely, may be misleading. For Canada, Germany, France and Italy, for instance, the real wage gap is positive for one sector and negative for the other in most of the 1980s. For the UK in the first half of the 1970s, the real wage gap picked-up by 20 per cent in manufacturing, but at the same time decreased by 20 per cent in services. Furthermore, the figures illustrate the real wage gap is not obviously highest in the countries with the highest unemployment rate, notable France, Italy and the UK.

4 The Models

Five models are established and estimated in this section. The first two models are employed by B&S. Since these models do not give satisfactory results, and include variables that may blur the genuine effect of the real wage gap an alternative timeseries model is employed. Finally, two models, which employ pooled cross-section and time-series data over countries, are estimated to reinforce the conclusions obtained by estimating the previous models. Moreover, these models enable us to test the ability of the real wage gap to contribute to the explanation of cross country differences in unemployment rates.

Model 1. The following partial adjustment model is one of the models estimated by B&S (1985)

$$u_t = \beta_0 + \beta_1 u_{t-1} + \beta_2 \text{time} + \beta_3 w^x_{t-1} + e_{1t},$$
$$0 < \beta_1 < 1, \beta_2 > 0, \beta_3 > 0, \quad (2)$$

where u is the log of the percentage of the unemployed labour force and e_t a zero-mean finite-variance disturbance term. It is not entirely clear why a time trend has been added in the equation. In his 1983 paper Sachs suggest it accounts for productivity. Productivity, however, is included in the estimations of the real wage gap. One may, however, argue that the time trend may capture the effects of the changes in (the log of) labour, capital and labour augmenting technical progress; effects that not are captured under the Cobb-Douglas technology assumption. These variables, together with labour productivity, influence the real wage gap under the translog technology assumption that is explicitly derived in the next chapter.

In line with the B&S estimates the model is estimated over the period 1961-81 employing the manufacturing real wage gap. In addition, the model is estimated with the real wage gap for manufacturing and private services plus manufacturing over the period 1961-88. The estimates of the model are presented in table 1 and summarized in the first three columns of table 3. The fourth column of table 3 shows the estimates obtained by B&S (1985, p185). The

Table 1. Estimations of model 1:

$$U_t = \beta_0 + \beta_1 U_{t-1} + \beta_2 \text{time} + \beta_3 W^x + e_t$$

Country	Sec	β_0	β_1	β_2	β_3	Estima. period	Durbin's h-stat.	R ²	Pred. fail.	Long- run W ^x
Canada	Man	-36.74 (2.50)	0.73 (7.00)	0.07 (2.96)	8.19 (2.55)	1961-81	-0.87	0.85	7.02	28.24
	Man	-30.18 (1.26)	0.76 (6.12)	0.06 (1.87)	6.75 (1.30)	1961-88	2.44	0.84		28.12
	Tot	-37.30 (2.50)	0.87 (7.06)	-0.02 (0.44)	8.24 (2.56)	1961-88	1.53	0.87		63.38
USA	Man	14.49 (0.28)	0.67 (3.29)	0.06 (1.55)	-2.89 (0.25)	1961-81	1.09	0.53	1.44	-8.75
	Man	-25.08 (0.52)	0.68 (4.14)	0.02 (0.71)	5.78 (0.54)	1961-88	2.58	0.61		18.06
	Tot	6.88 (0.17)	0.69 (3.58)	0.03 (0.66)	-1.20 (0.14)	1961-88	-	0.60		-3.87
Japan	Man	-5.26 (2.96)	0.50 (4.41)	0.01 (2.28)	1.25 (3.07)	1961-81	-1.03	0.92	1.98	2.50
	Man	-4.29 (2.68)	0.62 (6.80)	0.02 (2.71)	1.00 (2.82)	1961-88	-0.13	0.95		2.63
	Tot	-4.06 (1.97)	0.73 (7.51)	0.01 (0.66)	0.93 (2.08)	1961-88	0.25	0.95		3.44
Austral.	Man	-34.47 (3.10)	0.66 (5.73)	-0.04 (1.31)	7.58 (3.09)	1961-81	-0.82	0.94	5.94	22.29
	Man	-25.64 (2.24)	0.73 (5.73)	0.07 (1.61)	5.57 (2.24)	1961-88	0.20	0.93		20.62
	Tot	-25.79 (2.23)	0.77 (5.89)	0.04 (0.74)	5.59 (2.22)	1961-88	-0.04	0.93		24.30
New Zl.	Man	6.14 (0.31)	0.89 (2.49)	0.16 (1.46)	-1.44 (0.33)	1972-81	*	0.82	3.54	13.09
	Man	-11.86 (0.91)	0.63 (2.53)	0.19 (2.17)	2.41 (0.87)	1972-88	*	0.86		6.51
	Tot	-11.33 (0.69)	0.60 (2.40)	0.18 (2.06)	2.33 (0.65)	1972-88	*	0.86		6.82
Austria	Man	-6.57 (1.61)	0.50 (2.06)	-0.01 (0.53)	1.63 (1.70)	1965-81	-20.42	0.43	3.40	3.26
	Man	-3.60 (0.77)	0.77 (5.87)	0.02 (0.92)	0.83 (0.80)	1965-88	0.05	0.83		3.61
	Tot	6.89 (0.80)	0.63 (2.99)	0.07 (1.49)	-1.44 (0.78)	1965-88	2.75	0.83		-3.89
Belgium	Man	-18.06 (3.00)	0.73 (6.45)	0.14 (4.19)	3.83 (2.90)	1961-81	1.12	0.96	2.27	14.19
	Man	-25.85 (4.60)	0.69 (9.87)	0.13 (3.93)	5.56 (4.56)	1961-88	3.12	0.98		17.94
	Tot	-31.69 (4.51)	0.93 (13.76)	-0.05 (1.04)	6.92 (4.49)	1961-88	2.16	0.98		93.86

Table 1 continued.

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Country	Sec	β_0	β_1	β_2	β_3	Estima. period	Durbin's h-stat.	R ²	Pred. fail.	Long- run W ^x
Denmark	Man	-77.80 (1.15)	0.71 (2.78)	0.15 (0.68)	16.80 (1.13)	1967-81	-3.80	0.87	1.11	57.93
	Man	-91.22 (3.04)	0.63 (4.47)	0.16 (2.08)	19.72 (3.07)	1967-88	0.85	0.88		53.30
	Tot	-142.70 (4.49)	0.61 (5.24)	-0.05 (0.75)	31.01 (4.51)	1967-88	0.53	0.92		79.51
Finland	Man	-48.10 (2.95)	0.77 (4.96)	0.00 (0.03)	10.61 (2.97)	1961-81	2.14	0.83	0.44	46.13
	Man	-37.34 (3.55)	0.71 (5.59)	0.04 (1.45)	8.21 (3.60)	1961-88	2.56	0.86		28.31
	Tot	-22.52 (2.11)	0.70 (4.89)	0.02 (0.43)	5.05 (2.14)	1961-88	3.31	0.83		16.83
France	Man	-53.06 (2.53)	0.72 (5.27)	0.02 (0.51)	11.62 (2.51)	1961-81	-1.79	0.97	1.60	41.50
	Man	-22.78 (2.98)	0.91 (11.56)	0.03 (0.88)	4.95 (2.95)	1961-88	-1.80	0.99		55.00
	Tot	-22.27 (2.69)	0.86 (11.39)	0.02 (0.56)	4.84 (2.66)	1961-88	-1.47	0.99		34.57
Germany	Man	-64.26 (2.63)	0.65 (4.60)	-0.03 (0.54)	14.08 (2.61)	1961-81	-0.03	0.88	2.89	26.71
	Man	-42.99 (2.17)	0.89 (8.25)	-0.00 (0.01)	9.35 (2.16)	1961-88	2.15	0.95		85.00
	Tot	-0.77 (0.04)	0.79 (4.74)	0.08 (1.34)	0.08 (0.02)	1961-88	5.32	0.94		0.38
Greece	Man	-7.06 (1.45)	1.05 (4.80)	0.09 (1.42)	1.32 (1.08)	1966-81	4.48	0.86	2.86	-
	Man	-10.67 (1.82)	0.81 (8.76)	0.04 (1.83)	2.44 (1.77)	1966-88	3.27	0.91		12.84
	Tot	-14.10 (0.97)	0.90 (11.61)	0.00 (0.01)	3.08 (0.94)	1966-88	3.23	0.90		30.80
Ireland	Man	3.72 (0.21)	0.49 (2.29)	0.14 (2.60)	-0.46 (0.12)	1961-81	6.62	0.74	2.46	-0.90
	Man	-0.23 (0.01)	0.86 (7.29)	0.10 (1.86)	0.03 (0.01)	1961-88	2.68	0.95		-0.21
	Tot	7.80 (0.34)	0.82 (5.52)	0.13 (1.63)	-1.68 (0.35)	1961-88	3.37	0.95		-9.33
Italy	Man	3.53 (0.34)	0.44 (2.29)	0.10 (3.21)	-0.29 (0.14)	1961-81	1.43	0.84	1.46	-0.52
	Man	8.24 (0.80)	0.77 (6.46)	0.07 (2.80)	-1.67 (0.77)	1961-88	1.05	0.96		-7.26
	Tot	17.24 (1.49)	0.64 (4.03)	0.12 (2.77)	-3.56 (1.46)	1961-88	2.02	0.96		9.89
Luxemb.	Man	0.56 (0.36)	0.88 (5.74)	0.02 (1.19)	-0.14 (0.41)	1961-81	-1.14	0.85	2.90	-1.17
	Man	-0.10 (0.24)	0.80 (5.28)	0.02 (1.25)	-0.10 (0.30)	1961-88	0.37	0.94		-0.50
	Tot	-0.06 (0.04)	0.83 (6.69)	0.01 (1.09)	-0.00 (0.01)	1961-88	0.36	0.94		0.00

Country	Sec	β_0	β_1	β_2	β_3	Estima. period	Durbin's h-stat.	R^2	Pred. fail.	Long- run w^*
Nethl.	Man	36.29 (1.46)	0.67 (3.15)	0.19 (2.27)	-8.10 (1.48)	1961-81	2.07	0.91	2.80	-24.55
	Man	-21.27 (1.64)	0.94 (7.25)	0.05 (0.86)	4.60 (1.62)	1961-88	2.45	0.95		76.67
	Tot	-9.55 (0.73)	0.90 (5.73)	0.03 (0.29)	2.09 (0.71)	1961-88	4.13	0.95		20.90
Norway	Man	15.69 (2.19)	0.25 (1.29)	0.08 (3.63)	-3.38 (2.13)	1961-81	0.96	0.67	4.27	-4.51
	Man	10.40 (1.39)	0.40 (2.23)	0.07 (3.29)	-2.24 (1.37)	1961-88	3.94	0.76		-3.73
	Tot	5.36 (0.85)	0.43 (2.38)	0.06 (2.84)	-1.12 (0.81)	1961-88	3.04	0.74		-1.96
Portug.	Man	-21.75 (2.55)	0.97 (7.65)	0.00 (0.08)	4.75 (2.55)	1961-81	-0.11	0.92	1.81	158.33
	Man	-14.81 (2.48)	1.00 (8.20)	0.00 (0.01)	3.24 (2.54)	1961-88	1.61	0.92		-
	Tot	-24.98 (4.19)	0.89 (9.20)	-0.01 (0.34)	5.47 (4.25)	1961-81	1.22	0.94		49.73
Spain	Man	1.11 (0.11)	1.25 (15.95)	0.03 (0.80)	-0.35 (0.16)	1961-81	-1.07	0.98	3.87	-
	Man	-35.81 (5.37)	1.08 (20.74)	0.01 (0.31)	7.82 (5.29)	1961-88	0.51	0.99		-
	Tot	-98.66 (5.97)	1.22 (18.85)	-0.22 (3.36)	21.75 (5.94)	1961-88	-0.12	0.99		-
Sweden	Man	-6.32 (1.12)	0.63 (2.44)	0.02 (1.10)	1.50 (1.27)	1961-81	*	0.34	1.98	4.05
	Man	-9.26 (1.60)	0.87 (4.51)	0.00 (0.37)	2.07 (1.70)	1961-88	*	0.59		15.92
	Tot	2.22 (0.43)	0.68 (3.46)	0.01 (0.44)	-0.35 (0.33)	1961-88	*	0.54		-1.09
Switzl.	Man	0.10 (0.03)	0.57 (2.59)	0.01 (0.60)	-0.03 (0.10)	1961-81	*	0.53	2.75	-0.09
	Man	1.02 (0.75)	0.58 (3.29)	0.02 (1.59)	-0.25 (0.81)	1961-88	5.23	0.79		-0.78
	Tot	3.34 (0.77)	0.63 (4.07)	0.02 (1.73)	-0.75 (0.78)	1961-88	3.34	0.79		-2.03
UK	Man	27.71 (1.17)	0.60 (1.60)	0.24 (1.62)	-6.22 (1.19)	1961-81	*	0.81	2.17	-15.55
	Man	-9.49 (0.46)	0.89 (4.72)	0.03 (0.26)	2.08 (0.46)	1961-88	21.23	0.93		13.91
	Tot	-67.06 (2.58)	0.89 (8.24)	0.11 (2.23)	14.47 (2.57)	1961-88	2.37	0.95		131.53

Notes: t-statistics in parentheses. R^2 = squared multiple correlation coefficient adjusted for degrees of freedom. Pred. fail. = F-test for parameter constancy in the post sample period, 1982-88, $F(17, 7)$ -distributed. Long-run w^* is calculated as $\beta_3 / (1 - \beta_1)$. * = Durbin's h-statistics cannot be computed. Man = real wage gap for the manufacturing sector, Tot = real wage gap for the service sector plus the manufacturing sector.

estimated coefficients on the real wage gap, comparable with the B&S estimates, are quite similar except for the UK. In the B&S estimates *the real wage gap is significant*, with the expected sign, at the 5 per cent level, in 4 of their 6 cases compared to 10 of the 22 countries in the expanded country sample, indicating a country selection bias. The countries chosen for analysis by B&S appear to conform to the theory to a greater extent than on a sample of 22 countries.

This conclusion remains almost unchanged with the estimation period lengthened to 1988 employing the real wage gap for manufacturing or private services plus manufacturing. The R^2 's tend to be higher, though, when the real wage gap for manufacturing and private services is employed. The diagnostic tests suggest the model is likely to be misspecified. In nearly half of the cases, the Durbin's h-statistics are significant at the 5 per cent level, pointing towards first order serial correlation. For 10 countries, the predictive failure test is significant at the 5 per cent level, indicating parameter instability.

Model 2. Since the results of estimating model 1 suggest specification problems, and cyclical shift variables are left out, we now analyse the model employed by Bruno (1986) and fits the equation

$$u_t = \beta_0 + \beta_1 w^x_{t-1} + \beta_2 w^x_{t-2} + \beta_3 m_{t-1} + \beta_4 m_{t-2} + \beta_5 T_t \\ + \beta_6 T_{t-1} (+ \beta_7 F_{t-1} + \beta_8 F_{t-2}) + \beta_9 D_{6274} + \beta_{10} D_{7588} + e_{2t}, \\ \beta_1, \beta_2 > 0, \beta_{3-8} < 0, \quad (3)$$

where m is the monetary stock $M1$ ($M2$ for the US) deflated by consumer prices, T the deviation of the volume of world trade from its trend, F the change in cyclical and inflation corrected fiscal balance as a per cent of potential GDP, D_{6274} a time trend for the period 1962-74 and D_{7588} a time trend for the period 1975-82 and 1975-88 for a longer period. The reason why Bruno includes the split time trend is not clear but may have been included to capture the effects of capital, labour and labour augmenting technological progress as discussed above. Inclusion of the split-time trend, however, is potential dangerous. Since unemployment increased after 1974 in all OECD countries, inclusion of it is likely to overshadow the contributions of the other variables in the equation.

Like model 1, this model is estimated with the real wage gap in manufacturing over the period 1961-82 (as in Bruno (1986)), and 1961 to 1988 with the real wage gap in manufacturing and private services plus manufacturing. Equivalent to the estimates calculated by Bruno, the structural budget balance as a per cent of potential GDP replaces world trade for the US, otherwise it is not included as an explanatory variable. The deviation of the world trade from its trend is calculated as the exponent of

the residual from a regression where the world trade is regressed on a constant and a log time trend. Correction for first order autocorrelation in the residuals is done with a maximum likelihood procedure in the few cases where the Durbin h-statistics are below the lower bound.

The columns 5 to 7 in table 3 summarize the results; the detailed results are provided in table 2. At least one of the lags of the real wage gap is significant, at the 5 per cent level, and has the expected sign in most of the cases, no matter how w^x is measured and which data period is employed. Note, the significance level indicated in table 3 corresponds to the overall significance of the real wage gap lagged one and two years. It is remarkable that the sum of the coefficients on the wage gap is about a third of the long-run estimates in model 1. This may be due to omission of cyclical shift variables in model 1 and/or misspecification of one or both of the models.

The results obtained by Bruno are listed in the final column of table 3. Unlike the fairly close relationship between B&S and my results for the B&S countries in model 1 the correspondence between Bruno and my estimation results is remarkably poor. Firstly, Bruno's coefficients on the real wage gap have much lower standard errors than mine. Secondly, the coefficient estimates differ widely. The different results may reflect that some of the data sources

Table 2. Estimates of model 2:

$$U_t = \beta_0 + \beta_1 w_{t-1} + \beta_2 w_{t-2} + \beta_3 M_{t-1} + \beta_4 M_{t-2} + \beta_5 T_t + \beta_6 T_{t-1} + \beta_7 F_{t-1} + \beta_8 F_{t-2} + \beta_9 6274 + \beta_{10} 7588 + e_t$$

Sec	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9	β_{10}	Estima. period	D.W.	ρ	R ²	Pred. fail.	B.P.	RESET	(2)
Canada	Man	-24.41 (0.55)	15.76 (1.67)	-9.56 (0.82)	-1.86 (0.24)	5.17 (0.71)	-0.06 (0.47)	0.10 (0.79)	-0.02 (0.31)	0.43 (2.90)		1962-82	0.90		0.71	4.42	7.25	1.50	
	Man	-28.56 (1.29)	15.27 (3.57)	-7.09 (1.47)	-8.78 (3.32)	1.89 (0.74)	-0.10 (2.06)	-0.06 (1.39)	-0.01 (0.13)	0.29 (1.98)		1962-88		0.94	0.91				
	Tot	-99.17 (5.93)	14.02 (3.11)	9.20 (1.98)	-8.53 (3.64)	1.07 (0.46)	-0.14 (3.50)	-0.05 (1.27)	0.02 (0.41)	0.32 (4.08)		1962-88		0.68	0.93				
USA	Man	445.42 (2.62)	-76.64 (3.01)	-17.57 (0.48)	-0.58 (1.25)	0.16 (0.45)	0.04 (0.32)	0.33 (2.53)	-0.01 (0.18)	1.13 (2.68)		1962-82	1.10		0.71	4.42	11.38	4.64	
	Man	24.02 (0.44)	-5.76 (0.69)	2.94 (0.36)	-0.36 (1.98)	0.06 (0.31)	-0.16 (3.59)	-0.03 (0.56)	-0.04 (0.88)	0.17 (0.91)		1962-88		0.95	0.82				
	Tot	-101.95 (2.00)	-8.07 (0.54)	32.15 (2.76)	0.27 (0.67)	-0.38 (0.86)	-0.13 (1.46)	0.20 (2.01)	-0.15 (2.39)	0.09 (0.68)		1962-88	1.12		0.61		2.35	1.63	
Japan	Man	-5.18 (1.37)	1.45 (1.72)	-0.10 (0.00)	0.00 (1.45)	-0.00 (0.56)	-0.02 (1.33)	0.00 (0.24)	-0.01 (1.49)	0.04 (1.93)		1962-81	1.80		0.95	1.37	4.95	0.14	
	Man	-6.79 (2.00)	1.78 (2.05)	-0.08 (0.12)	0.00 (1.44)	-0.00 (0.43)	-0.02 (2.46)	-0.01 (0.78)	-0.02 (1.11)	0.05 (4.18)		1962-88	1.49		0.97		12.44	4.34	
	Tot	-7.54 (1.83)	1.03 (0.93)	0.87 (0.98)	0.00 (0.19)	0.00 (0.10)	-0.02 (2.03)	-0.01 (1.04)	-0.02 (1.41)	0.05 (3.71)		1962-88	1.42		0.97		13.32	6.71	
Austra.	Man	-8.08 (0.47)	-2.22 (0.77)	3.36 (1.31)	-0.02 (2.44)	0.05 (6.88)	0.17 (4.32)	-0.14 (3.71)	-0.09 (2.39)	0.42 (7.19)		1962-82	2.22		0.98	9.49	7.31	1.70	
	Man	-91.16 (4.16)	8.05 (1.87)	11.31 (2.68)	-0.03 (1.85)	0.05 (3.63)	0.05 (0.83)	-0.15 (2.79)	0.05 (0.71)	0.41 (5.86)		1962-88	1.46		0.95		8.64	2.64	
	Tot	-113.05 (7.44)	18.50 (2.50)	7.29 (1.16)	-0.04 (3.25)	0.01 (0.76)	-0.03 (0.62)	-0.05 (1.16)	0.12 (2.68)	0.46 (7.22)		1962-88	1.77		0.98		12.62	0.14	
New Zl.	Man	-34.67 (1.78)	5.57 (0.93)	2.53 (0.39)	-0.01 (0.11)	-0.05 (0.51)	-0.02 (0.31)	-0.01 (1.04)	0.28 (0.70)	0.44 (2.75)		1973-88	2.35		0.86		11.00	11.99	
	Tot	-44.78 (1.77)	3.48 (0.54)	6.53 (1.10)	0.01 (0.09)	-0.04 (0.44)	-0.03 (0.37)	-0.05 (0.49)	0.26 (0.57)	0.45 (2.62)		1973-88	2.35		0.85		7.19	8.44	

Table 2 continued.

Sec	β_0	β_1	β_2	β_3	β_4	$\beta_5(\beta_7)$	$\beta_6(\beta_8)$	β_9	β_{10}	Estima. period	D.W.	ρ	R ²	Pred. fail.	H.P. RESET(Z)
Austria Man	-6.93 (1.01)	0.34 (0.18)	1.19 (0.75)	0.23 (0.27)	0.64 (0.66)	0.08 (2.45)	0.05 (1.06)	0.02 (0.53)	0.13 (2.35)	1966-82	2.42		0.79	1.79	5.73 1.98
Man	-11.84 (1.72)	-0.07 (0.04)	2.55 (1.60)	0.45 (0.50)	0.78 (0.76)	-0.07 (2.15)	-0.07 (2.11)	0.02 (0.54)	0.08 (2.13)	1966-88	1.84		0.90		4.74 0.16
Tot	-11.86 (1.36)	0.71 (0.33)	2.27 (1.10)	-0.39 (0.40)	0.06 (0.05)	-0.05 (1.75)	-0.07 (1.91)	0.47 (0.13)	0.10 (3.20)	1966-88	1.87		0.89		7.11 1.22
Belgium Man	-3.64 (0.32)	5.40 (2.01)	-5.06 (2.03)	-0.04 (0.11)	0.40 (1.25)	-0.06 (1.12)	-0.03 (0.56)	-0.06 (1.49)	0.96 (11.73)	1962-82	1.32		0.98	7.58	7.44 1.40
Man	-81.77 (10.17)	9.61 (4.46)	9.77 (3.96)	-0.44 (2.72)	0.08 (0.06)	-0.06 (2.33)	-0.15 (5.58)	0.02 (0.71)	0.32 (6.53)	1962-88		0.71	0.99		
Tot	-92.36 (10.84)	7.82 (1.98)	13.68 (3.02)	-0.65 (2.20)	0.15 (0.62)	-0.09 (2.15)	-0.14 (3.59)	0.02 (0.59)	0.30 (6.00)	1962-88	1.09		0.99		8.58 1.26
Denmark Man	-111.19 (0.78)	27.35 (1.15)	-4.66 (0.16)	7.59 (0.63)	0.84 (0.08)	-0.08 (0.43)	0.05 (0.20)	-0.13 (0.58)	0.63 (1.89)	1968-82	1.84		0.89	1.53	3.56 5.79
Man	-199.12 (3.29)	28.34 (1.58)	15.91 (0.98)	-5.76 (1.82)	3.15 (0.51)	0.03 (0.26)	-0.00 (0.00)	-0.61 (0.36)	0.65 (3.83)	1968-88	1.82		0.84		10.77 4.16
Tot	-162.96 (2.49)	30.50 (2.05)	6.10 (0.42)	-5.24 (1.44)	1.41 (0.38)	-0.03 (0.21)	0.05 (0.41)	-0.13 (0.69)	0.40 (1.45)	1968-88	1.88		0.81		7.87 4.75
Finland Man	-72.23 (2.84)	8.78 (1.64)	7.58 (2.16)	-0.02 (1.55)	0.02 (1.57)	0.10 (1.23)	-0.20 (2.08)	-0.12 (2.20)	0.32 (2.54)	1962-82	1.63		0.88	0.89	6.16 3.38
Man	-92.25 (6.78)	15.63 (5.46)	5.26 (1.83)	-0.01 (1.32)	0.01 (1.03)	0.00 (0.09)	-0.04 (0.67)	-0.15 (3.77)	0.18 (2.55)	1962-88	1.42		0.88		5.63 1.29
Tot	-86.01 (8.71)	18.37 (4.64)	1.71 (0.41)	-0.36 (0.04)	0.01 (0.66)	-0.01 (0.31)	-0.05 (1.08)	-0.10 (3.39)	0.31 (4.73)	1962-88	1.70		0.92		5.91 0.29
France Man	-38.73 (1.42)	19.26 (1.48)	-10.94 (1.56)	0.05 (0.27)	0.19 (1.12)	-0.01 (0.07)	0.05 (1.22)	0.03 (0.97)	0.48 (4.76)	1962-82	1.92		0.97	2.81	4.49 0.28
Man	-41.42 (3.02)	6.47 (1.30)	2.56 (0.46)	0.01 (0.03)	0.19 (0.86)	-0.18 (0.05)	0.01 (0.29)	0.02 (0.58)	0.56 (10.62)	1962-88	1.25		0.98		14.00 1.93
Tot	-42.21 (3.31)	19.20 (3.83)	-10.01 (1.69)	0.01 (0.07)	0.12 (0.72)	-0.02 (0.77)	-0.01 (0.21)	0.05 (2.03)	0.55 (10.71)	1962-88	1.76		0.99		10.57 0.12
Germany Man	-142.49 (6.87)	16.31 (3.15)	14.91 (2.50)	-1.05 (1.21)	1.07 (0.98)	-0.14 (3.39)	-0.01 (0.18)	-0.04 (1.15)	0.05 (0.59)	1962-82	1.78		0.97	6.97	4.86 6.47
Man	-128.56 (5.50)	19.96 (2.45)	8.42 (0.99)	-0.25 (0.19)	-0.52 (0.36)	-0.07 (1.27)	-0.08 (1.41)	-0.01 (0.14)	0.42 (4.59)	1962-88	1.08		0.97		13.04 2.09
Tot	-167.18 (1.96)	12.37 (2.65)	5.95 (0.54)	-1.46 (2.04)	-1.47 (0.61)	-0.01 (0.15)	-0.03 (0.14)	0.05 (0.84)	1.17 (4.28)	1962-88	0.96		0.95		16.97 13.64

Table 2 continued.

Sec	β_0	β_1	β_2	β_3	β_4	$\beta_5(\beta_7)$	$\beta_6(\beta_8)$	β_9	β_{10}	Estima. period	D.W.	P	R ²	Pred. fail.	B.P.	RESET(2)
Greece	Man	-35.67 (1.74)	4.11 (0.69)	3.41 (0.60)	0.10 (0.10)	0.90 (1.17)	-0.33 (2.21)	-0.15 (1.00)	0.09 (0.60)	-0.24 (1.73)	1967-82	1.47	0.86	1.89	7.96	52.18
	Man	-12.32 (1.30)	2.76 (0.76)	0.84 (0.24)	-0.89 (1.27)	0.78 (1.14)	-0.17 (3.03)	-0.13 (1.68)	0.13 (1.22)	0.25 (2.41)	1967-88	1.52	0.92		11.61	0.04
	Tot	-12.20 (0.49)	1.66 (0.23)	2.28 (0.32)	-0.86 (1.14)	0.36 (0.51)	-0.17 (2.73)	-0.12 (1.38)	0.09 (0.70)	0.27 (1.54)	1967-88	1.34	0.90		9.77	0.03
Ireland	Man	-70.95 (3.33)	7.30 (1.71)	8.94 (2.46)	-0.21 (1.88)	0.29 (2.74)	0.03 (0.34)	-0.25 (3.54)	-0.11 (2.36)	0.33 (2.65)	1962-82	1.92	0.90	6.23	7.52	10.88
	Man	-50.88 (1.98)	9.43 (1.58)	3.30 (0.63)	-0.21 (1.22)	0.07 (0.47)	0.03 (0.29)	-0.25 (2.68)	0.04 (0.61)	0.92 (12.54)	1962-88	0.93	0.95		9.21	7.01
	Tot	-80.92 (3.48)	16.11 (2.91)	3.70 (0.68)	-0.18 (1.25)	-0.12 (0.79)	-0.07 (0.74)	-0.14 (1.83)	0.17 (2.54)	0.99 (15.28)	1962-88	1.22	0.97		13.39	7.54
Italy	Man	-2.93 (0.21)	0.02 (0.08)	1.52 (0.42)	0.01 (0.90)	-0.00 (0.24)	0.02 (0.32)	-0.12 (2.38)	-0.02 (0.46)	0.30 (3.66)	1962-82	1.98	0.89	0.83	6.20	2.26
	Man	-5.67 (0.51)	-0.37 (0.12)	2.56 (0.91)	0.73 (0.98)	-0.00 (0.46)	0.03 (0.98)	-0.11 (3.09)	0.01 (0.37)	0.41 (8.11)	1962-88	1.71	0.97		1.82	2.33
	Tot	1.41 (0.14)	-2.11 (0.79)	2.72 (1.04)	0.00 (0.82)	-0.00 (0.20)	0.03 (0.93)	-0.11 (3.23)	0.02 (0.56)	0.39 (7.56)	1962-88	1.56	0.97		5.85	3.96
Luxemb.	Man	-2.00 (1.35)	0.42 (1.43)	0.18 (0.45)	-0.04 (0.63)	-0.02 (0.52)	-0.00 (0.29)	-0.01 (1.16)	-0.01 (1.71)	0.11 (5.14)	1962-82	2.27	0.96	6.01	6.20	6.00
	Man	-4.89 (3.50)	0.31 (0.77)	1.12 (2.42)	-0.15 (1.82)	0.01 (0.02)	-0.00 (0.06)	-0.04 (3.02)	-0.02 (2.09)	0.07 (5.38)	1962-88	1.72	0.96		10.27	3.86
	Tot	-5.85 (2.53)	0.17 (0.24)	1.38 (2.29)	-0.14 (1.48)	0.03 (0.37)	0.01 (0.60)	-0.03 (2.65)	-0.01 (0.78)	0.08 (5.00)	1962-88	1.50	0.95		14.58	0.39
Nethl.	Man	-27.99 (0.59)	-5.46 (0.68)	10.68 (1.04)	-4.38 (0.40)	15.99 (1.81)	-0.22 (1.81)	0.03 (0.26)	-0.12 (1.48)	0.42 (2.25)	1962-82	1.14	0.92	1.96	7.71	19.60
	Man	-79.78 (3.87)	-3.60 (0.48)	21.15 (3.07)	-10.53 (1.30)	14.36 (1.62)	-0.10 (1.06)	-0.06 (0.63)	-0.17 (2.81)	0.61 (3.47)	1962-88	1.01	0.94		6.53	5.24
	Tot	-83.95 (4.75)	3.83 (0.47)	16.85 (2.48)	-15.21 (1.99)	-1.28 (0.14)	-0.10 (0.97)	-0.07 (0.66)	-0.03 (0.53)	0.90 (4.33)	1962-88	0.90	0.95		7.64	14.18
Norway	Man	8.05 (0.73)	1.45 (0.81)	-3.32 (1.38)	5.16 (1.72)	-1.91 (0.68)	-0.02 (0.56)	0.01 (0.34)	-0.02 (0.93)	0.08 (1.22)	1962-82	1.96	0.65	4.42	5.32	0.00
	Man	-20.99 (2.34)	5.47 (4.11)	-0.61 (0.45)	2.18 (2.77)	-1.89 (1.62)	0.01 (0.43)	-0.06 (2.83)	-0.04 (1.90)	0.01 (0.12)	1962-88		0.80	0.81		
	Tot	-19.59 (1.80)	5.61 (1.47)	-0.98 (0.74)	1.73 (1.14)	-2.95 (1.77)	-0.03 (0.67)	-0.01 (0.78)	-0.01 (0.44)	0.08 (1.11)	1962-88	1.01	0.65		12.30	0.01

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Table 2 continued.

Sec	β_0	β_1	β_2	β_3	β_4	$\beta_5(\beta_7)$	$\beta_6(\beta_8)$	β_9	β_{10}	Estima. period	D.W.	ρ	R ²	Pred. fail.	B.P.	RESET(2)
Greece																
Man	-35.67 (1.74)	4.11 (0.69)	3.41 (0.60)	0.10 (0.10)	0.90 (1.17)	-0.33 (2.21)	-0.15 (1.00)	0.09 (0.60)	-0.24 (1.73)	1967-82	1.47		0.86	1.89	7.96	52.18
Man	-12.32 (1.30)	2.76 (0.76)	0.84 (0.24)	-0.89 (1.27)	0.78 (1.14)	-0.17 (3.03)	-0.13 (1.68)	0.13 (1.22)	0.25 (2.41)	1967-88	1.52		0.92		11.61	0.04
Tot	-12.20 (0.49)	1.66 (0.23)	2.28 (0.32)	-0.86 (1.14)	0.36 (0.51)	-0.17 (2.73)	-0.12 (1.38)	0.09 (0.70)	0.27 (1.54)	1967-88	1.34		0.90		9.77	0.03
Ireland																
Man	-70.95 (3.33)	7.30 (1.71)	8.94 (2.46)	-0.21 (1.88)	0.29 (2.74)	0.03 (0.34)	-0.25 (3.54)	-0.11 (2.36)	0.33 (2.65)	1962-82	1.92		0.90	6.23	7.52	10.88
Man	-50.88 (1.98)	9.43 (1.58)	3.30 (0.63)	-0.21 (1.22)	0.07 (0.47)	0.03 (0.29)	-0.25 (2.68)	0.04 (0.61)	0.92 (12.54)	1962-88	0.93		0.95		9.21	7.01
Tot	-80.92 (3.48)	16.11 (2.91)	3.70 (0.68)	-0.18 (1.25)	-0.12 (0.79)	-0.07 (0.74)	-0.14 (1.83)	0.17 (2.54)	0.99 (15.28)	1962-88	1.22		0.97		13.39	7.54
Italy																
Man	-2.93 (0.21)	0.02 (0.08)	1.52 (0.42)	0.01 (0.90)	-0.00 (0.24)	0.02 (0.32)	-0.12 (2.38)	-0.02 (0.46)	0.30 (3.66)	1962-82	1.98		0.89	0.83	6.20	2.26
Man	-5.67 (0.51)	-0.37 (0.12)	2.56 (0.91)	0.73 (0.98)	-0.00 (0.46)	0.03 (0.98)	-0.11 (3.09)	0.01 (0.37)	0.41 (8.11)	1962-88	1.71		0.97		1.82	2.33
Tot	1.41 (0.14)	-2.11 (0.79)	2.72 (1.04)	0.00 (0.82)	-0.00 (0.20)	0.03 (0.93)	-0.11 (3.23)	0.02 (0.56)	0.39 (7.56)	1962-88	1.56		0.97		5.85	3.96
Luxemb.																
Man	-2.00 (1.35)	0.42 (1.43)	0.18 (0.45)	-0.04 (0.63)	-0.02 (0.52)	-0.00 (0.29)	-0.01 (1.16)	-0.01 (1.71)	0.11 (5.14)	1962-82	2.27		0.96	6.01	6.20	6.00
Man	-4.89 (3.50)	0.31 (0.77)	1.12 (2.42)	-0.15 (1.82)	0.01 (0.02)	-0.00 (0.06)	-0.04 (3.02)	-0.02 (2.09)	0.07 (5.38)	1962-88	1.72		0.96		10.27	3.86
Tot	-5.85 (2.53)	0.17 (0.24)	1.38 (2.29)	-0.14 (1.48)	0.03 (0.37)	0.01 (0.60)	-0.03 (2.65)	-0.01 (0.78)	0.08 (5.00)	1962-88	1.50		0.95		14.58	0.39
Nethl.																
Man	-27.99 (0.59)	-5.46 (0.68)	10.68 (1.04)	-4.38 (0.40)	15.99 (1.81)	-0.22 (1.81)	0.03 (0.26)	-0.12 (1.48)	0.42 (2.25)	1962-82	1.14		0.92	1.96	7.71	19.60
Man	-79.78 (3.87)	-3.60 (0.48)	21.15 (3.07)	-10.53 (1.30)	14.36 (1.62)	-0.10 (1.06)	-0.06 (0.63)	-0.17 (2.81)	0.61 (3.47)	1962-88	1.01		0.94		6.53	5.24
Tot	-83.95 (4.75)	3.83 (0.47)	16.85 (2.48)	-15.21 (1.99)	-1.28 (0.14)	-0.10 (0.97)	-0.07 (0.66)	-0.03 (0.53)	0.90 (4.33)	1962-88	0.90		0.95		7.64	14.18
Norway																
Man	8.05 (0.73)	1.45 (0.81)	-3.32 (1.38)	5.16 (1.72)	-1.91 (0.68)	-0.02 (0.56)	0.01 (0.34)	-0.02 (0.93)	0.08 (1.22)	1962-82	1.96		0.65	4.42	5.32	0.00
Man	-20.99 (2.34)	5.47 (4.11)	-0.61 (0.45)	2.18 (2.77)	-1.89 (1.62)	0.01 (0.43)	-0.06 (2.83)	-0.04 (1.90)	0.01 (0.12)	1962-88		0.80	0.81			
Tot	-19.59 (2.34)	5.61 (4.11)	-0.98 (0.45)	1.73 (2.77)	-2.95 (1.62)	-0.03 (0.43)	-0.01 (2.83)	-0.01 (1.90)	0.08 (0.12)	1962-88	1.01		0.65		12.70	0.01

Table 2 continued.

Sec	β_0	β_1	β_2	β_3	β_4	$\beta_5(\beta_7)$	$\beta_6(\beta_8)$	β_9	β_{10}	Estima. period	D.W.	ρ	R ²	Pred. fail.	B.P.	RESET(2)
Port.																
Man	5.77 (0.59)	-0.52 (0.35)	-0.46 (0.26)	-0.18 (1.65)	0.39 (3.82)	0.25 (4.66)	-0.16 (4.07)	-0.17 (4.90)	0.58 (10.19)	1962-82	1.78		0.97	19.84	6.12	1.71
Man	-34.40 (1.83)	-0.28 (0.08)	8.10 (2.26)	-0.09 (0.36)	0.22 (0.96)	-0.05 (0.52)	0.01 (0.05)	-0.11 (1.32)	0.48 (4.87)	1962-88	1.25		0.84		14.13	0.00
Tot	-49.47 (2.55)	-0.45 (0.07)	11.11 (2.56)	-0.14 (0.63)	0.35 (1.93)	-0.06 (0.77)	0.00 (0.03)	-0.03 (0.32)	0.38 (5.93)	1962-88	1.15		0.88		16.71	7.22
Spain																
Man	8.00 (0.51)	-8.15 (2.51)	6.41 (1.80)	0.09 (1.65)	-0.08 (1.36)	-0.14 (2.85)	0.13 (2.65)	0.09 (2.23)	1.73 (15.64)	1962-82	1.79		0.99	11.93	8.21	11.52
Man	-38.16 (1.02)	0.19 (0.04)	8.02 (1.51)	0.05 (1.95)	-0.02 (0.83)	-0.22 (2.54)	0.03 (0.35)	0.07 (1.34)	1.53 (16.19)	1962-88	0.90		0.98		9.69	8.56
Tot	-123.14 (3.84)	23.87 (3.00)	3.68 (0.28)	0.07 (2.48)	-0.07 (3.04)	0.10 (1.37)	0.74 (1.36)	1.57 (1.36)	1.58 (20.09)	1962-88	0.99		0.98		13.05	18.05
Sweden																
Man	5.81 (0.74)	1.19 (0.80)	-2.14 (1.51)	-5.36 (0.73)	4.73 (0.63)	-0.02 (0.38)	0.01 (0.35)	0.09 (3.82)	0.21 (2.42)	1962-82	1.99		0.53	2.93	5.55	0.59
Man	5.46 (0.76)	2.21 (1.40)	-2.89 (1.72)	0.08 (0.07)	-3.10 (3.06)	-0.07 (2.12)	0.07 (1.77)	0.10 (3.64)	0.25 (4.61)	1962-88	1.62		0.50		8.31	0.24
Tot	-4.43 (0.49)	1.01 (0.30)	0.45 (0.14)	0.18 (0.14)	-2.77 (2.42)	-0.07 (1.72)	0.04 (1.00)	0.08 (2.69)	0.24 (3.20)	1962-88	1.28		0.43		9.55	3.33
Switzl.																
Man	-1.83 (3.09)	-0.16 (0.15)	0.70 (0.64)	-0.81 (1.89)	0.32 (0.68)	0.02 (2.28)	-0.02 (2.51)	-0.03 (3.45)	-0.01 (0.83)	1962-82	1.94		0.84	7.01	14.48	14.11
Man	-1.41 (1.42)	-3.03 (1.76)	3.44 (2.05)	-0.38 (0.57)	0.19 (0.25)	0.01 (0.97)	-0.05 (3.69)	-0.03 (2.48)	0.01 (0.41)	1962-88	1.39		0.83		10.89	18.63
Tot	-0.79 (0.14)	1.15 (0.84)	-1.07 (0.65)	-0.28 (0.37)	1.41 (1.71)	0.02 (1.16)	-0.06 (2.87)	-0.05 (0.67)	0.01 (0.67)	1962-88	1.07		0.80		12.59	10.00
UK																
Man	-19.36 (1.97)	11.16 (1.80)	-3.49 (0.57)	-16.87 (2.39)	-13.22 (1.46)	-0.09 (1.57)	0.02 (0.24)	0.08 (1.97)	0.73 (7.43)	1962-82	1.60		0.94	0.38	5.02	8.90
Man	-24.76 (3.08)	6.98 (1.53)	0.29 (0.06)	-10.38 (2.29)	-5.16 (0.90)	-0.11 (2.58)	-0.03 (0.74)	0.07 (2.18)	0.86 (15.83)	1962-88	1.06		0.98		9.40	6.75
Tot	-5.80 (0.09)	-8.88 (0.96)	12.36 (1.60)	-20.12 (3.52)	1.76 (0.25)	-0.02 (0.36)	-0.01 (0.08)	0.12 (1.88)	1.04 (15.81)	1962-88	1.04		0.97		12.56	0.83

Notes: t-statistics in parentheses. D.W. = Durbin-Watson test for first order autoregression, ρ = autocorrelation coefficient, R² = multiple correlation coefficient adjusted for degrees of freedom. Pred. fail. = test for parameter constancy in the forecast period, 1983-88, F(14,6)-distributed under the null of parameter constancy, N.P. = Breusch-Pagan test of homoscedasticity, $\chi^2(8)$ -distributed under the null of homoscedasticity, RESET(2) = Ramsey's RESET test of misspecification/non-linearity with the power of two, F(1, n-k-1) distributed under the null of well-specification/linearity, where n is the number of observations and k the number of explanatory variables. Man = real wage gap for the manufacturing sector, Tot = real wage gap for the service sector plus the manufacturing sector.

Table 3. Long-run coefficients on the real wage gap.

	Table 1			B&S	Table 2			Bruno
	Man ₈₁	Man ₈₈	Tot ₈₈	Man ₈₁	Man ₈₂	Man ₈₈	Tot ₈₈	Man ₈₂
Canada	28.2*	28.1	63.4*	42.5*	6.2	8.1*	23.4*	28.8*
USA	-8.8	10.0	-3.87	11.1	-94.21	-2.8	24.0	18.7*
Japan	2.5*	2.6*	3.4*	5.2*	1.3	1.7	1.9	3.9
Australia	22.3*	20.6*	24.3*	-	1.2	19.4*	25.8*	-
N. Zeal.	13.1	6.51	6.8	-	-	8.3	10.0	-
Austria	3.2*	3.6	-4.0	-	1.5	2.4	3.0	-
Belgium	14.2*	17.9*	98.9	-	0.3*	19.4*	21.4*	11.0*
Denmark	57.9	53.3*	79.5*	-	22.7	44.25	36.6	46.7*
Finland	46.1*	28.3*	16.8*	-	16.4*	21.0*	20.1*	-
France	41.5*	55.0*	34.6*	63.6	8.3*	9.0	9.2*	-4.2*
Germany	26.7*	85.0*	0.4	17.7*	31.2*	28.4	38.3	11.4*
Greece	-	12.8*	30.8	-	7.5	3.6	4.0	-
Ireland	-0.9	-0.2	-9.3	-	16.2*	12.7	19.8*	-
Italy	-0.5	-7.3	9.9	-	1.5	2.2	0.6	-
Luxemb.	-1.2	-0.5	0.0	-	0.6	1.4*	1.6	-
Netherl.	-24.6	76.7	20.9	-	5.2	17.6*	20.7	-
Norway	-4.5*	-3.7	-2.0	-	-1.9	4.9	4.6	-
Portugal	158.3*	-	49.7*	-	-1.0	7.8	10.6	-
Spain ¹	-0.4	7.8*	21.8*	-	-1.7*	8.2	27.6*	-
Sweden	4.1	15.9*	-1.1	-	-1.0	-0.7	1.5	-
Switzerl.	-0.1	-0.8	-2.0	-	0.5	0.4*	0.8	-
UK	-15.6	18.9	131.5*	20.5*	7.7	7.2	3.5	22.3*

*: Significant at the 5 per cent level.

1. Short-run coefficients for the estimates of model 1 since the estimate is dynamic unstable.

differ and the cyclical shift variables are differently estimated.

The diagnostic tests of model 2 suggest specification problems. The RESET test, of the power two, is significant at the 5 per cent level in more than a third of the cases pointing toward misspecification and/or functional form problems. The predictive failure test rejects the hypothesis of parameter constancy in the forecast period, 1983-88, for more than half of the countries, at the 5 per cent level.

Model 3. The discussion of the previous two models indicated specification problems and the inclusion of time trends are likely to invalidate or blur some of the results. Furthermore, the different parameter estimates of estimating model 2 indicate that the cyclical variables may interfere with the parameter estimates on the real wage gap. Finally, the cyclical variables may not be good proxies for the business cycle. This suggests it may be fruitful to consider another model specification to reveal the more genuine influence of the real wage gap on unemployment. The following model is estimated

$$U_t = \beta_0 + \beta_1 U_{t-1} + \beta_2 cyc_t + \beta_3 w^x + e_{3t},$$

$$\beta_3 < 0 \text{ and } \beta_2 > 0,$$

(4)

where cyc is the deviation of the log of GDP in manufacturing and private services from its log time trend.² Although the model may look similar to the previous models it gives remarkably different results.

The results of estimating model 3, with data for manufacturing and private services, are shown in table 4. A maximum likelihood procedure is applied to account for the presence of first order serial correlation in those cases indicated in the table. The diagnostic tests, apart from the heteroscedasticity tests discussed below, suggest the model specification is acceptable. The coefficient estimates are quite tidy compared to the previous results. All coefficients have their expected signs. The real wage gap is significant, at the 5 per cent level, in 13 instances, which is an improvement from the previous estimates. Do these results imply that the unemployment path can be explained by the real wage gap and cyclical variables? No, certainly not. The coefficient on the lagged dependent variable is very close to, and even above, unity for most countries. Disregarding the cases where the coefficient on the lagged dependent is above unity the result may suggest a the very long adjustment period to innovations in the explanatory variables. This, however, is highly unlikely to be the case. Firstly, adjustment of the

2. A more general model, with both w^x and cyc lagged two periods, was estimated with sequential deletion of insignificant variables. Almost the same results were obtained of estimating this model.

Table 4. Parameter estimates of model 3. $U_t = \beta_0 + \beta_1 U_{t-1} + \beta_2 CYC_t + \beta_3 w^x + e_{3t}$.

	β_0	β_1	β_2	β_3	LM	BP	RESET(2)
Canada	-33.91(3.28)	0.93(7.61)	-3.00(1.11)	7.35(3.29)	0.92	23.55	-0.30
USA	-19.57(0.76)	0.88(6.61)	-4.55(1.38)	4.40(0.79)	0.55	18.61	0.37
Japan	-5.26(4.40)	0.89(8.86)	-0.69(1.55)	1.14(4.29)	0.05	25.19	0.13
Australia	-30.64(2.99)	0.89(10.1)	-1.91(0.61)	6.64(3.02)	0.38	5.03	2.28
N. Zeal.	-1.33(0.05)	1.02(6.52)	-6.00(0.76)	0.35(0.06)	0.94	5.92	2.53
Austria	-8.73(1.75)	0.92(9.06)	-3.67(0.91)	1.86(1.80)	0.02	1.78	1.11
Belgium#	-37.75(6.11)	0.90(20.3)	-8.19(3.21)	8.07(6.15)	0.70	20.18	0.44
Denmark	-113.78(4.35)	0.60(6.48)	-8.96(1.73)	25.05(4.37)	0.22	5.99	3.01
Finland#	-34.86(2.62)	0.63(4.97)	-2.50(1.11)	7.76(2.69)	1.20	4.82	-0.84
France#	-30.95(6.92)	0.93(40.9)	-3.21(3.15)	6.70(6.98)	0.66	19.95	-1.87
Germany#	-20.41(0.71)	0.73(5.73)	-10.38(3.11)	4.72(0.76)	1.33	9.83	-3.56
Greece#	-8.75(1.01)	0.82(6.86)	-1.74(0.55)	3.04(1.10)	1.35	16.10	-0.97
Ireland#	-29.81(1.67)	1.05(12.2)	-2.35(0.88)	6.37(1.69)	0.03	19.38	0.37
Italy	-9.44(1.37)	1.15(16.2)	-2.93(1.62)	1.85(1.24)	0.01	23.72	1.31
Luxembourg	-1.88(1.77)	0.99(14.4)	-0.46(0.99)	0.40(1.80)	0.38	6.80	3.12
Netherl.#	-21.77(1.85)	0.92(13.5)	-7.71(1.58)	4.76(1.90)	0.40	12.33	0.67
Norway	-9.17(1.47)	0.80(4.79)	-2.14(0.74)	2.03(1.51)	0.38	15.44	0.18
Portugal	-30.86(4.75)	0.94(15.6)	-3.29(1.82)	6.62(4.85)	0.39	21.31	1.02
Spain#	-53.32(4.27)	1.00(34.4)	-2.93(1.00)	11.59(4.31)	0.29	17.28	5.01
Sweden	-1.04(0.26)	0.86(6.12)	-6.34(3.89)	0.29(0.34)	0.54	18.35	1.37
Switzerl.#	-1.95(0.46)	0.39(2.49)	-2.72(3.04)	0.46(0.51)	0.71	12.68	-2.26
UK#	-4.93(0.24)	1.12(16.4)	-18.23(4.74)	0.99(0.22)	0.31	15.46	4.54

Notes: See notes to table 1. LM is a Lagrange multiplier test of first order serial correlation, $t(n-k-1)$ -distributed under the null of no serial correlation.

labour inputs, to the desired level, is not likely to take much more than a couple of years. Secondly, the results indicate it takes longer to adjust labour inputs in Canada and the US than in most of the North European countries; which is very much at variance with the accepted view on this issue (see for instance Krugman (1985)).

The high magnitude of the coefficients on the lagged dependent variable is more likely to reflect the upward drift in the unemployment rate that has occurred over the period caused by other factors than the business cycle and the real wage gap. From this we can conclude the real wage gap has contributed to the unemployment path, for most countries, but is not able to account for the persistent rise in the unemployment rate in the OECD countries. This interpretation is supported by the time profile of the unemployment rates and the real wage gaps. For all countries, by and large, the real wage gap increased strongly from the mid 1960s to the mid 1970s and continually declined thereafter. Hence, the almost secular increase in the unemployment rate in the OECD countries since the mid 1970s is unlikely to be a result of the real wage gap, even if the model is modified for the influence of the business cycle.

The time profiles of the unemployment rate and wage gaps are likely to be the reasons for the presence of heteroscedasticity and it is possible that the

heteroscedasticity is an indication of the measurement of the real wage gap in the sense that the decline of the real wage gap after the mid 1970s is likely to be exaggerated in the estimates. This may have occurred for two reasons. First, the estimates of the real wage gap under a translog technology in the next chapter demonstrate that the real wage gap has declined at a slower rate under this technology assumption than under the Cobb-Douglas real wage gap. Second, Krugman (1985) has pointed out that the real wage gap over the long-run, and even in the medium term, may be underestimated. An increase in the real wage gap, for instance, triggers a capital deepening process, which in turn increases the marginal productivity of labour and hence lowers the real wage gap. This effect may have been important since the growth of the capital stock, in most OECD countries, was much higher before the mid 1970s than after. The slow-down in demand after 1973 has of course influenced the growth of capital stock.

Model 4. To investigate further the extent to which the real wage gap has contributed to the unemployment path over time, changes in the unemployment rate are regressed on changes in the real wage gap and income employing pooled cross-section and time-series data

$$(u_t - u_{t-i}) = \beta_0 + \beta_1(w_t^x - w_{t-i}^x) + \beta_2(y_t - y_{t-i}) + e_{4t},$$
$$\beta_1 > 0, \beta_2 < 0, i = 4, 7, \quad (6)$$

where country subscripts are suppressed. Estimation of this equation may additionally shed light on whether changes in the real wage gap across countries can explain, or contribute to, changes in the unemployment rates across countries. The model is estimated with "long differences"; that is changes in variables over a four and a seven years time span corresponding to the duration of an average business cycle.³

The model is estimated with "long differences" to count for the fact that the actual timing of the relationship between unemployment/employment and the real wage gap in the previous models may be blurred for the following reasons: First, the time period it takes the markets to clear after a change in the real wage gap is likely to vary depending on the activity level and whether there is a cyclical upturn or downturn. In Europe, at least, labour is a quasi-fixed factor; that is firms are not free to fire workers and have to give notice long in advance. Therefore, it may take some years before an equilibrium is reached. The time it takes for the markets to clear after an increase in the real wage gap, amongst other factors, depends on the cyclical demand for labour and the outflow of the labour from the labour market due to retirement etc. Second, a

3. If one uses long differences with yearly data, a moving average in the residuals appear. In order to circumvent this problem generalized least squares (GLS) may be employed. Changing adjustment period over time and the shift in factors that triggered the change in the real wage gap over time, however, renders the usage of GLS unsuitable.

causality from excessive wage changes to employment changes may be blurred if wages fluctuate more than prices over the business cycle.⁴ If prices increase less than the nominal wage in a cyclical upturn, for instance, the real wage gap will increase side by side with a rise in income, and hence tend to push employment in an upward direction. Thirdly, Helliwell (1988) has shown that the profit maximization approach in labour demand, as used by B&S, relative to the cost minimizing approach, overstates the real wage gap when profitability is relatively low. Since revenues are likely to fluctuate more than costs over the business cycle, a "causality" from the real wage gap to employment is likely to be overstated. Fourthly, if firms increase prices due to a surge in demand in the first period, and then increase the supply of goods in the next, a negative relationship between employment and the real wage gap is established (Summers (1987)).

The model is estimated by pooling time-series and cross-section data for all the countries previously considered except New Zealand, Austria, Denmark and Greece, where the data period commence later than 1960. The real wage gap is the composite of the wage gap for private services and manufacturing. As the null hypothesis of homoscedasticity across countries is rejected at the 1 per cent level, the models are estimated by feasible generalised least squares

4. Bils (1987) finds the price-marginal cost margin ratio to be markedly countercyclical for the US industries.

(FGLS). The Lagrangian multiplier tests are performed to decide whether to estimate random effects or fixed effects models and the tests only weakly favoured the random effects model to the fixed effects model, at the 5 per cent level.⁵ Hence the estimation results of both estimators are reported.

The estimation results are presented in table 5. The wage gap is insignificant, even at the 10 per cent level, in all the estimates.⁶ Consequently, the wage gap cannot contribute much to the explanation of the change in the path of the unemployment rate over time and across countries. This result concurs with that of estimating model 3 in the sense that the path of the unemployment rate is mainly explained by its past values and the real wage gap and business cycles do not have a strong influence on the path. The coefficient on the change in the GDP is significant at the 5 per cent level and has the expected sign in all the estimates.

Model 5. The results of estimating model 4 do not invalidate the real wage gap theory. The real wage gap theory relates the real wage gap to labour inputs and the

5. In the fixed effect models the slope coefficients are assumed equal, but the constant term different across countries by the inclusion of country dummies. In the random effects models the slope coefficients are assumed equal across countries, but the constant term is treated randomly and merged with the disturbance term.

6. The significance of the coefficient on the change in the real wage did not change much with the change in the GDP excluded. These results are not reported.

Table 5. Estimates of model 5 and 6:

$$(u_t - u_{t-i}) = \beta_0 + \beta_1 (w_t^x - w_{t-i}^x) + \beta_2 (y_t - y_{t-i}) + e_t$$

$$(l_t - l_{t-i}) = \beta_0 + \beta_1 (w_t^x - w_{t-i}^x) + \beta_2 (y_t - y_{t-i}) + \beta_3 \pi + e_t$$

Dep. var.	β_0	β_1	β_2	β_3	$R^2(B)$	SSE	N*T	Type
$u_t - u_{t-4}$	2.04 (0.66)	-0.164 (0.24)	-4.84 (5.08)		0.54	1.06	126	FE
$u_t - u_{t-1}$	0.24 (0.14)	0.139 (0.15)	-4.24 (4.59)		0.21	0.74	126	RE
$u_t - u_{t-7}$	1.51 (0.21)	0.133 (0.13)	-6.09 (4.64)		0.72	1.17	72	FE
$u_t - u_{t-7}$	2.70 (0.75)	-0.487 (0.39)	-3.85 (4.30)		0.34	0.50	72	RE
$l_t - l_{t-4}$	4.08 (4.08)	-0.172 (3.88)	0.40 (9.11)		0.83	1.04	126	FE
$l_t - l_{t-4}$	0.40 (3.09)	-0.145 (3.18)	0.40 (7.33)		0.54	0.54	126	RE
$l_t - l_{t-4}$	1.20 (5.33)	-0.224 (4.83)	0.34 (6.47)	0.10 (3.16)	0.83	1.07	126	FE
$l_t - l_{t-7}$	0.93 (3.31)	-0.191 (3.07)	0.44 (8.27)		0.90	1.14	72	FE
$l_t - l_{t-7}$	0.84 (3.09)	-0.207 (3.18)	0.37 (7.33)		0.60	0.50	72	RE
$l_t - l_{t-7}$	1.28 (3.55)	-0.236 (3.30)	0.40 (6.87)	0.11 (2.44)	0.91	1.16	72	FE

Notes: t-statistics in parentheses. N*T = number of observations. 17 country dummies are included in each equation. Feasible generalized least squares maximum likelihood estimation method is used to correct for heteroscedasticity across countries. FE = fixed effects model and RE = random effects model. $R^2(B)$ = Buse raw-moment R^2 and SEE = standard error of estimate.

labour demand may be below its full employment level due to excessive wages. Estimates of the wage gap-unemployment relationship may be blurred as a result of changes in the part of the labour supply which is not explained by the real wage gap as discussed earlier. Hence model 4 is estimated with changes in working hours⁷ as the dependent variable and with the net operating surplus as a per cent of GDP, π , added as an explanatory variable

$$(l_t - l_{t-i}) = \beta_0 + \beta_1(w^x_t - w^x_{t-i}) + \beta_2(y_t - y_{t-i}) \\ + \beta_3\pi + e_{5t}, \quad \beta_1 < 0, \beta_2 > 0, \beta_3 > \text{ or } < 0. \quad (7)$$

The model is estimated with and without π . π is included to account for a level effect in profits as the change in the real wage gap may be expected to have the strongest impact on employment when π is low (Gordon (1982)). The model assumes unemployment provides a buffer between labour demand and labour supply so working hours can be treated as labour demand. The assumption may periodically have been violated in the 1960s in some countries, when excess demand for labour was widespread and actual working hours have been less than desired. Although production and the labour recruitment decisions may be taken simultaneously, the

7. Strictly speaking, this requires an infinite elasticity of substitution between persons employed and hours. The practical error of relating the real wage gap to employment in hours is that employers taxes and contributions to social security, among other expenses, are mostly related to the number of persons employed.

hypothesis of GDP being weakly exogeneous was not rejected.⁸ Hence GDP is not instrumented.

In the model all variables encompass private services and manufacturing and are estimated by FGLS. Again the tests slightly favoured the random effects models to the fixed effects models. Hence, both the random effects and the fixed effects models are estimated and reported in table 5. The coefficient on the real wage gap has the negative expected sign and is significant at the 1 per cent level independent of model specification and the length of differences. The wage gap elasticity is estimated to be in the neighbourhood of 0.20. The income term is significant and its elasticity is in the neighbourhood of 0.40. Inclusion of the net operation surplus in per cent of GDP does not alter the results much, although the coefficient attached to the real wage gap tends to increase.

Do the models 1 and 2 predict turning points? Table 6 reports the actual and predicted dates of turning points in the unemployment rate in the post sample period of the B&S estimates (the models 1 and 2) with the real wage gap in

8. A Hausman specification test for weak exogeneity of GDP in the single country estimates, where working hours were regressed on the real wage gap and GDP, only rejected the hypothesis of exogeneity for Canada. The following instruments were used: the cyclical and inflation adjusted structural General Government budget balance changes in per cent of potential GDP, the world trade volume, the monetary stock, M1, deflated by consumer prices and GDP lagged one period. All instruments, except income, appeared unlagged and lagged one period. The results are not reported.

Table 6. Prediction of turning points in the unemployment rate, from 1981 (1982) to 1988.

Country	Actual	Model 1	Model 2
Canada	1983/84	1984/85	1983/84
USA	1983/84	1984/85	1985/86
Japan	1984/85	1985/86	1983/84
Australia	1983/84	1984/85	1983/84
New Zealand	1984/85	1985/86	1987/88
Austria	1983/84	1984/85	1983/84
Belgium	1984/85	1984/85	1987/88
Denmark	1983/84	1983/84	-
Finland	1983/84	1983/84	1984/85
France	1987/88	1985/86	1983/84
Germany	1985/86	1984/85	1983/84
Greece	1984/85	1986/87	1984/85
Ireland	-	-	1983/84
Italy	-	-	-
Luxembourg	1984/85	1985/86	-
Netherlands	1984/85	1984/85	1987/88
Norway	1983/84	1984/85	1986/87
Portugal	1986/87	1986/87	1985/86
Spain	1985/86	1986/87	1985/86
Sweden	1983/84	1984/85	1983/84
Switzerland	1984/85	1985/86	1984/85
UK	1986/87	1987/88	1984/85

Notes: a "--" indicates that no turning point has occurred or being predicted.

manufacturing. The turning point, or a continuous increase in the unemployment rate, is predicted by both models in 7 of the 22 cases. For a couple of countries, the models predict the turning points too early. This prediction performance indicates either inadequate model specifications and/or that the real wage gap does not explain the path of the unemployment rate too well.

5 Zero Wage Gap Unemployment in the OECD Countries

In order to assess the influence of the real wage on the unemployment rate pattern across OECD countries via the labour demand function, table 7 compares the zero wage gap unemployment rate with the actual unemployment rate in 1988. The zero gap unemployment rate is calculated by estimating the employment that would have prevailed in 1988 if the real wage is zero. The labour demand wage elasticity is set to 0.20, as obtained in the estimates above, for all countries, and labour supply is assumed to be unaffected by employment. Hence, if the actual wage gap is 10 per cent in 1988, for instance, the zero wage gap employment is 2 per cent higher than actual employment.

Table 7 shows that the high unemployment countries would not be better off, in terms of a lower unemployment rate, than the low unemployment countries in the zero wage gap situation. Moreover, the standard deviation of the zero wage gap unemployment rate across countries is 7.1 whilst

Table 7. Actual and zero wage gap unemployment rate in 1988.

Country	Actual	Zero gap
Canada	7.8	6.2
USA	5.5	4.6
Japan	2.5	-4.1
Australia	7.1	5.5
New Zealand	6.0	8.6
Austria	3.6	-2.4
Belgium	10.0	5.0
Denmark	8.6	7.6
Finland	4.6	0.0
France	10.0	8.1
Germany	7.9	7.8
Greece	7.7	-0.7
Ireland	16.7	18.8
Italy	12.2	12.1
Luxembourg	1.5	-3.6
Netherlands	8.3	4.9
Norway	3.2	0.0
Portugal	5.8	6.7
Spain	19.5	24.5
Sweden	1.6	0.8
Switzerland	0.7	-3.9
UK	8.2	6.2
Standard Dev.	4.7	7.1

4.7 for the actual unemployment. This result is remarkable in the sense that the real wage gap under the Cobb-Douglas technology assumption does not contribute to the explanation for the distribution of the unemployment rates across countries around the OECD mean in 1988.

6 Concluding Remarks

This chapter has tested the extent to which the real wage gap has contributed to the rise in the unemployment rate after the first oil price shock using data for manufacturing and private services in 22 OECD countries. The estimates of the models used by Bruno and Sachs (1985) and Bruno (1986) were demonstrated to be inadequate and unable to reveal the genuine effect of the real wage gap on the unemployment path and in most cases unable to predict the turning points in the unemployment rates in the mid 1980s. Another model specification, which circumvent most of the problems encountered in the Bruno and Sachs models, indicated that the real wage gap has contributed to the unemployment path for most countries. The estimates suggested, however, that most of the unemployment path was explained by past movements in the unemployment rate. This result suggests omitted variables rather than a hysteresis effect since hysteresis in unemployment is caused by an excessive wage which is accounted for in the estimates. Hysteresis in unemployment will be rigoursly analysed in chapter 7.

Estimates with pooled cross-section and time-series data lend further support to this finding and suggest that the real wage gap is unable to explain changes in unemployment rates across countries. The real wage gap theory, however, was not rejected on this ground since it theoretically relates to labour demand. The estimates with changes in labour demand as dependent variables were in fact related significantly (negatively) to the real wage gap across countries and over time.

Since the real wage gap affects unemployment via labour demand an attempt was made to estimate whether differences in unemployment rates across countries are partly a result of different changes in employment generated by different changes in the real wage gap. This was found not to be the case, which further supports the results obtained from the pooled cross-section and time-series estimates.

DATA SOURCES

Unemployment: OECD, *Economic Outlook (EO)* and *Historical Statistics (HS)*. For Luxembourg, Switzerland and Greece (before 1978): ILO, *Year-Book (YB)* and OECD, *Labour Force Statistics (LFS)*.

Working hours: YB.

Employment: Employment in manufacturing and non-agricultural activities; OECD, *LFS*, *HS* and *Main Economic Indicators (MEI)*. Government employment 1966-88: OECD, *National Accounts (NA)* and *HS*. Government employment 1960-88: Backward extrapolation of 1966-88 average yearly growth rate.

Cyclical and inflation adjusted structural budget balance changes in per cent of potential GDP: in the period 1972-83; OECD, "Structural Budget Deficits and Fiscal Stance", *Working Papers*, No. 15., 1984. In the period 1984-88: OECD, *EO*. In the period 1965-1972; OECD, *Occasional Studies*, 1979, except for Australia, New Zealand, Austria, Belgium, Denmark, Finland, Greece, Ireland, Luxembourg, Portugal, Spain and Switzerland. 1960-64(71): the change in Government consumption divided by GDP; IMF, *International Financial Statistics (IFS)*, *Year-book*.

World trade volume: *IFS*. The average of import and export volume.

M1 and M2: *IFS*.

Consumer Prices: *IFS*.

GDP and value-added price-deflators: OECD, *NA*. When not available for manufacturing production and manufacturing wholesale prices from *MEI* and *IFS* are used. **Specific for countries:** Japan: agricultural GDP not available in the period 1960-70. New Zealand: GDP in the private sector is calculated as total GDP minus Government consumption, deflated by the implicit GDP deflator from *IFS* in the period 1971-76. Agricultural GDP in fixed prices 1971-76, OECD, *Country Survey: New Zealand*. Manufacturing GDP is deflated by consumer prices 1971-76. France: private sector 1960-69, GDP minus Government consumption, deflated by the value-added price-deflator, *IFS*. Ireland: private sector, GDP minus Government consumption, except for GDP in current prices in the period 1975-88. Agriculture, gross agricultural output and agricultural wholesale prices: OECD, *Country Survey: Ireland*. The Netherlands: Volume gas production, *MEI*, is used as mining GDP. Switzerland: private sector, GDP minus Government consumption adjusted to 1985 figures from *NA*. Agricultural sector, no data on production available.

Compensation to employees: 1970-88, OECD, NA. For the following countries, sectoral compensation is not available over some or all of the period: Austria 1970-88, Belgium 1970-88, France 1970-76, Greece 1970-88, the Netherlands 1970-74, Portugal 1970-76, Spain 1970-79. For these countries, the compensation to the total labour force is distributed in accordance to hourly wage rate and working hours.

Hourly wage in manufacturing: MEI and YB.

Hourly wage in non-agricultural activities: YB except Finland, Greece, Ireland, Norway and Sweden, where it is assumed to follow the manufacturing hourly wage rate.

Net operating surplus: NA.

Unemployment rate: OECD's standardized unemployment rate is used for the 15 countries for which it is available from 1966. The non-standardized unemployment rate is used for the remaining countries and periods.

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CHAPTER 4

WAGE GAP AND TECHNOLOGY

Abstract. In this chapter the real wage gap is derived, estimated and compared under the Cobb-Douglas, the constant elasticity of substitution and the translog technology assumption. Discrimination between the models suggests the translog approximation to be the best technology assumption. The estimates indicate the real wage gap to be insensitive to technology assumption up to the mid 1970s. Thereafter the path and the magnitude of the real wage gap is sensitive to technology assumption.

1 Introduction

The wage gap theory in the previous chapter was tested employing the real wage gap estimated under the Cobb-Douglas (CD) technology assumption. This chapter derives, estimates and compares the real wage gap under different technology assumptions. Since the shape of the labour demand function is dependent on production technology, one will a priori expect the real wage gap to be sensitive to technology assumption. Despite this not much research has been carried out to formally estimate and compare the real wage gap under different technology assumptions. In Sachs (1983) and B&S (1985), full employment marginal productivity of labour is computed under the CD technology assumption. This assumption is somewhat relaxed in their later papers. In Bruno (1986) and Sachs and Wyplosz (1986) constant elasticity of substitution (CES) technology is employed without involvement of direct estimation of technology parameters.

The purpose of this chapter is to estimate the real wage gap under the CD, CES and translog (TL) technology assumptions for private services and manufacturing in the 22 OECD countries considered in the previous chapter. The TL function, under factor augmented technological progress, is adopted as a flexible technology representation and is superior to the CES formulation (see for instance Pollak et al. (1984)).

The chapter finds, in agreement with B&S, that the real wage gap increased substantially from the mid 1960s to the mid 1970s in most OECD countries. For the 1980s, however, the real wage gap decreased more under the CD and CES technology assumption than under the TL technology assumption. Finally, nested and non-nested tests suggest that the TL technology assumption is superior to the other technology assumptions.

The chapter is organised as follows. Section 2 derives the real wage gap under CD, TL and CES technology. Section 3 presents the data and the empirical estimates are shown in section 4. Section 5 compares the real wage gap estimated under different technologies and section 6 discriminates between the estimates. Section 7 contains some concluding remarks.

2 The Wage Gap Under Different Production Technologies

The real wage gap depends on the production technology assumption via the full employment marginal productivity of labour. This section derives the real wage gap under different production technologies.

2.1 Cobb-Douglas Technology

The restricted CD production function is given by $Q = AL^\alpha K^{1-\alpha}$, with L as working hours and K capital services. With small letters denoting logs the CD technology real wage gap in the previous chapter was defined as

$$w^x = (w - p_Q) - (q^f - l^f + \log(\alpha)), \quad (1)$$

where w^x is the real wage gap, w the total labour costs divided by working hours, and p_Q the value-added price-deflator and $\alpha(Q^f/L^f)$ the full-employment marginal product of labour.

2.2 Translog Technology

The translog production function in the two factor case, with factor augmenting technical progress, can be written as

$$\begin{aligned} \log Q = & \lambda \gamma \alpha_0 + \beta_t \log T + \alpha_l \log L + \alpha_k \log K \\ & + 1/2 \gamma_{ll} (\log L)^2 + 1/2 \gamma_{kk} (\log K)^2 \\ & + \gamma_{lk} \log L \log K + \theta_{lt} \log T \log L \\ & + \theta_{kt} \log T \log K + 1/2 \theta_{tt} (\log T)^2, \end{aligned} \quad (2)$$

where $\log(T)$ is technological progress approximated by a log time trend. By assumption, the production function is

linear homogeneous in inputs, implying the following homogeneity constraints on the translog form

$$\alpha_1 + \alpha_k = 1 \quad \gamma_{11} + \gamma_{1k} = 0 \quad \gamma_{kk} + \gamma_{1k} = 0 \quad \theta_{1t} + \theta_{kt} = 0. \quad (3)$$

The full employment marginal productivity of labour can be calculated as the following. The full employment output, Q^f , is computed from estimates of equation (2) with $L = L^f$, where L^f is approximated as the sum of employed and unemployed person hours¹

$$\begin{aligned} \log Q^f = & \lambda \gamma \alpha_0 + \beta_t \log T + \alpha_1 \log L^f + \alpha_k \log K \\ & + 1/2 \gamma_{11} (\log L^f)^2 + 1/2 \gamma_{kk} (\log K)^2 \\ & + \gamma_{1k} \log L^f \log K + \theta_{1t} \log T \log L^f \\ & + \theta_{kt} \log T \log K + 1/2 t_t (\log T)^2. \end{aligned} \quad (4)$$

1. L^f could alternatively be estimated as employed plus unemployed person hours minus the non-accelerating inflation rate of unemployment (NAIRU), the bench-mark level of the unemployment rate where the inflation starts increasing. Artus, for instance, estimates high-employment as the sum of employed and unemployed net of structural unemployment. This measure is not used here partly in order to certify a consistent comparison of the real wage gap estimated under the different technologies and partly because it is highly questionable whether it is possible to adequately estimate the NAIRU. Estimation of the NAIRU requires an estimate of a price and a wage equation in which unemployment is required to be statistically significant. The last two chapters demonstrate unemployment to be insignificant in wage equations for most countries.

The difference between Artus' definition of full employment and the definition employed here is likely to be minor anyway since the difference between $\delta Y / \delta L$ and $\delta Y^f / \delta L^f$ is due to the non-linearity of the production function in variables and is approximately the same in the neighbourhood of L .

The actual capital stock is assumed to be equal to the full employment capital stock. This may not be true since profitability, which is higher under full employment, influences investments via changes in financial constraints and Tobins' Q which was discussed in chapter 2. The results by Cartinal et al. (1988), however, suggest the effects of profitability on investments are likely to be small, although statistically significant.

Differentiating equation. (4) gives the full employment marginal productivity of labour

$$dQ^f/dL^f = Q^f/L^f [\log\alpha_1 + \gamma_{1l}\log L^f + \gamma_{1k}\log K + \theta_{1t}\log T], \quad (5)$$

and so is $w^x = (w - p_Q) - dQ^f/dL^f$. From this it can be seen that the real wage gap is not only dependent upon the full employment average product of labour as in the CD case. It is also dependent on the log of full employment, the log of capital and the log of labour augmented technological progress. Note, that the sum of capital and labour augmented technical progress, θ_{1t} and θ_{kt} , in equation (2) is restricted to zero. Capital (labour) augmenting technological progress results in labour (capital) saving technological progress. This in turn, tends to lower (higher) the full employment marginal productivity of labour, and hence the warranted wage, over time.

The TL production function to be estimated is given by equation (2) subject to the homogeneity constraints (3). Given the large number of parameters to be estimated, relative to the length of the data period of 29 years in most cases, the parameter estimates are likely to be imprecise. Hence, equation (2) is estimated in conjunction with a cost share function, a method suggested by Berndt and Christensen (1973). Since the cost share of capital and labour add to unity, only the labour cost share function is estimated. The labour cost share function is derived as

$$\begin{aligned} CS_L = \delta \log Q / \delta \log L = \log \alpha_1 + \gamma_{11} \log L + \gamma_{1k} \log K \\ + \theta_{1t} \log T, \end{aligned} \quad (6)$$

where CS_L is the labour share of total costs.

2.3 CES Technology

In this section the real wage gap is first derived directly under the CES technology assumption. Thereafter the CES derived wage gap following the methods suggested by Bruno (1986) and Artus (1984), are briefly presented.

Assuming Hicks-neutral technological progress and constant returns to scale, the CES production function is given by

$$Q = \gamma e^{\lambda t} [(1 - \delta)L^{-\rho} + \delta K^{-\rho}]^{-1/\rho}, \quad (7)$$

where $\rho = (1 - \sigma)/\sigma$, with σ as the elasticity of substitution, $e^{\lambda t}$ technological progress and δ a distributional parameter. The full employment marginal productivity of labour then is

$$dQ^f/dL^f = (\gamma e^{\lambda t})^{-\rho} (1 - \delta) [Q^f/L^f]^{1+\rho}, \quad (8)$$

where Q^f is derived from equation (7) with L^f substituted for L . The real wage gap is the actual real product wage minus dQ^f/dL^f .²

In order to avoid direct estimation of the CES production function Bruno (1986) suggests an approximation formula. In this approximation the log of the marginal labour productivity, still under the assumption of Hicks-neutral technological progress, is calculated as

$$\log(dQ/dL) = \log(Q/L) + ((1 - \sigma)/\sigma) S_K \log(K/L), \quad (9)$$

2. The CES production function under factor augmenting technological progress is given by

$$Q = [\delta (A \exp(\lambda_L t) L)^{-\rho} + (1 - \delta) (\beta \exp(\lambda_K t) K)^{-\rho}]^{-1/\rho}.$$

The full employment marginal productivity of labour is then

$$MP_L^f = 1/\rho [\delta (A e^{\lambda_L t} L^f)^{-\rho} + (1 - \delta) (\beta e^{\lambda_K t} K)^{-\rho}]^{-(1+\rho)/\rho} \\ * \delta \rho (A e^{\lambda_L t} L^f)^{-(1+\rho)} A \exp(\lambda_L t) L^f.$$

The parameters cannot be identified by direct estimation of the production function. Imposing the marginal condition and isolate the $\log(Q/L)$ and $\log(Q/K)$ on the left hand side gives two expressions that can be estimated to provide parameter estimates to MP_L^f . Note, that factor augmenting technological progress cannot be identified in the CD case as will be shown in chapter 6.

where S_k is the share of capital of the national product. The second term on the right hand side of equation (9) approaches zero as σ approaches one; that is the CD case. If $0 < \sigma < 1$ and S_k constant, an increase in the K/L ratio enlarges the marginal productivity of labour, and hence the warranted real product wage.

Artus (1984) is probably the first to suggest a method to estimate the CES real wage gap. He establishes two models; one with a production function composed of labour and capital and a two-tier production function with labour, capital and energy. As the constant elasticity of substitution assumption and transformation is highly restrictive with more than two inputs, demonstrated by Uzawa (1962) and McFadden (1963), only the two factor case will be considered here.³ The estimation procedure is as follows. Employing a Taylor approximation of equation (7), as suggested by Kmenta (1967), we get

$$q = \ln \gamma + \lambda t + (1 - \delta)l + \delta k - 1/2\rho(1 - \delta)\delta[\ln(K/L)]^2. \quad (10)$$

As the distributional parameter, δ , cannot be assumed to be constant over the estimation period, Artus suggests an approximation where the distribution between capital and labour changes by a linear time trend

3. The real wage gap path estimated from the two methods are quite similar anyway (Artus (1984)).

$$\ln Q = \ln \gamma + \lambda t + (1 - \delta_0 - \delta_1 t)l + (\delta_0 + \delta_1)k \\ - 1/2 \rho (1 - \delta_0 - \delta_1 t)(\delta_0 + \delta_1 t)[\ln (K/L)]^2. \quad (11)$$

Due to few observations, relative to the number of parameters to be estimated, Artus suggests following two-step procedure. Equating the marginal product of labour, derived from equation (11), with the real product wage, we get the labour share of the national product after some manipulations

$$S_L = (1 - \delta_0 - \delta_1 t) + \rho(\delta_0 + \delta_1 t)(1 - \delta_0 - \delta_1 t)\ln(K/L). \quad (12)$$

The two-step procedure is first to estimate the stochastic version of equation (12) in order to obtain estimates of δ_0 and δ_1 , and then to estimate equation (11) with the parameter estimates of δ_0 and δ_1 from equation (12). Artus estimates equation (12) over a period where he expects the conditions, under which (12) is derived, to hold; that is essentially from 1955 to 1973. The full employment wage rate can then be estimated as

$$\ln(w/p_Q)^f = \ln(Q/L)^f + \ln(S_L)^f = \ln \gamma + \lambda t \\ + (\delta_0 + \delta_1 t)\ln(K/L^f) - 1/2\rho(1 - \delta_0 - \delta_1 t) \\ * (\delta_0 + \delta_1 t)[\log (K/L^f)]^2 + \ln(S_L)^f. \quad (13)$$

The wage gap is calculated as (w/p_Q) minus $(w/p_Q)^f$.⁴ Note there are some disadvantages from obtaining parameter estimates from the CES approximation compared to direct estimation of the CES production function (see Griliches and Ringstad (1971)). Three other problems are involved in the method suggested by Artus. First, the two-step estimation procedure yields two estimates of ρ and the real wage gap is sensitive to which of estimate of r is employed. Second, δ is assumed to change at the same rate over time before and after 1973. This assumption is unlikely to hold as analytically demonstrated and tested below. Third, the period the share function is assumed to hold remains guess-work. Artus estimates the share function over the period from 1955 to 1973 (a shorter period for some countries); a period where he expects the marginal condition, with labour being paid its marginal product, to hold. This assumption, however, is unlikely to hold since employers may have been off their notional labour demand schedules in the periods of pronounced excess demand for labour, notable in periods of the 1960s.

3 Data

The data for GDP, employee compensation and the value-added price-deflators are explained in the previous chapter. Capital stock is measured as net capital stock, except for

4. The real wage gap can alternatively, and much easier, be estimated as $w^x = (w - p_Q) - dQ^f/dL^f$, where $dQ^f/dL^f = Y^f/L^f(1 - \delta + \rho\delta(1 - \delta)\log(K/L))$.

Japan, where gross capital stock is used. The capital stock data are taken from different sources listed in the data appendix, and when necessary updated with national account investments. For the few countries where capital stock data are not available, the perpetual inventory method is used after the following principles: the capital GDP ratio is assumed to be equal to 0.91 and 1 for manufactures and private services respectively in 1960, where the multiplication factors are found as the average ratio of capital and GDP in the respective sectors for Canada, the US, France and Germany in 1960. Since national account investments published by the OECD do not distinguish between structures and equipment, the perpetual inventory method is applied to sectoral investments in structures and equipment with a 6.9 per annum depreciation rate estimated as the average depreciation rate for the Danish economy (Otto (1987)). The share of capital, S_K , is estimated as gross operating surplus.

User cost of capital, used to compute the cost shares, is calculated as

$$c = p_K[(r + \tau) - 0.5\dot{p}_K/p_K],$$

where p_K is the price of capital, r is a long-term government bond interest rate, τ a depreciation rate of capital stock, set to 6.9, and $\dot{p}_K/p_K$ capital gain. p_K is calculated from a price index of investment goods. Capital

gain is usually not multiplied by a factor of 0.5 as done here. This is done here because the investment deflator is likely to exaggerate capital gains. This is especially true in periods of the 1970s, where high inflation rendered capital costs negative. The oil price shocks may additionally have rendered some of the capital stock obsolete (Artus (1984)). Since the oil price shocks coincided with the high inflation periods the capital gains, as the result of inflation, is exaggerated in the considered period. More importantly, c measures the expected user costs of capital in the cost share function. Since the major parts of capital gains, in particular in the wake of the two oil price shocks, are likely to have been unexpected, $\dot{p}_k/p_k$ is likely to have exaggerate expected capital gains. The multicountry nature of this study excluded a more rigourous calculation of (expected) user costs.

Capital shares are estimated as the following. For manufacturing, the capital share is calculated as the gross operating surplus as a percent of gross value added. These data are first readily available from 1966 or later. For private services gross operating surplus is available only for a few countries over a relatively short time span. Hence, capital shares for the manufacturing plus private services are calculated as the gross operating surplus for the whole economy as a per cent of GDP in manufacturing and private services. Since the Government sector accounts for

the highest proportion of the sectors not covered in this study the error made by applying the gross operating surplus of the whole economy to private services and manufacturing is likely to be small.

4 Empirical Results

4.1 Estimates of Translog Production Function

The stochastic versions of models (2) and (6) are estimated using Zellner's iterative estimation procedure (SURE) where error correlations across equations are accounted for. The variables are normalized to two in the initial period. The estimations are performed with the homogeneity and the cross-equation restrictions imposed.⁵ The cross-equation, or symmetry, restrictions are tested by the likelihood ratio test

$$LR = n(\log[\hat{\Omega}_r] - \log[\hat{\Omega}_u]),$$

where $[\hat{\Omega}_r]$ and $[\hat{\Omega}_u]$ are determinants of the estimated error covariance matrices for the restricted and unrestricted models and n the number of observations. The statistic is distributed as a chi-square under the null hypothesis with four degrees of freedom, which is the number of restrictions imposed. To assure that the estimated

5. Artus (1984) argues convincingly in favour of the assumption of constant return to scale, and hence the assumption of homogeneity, on macro level.

production functions are well-behaved, it is tested whether they are quasi-concave and monotone. Monotonicity requires $\delta Q/\delta K$ and $\delta Q/\delta L > 0$ at every data point, and quasi-concavity requires the bordered Hessian matrix to be negative definite. Finally, the elasticity of substitution between labour and capital, obtained from Uzawa (1962), is estimated as

$$\sigma_{1k} = (\gamma_{1k} + CS_L CS_K) / CS_L CS_K,$$

where CS_K is the capital cost share. Treating the cost share sample means as constant over sub samples, the asymptotic variance of σ_{1k} is given by

$$\text{asy var}(\sigma_{1k}) = (1/CS_L CS_K)^2 \text{asy var}(\gamma_{1k}).$$

The estimations, which uses data for manufacturing plus private services, are presented in table 1. The estimated production functions are well-behaved with the exception of Italy and Sweden, where $\delta Q/\delta K < 0$ in three and five data points respectively. The majority of the coefficient estimates are significant at the 5 per cent level. The augmented Dickey-Fuller (ADF) tests for co-integration are computed as the estimate of β_1 divided by its standard deviation from the regression $\Delta e_{it} = \beta_{i0} + \beta_{i1}e_{it-1} + \beta_{i2}\Delta e_{t-1} + \varepsilon_{it}$, where e_i are the residuals from the production or the cost share function. Since the sample size is small, implying a low power of the ADF tests, a

Table 1. TL parameter estimates for the private sector.

	Canada	USA	Japan	Austral	New Z	Austria	Belg	Denm	Finl	France	Germany	Greece	Irel	Italy	Luxemb.	Neth.	Norway	Port.	Spain	Sweden	Switzl	UK	
α_0	-0.102 (6.00)	-0.012 (0.52)	-0.199 (7.05)	-0.072 (3.21)	0.027 (0.43)	0.027 (0.43)	-0.151 (4.96)	-0.212 (10.64)	-0.185 (12.87)	-0.085 (3.51)	-0.114 (15.35)	-0.106 (8.29)	-0.048 (2.37)	-0.057 (2.23)	-0.065 (4.15)	-0.059 (3.32)	-0.146 (7.49)	-0.052 (2.19)	-0.219 (6.50)	-0.064 (2.45)	0.066 (2.79)	-0.120 (5.66)	-0.039 (1.80)
α_1	0.759 (18.75)	0.822 (30.96)	0.619 (15.14)	0.728 (3.42)	0.879 (8.65)	0.879 (8.65)	0.657 (0.343)	0.627 (17.75)	0.966 (74.03)	0.833 (17.25)	0.806 (42.17)	0.79 (21.04)	0.928 (19.59)	0.855 (16.34)	1.028 (24.11)	0.945 (42.59)	0.950 (131.89)	0.805 (14.29)	0.946 (27.39)	0.554 (8.76)	1.07 (17.23)	0.692 (16.17)	0.953 (16.49)
α_k	0.241 (5.94)	0.178 (3.98)	0.381 (19.04)	0.272 (5.65)	0.121 (1.19)	0.121 (1.19)	0.343 (7.70)	0.373 (10.57)	0.003 (2.62)	0.166 (3.43)	0.195 (10.18)	0.20 (5.45)	0.072 (1.52)	0.145 (2.78)	-0.028 (0.65)	0.055 (2.48)	0.050 (6.89)	0.195 (3.45)	0.054 (1.55)	0.446 (7.05)	-0.074 (1.18)	0.308 (7.19)	0.049 (0.81)
γ_{ij}	0.128 (2.63)	0.138 (2.19)	-0.048 (1.71)	0.195 (3.20)	-0.062 (0.05)	-0.062 (0.05)	-0.053 (0.90)	0.211 (6.01)	-0.002 (0.12)	-0.036 (0.57)	0.109 (5.25)	0.082 (1.57)	-0.053 (0.77)	0.026 (0.46)	-0.299 (4.93)	0.026 (0.67)	-0.022 (1.83)	-0.217 (2.97)	-0.084 (1.73)	-0.064 (1.14)	-0.323 (4.50)	0.162 (3.42)	-0.084 (1.10)
θ_{it}	-0.004 (5.36)	-0.004 (5.23)	0.006 (3.03)	-0.003 (3.42)	-0.018 (4.86)	-0.018 (4.86)	-0.001 (0.63)	0.012 (5.02)	-0.003 (3.31)	-0.003 (1.16)	0.002 (2.51)	0.000 (0.17)	-0.005 (6.45)	-0.004 (1.16)	-0.019 (8.19)	-0.001 (1.19)	-0.002 (5.65)	-0.002 (4.94)	-0.012 (4.94)	-0.002 (1.28)	-0.019 (5.94)	0.004 (2.95)	-0.011 (2.94)
β_t	0.010 (2.27)	-0.005 (0.95)	0.054 (4.20)	-0.005 (0.73)	0.087 (1.49)	0.087 (1.49)	0.063 (12.20)	0.025 (5.37)	0.079 (30.91)	0.041 (4.69)	0.027 (7.02)	0.026 (3.78)	0.051 (3.62)	0.016 (1.64)	0.095 (9.22)	0.024 (2.89)	0.060 (13.43)	0.068 (9.18)	0.092 (6.59)	0.051 (10.97)	0.058 (8.39)	0.014 (3.29)	0.037 (4.60)
θ_{tt}	-0.000 (3.72)	-0.000 (1.74)	-0.000 (0.01)	0.000 (0.21)	-0.000 (0.41)	-0.000 (0.41)	-0.001 (9.52)	0.000 (8.86)	-0.002 (23.44)	-0.000 (2.30)	-0.000 (3.81)	-0.000 (2.44)	-0.001 (5.53)	0.000 (0.70)	-0.002 (9.43)	-0.000 (1.49)	-0.001 (9.86)	-0.001 (8.44)	-0.002 (6.68)	-0.000 (5.37)	-0.001 (8.63)	-0.000 (2.59)	-0.001 (2.90)
ADFA	2.62	2.06	2.80	1.81	2.62	2.62	2.10	1.39	3.10	2.37	2.90	3.29	2.39	2.05	2.54	4.96	2.03	2.68	2.13	3.41	1.91	1.94	2.44
ADFB	2.08	1.68	3.96	1.96	3.33	3.33	2.89	2.45	2.32	2.58	2.17	3.49	2.21	1.74	2.71	3.16	2.32	2.07	2.01	4.14	1.64	3.18	2.81
LM _A	4.17	6.06	4.65	5.68	1.63	1.63	0.30	5.91	6.39	6.00	3.78	2.82	3.02	3.62	2.08	1.10	4.72	2.84	5.40	0.28	4.53	6.21	3.73
LM _B	4.47	3.79	2.46	6.32	0.02	0.02	2.53	1.88	2.49	5.51	3.53	2.51	3.17	4.60	3.62	2.47	5.42	2.88	4.58	2.28	6.48	5.41	3.04
LR _R	4.26	11.17	29.02	47.91	10.35	10.35	25.98	29.23	17.66	22.74	8.53	2.03	25.17	10.15	3.04	11.17	13.20	19.89	22.74	50.14	21.52	12.99	9.34
σ_{60-69}	0.05 (0.36)	-0.51 (0.69)	1.21 (0.12)	-0.51 (0.47)	-	-	1.22 (0.25)	-0.43 (0.24)	1.05 (0.42)	1.23 (0.39)	-0.08 (0.21)	0.42 (0.37)	1.48 (0.63)	0.80 (0.42)	2.73 (0.35)	0.47 (0.79)	1.33 (0.18)	2.00 (0.33)	1.64 (0.36)	1.62 (0.55)	2.78 (0.40)	-0.17 (0.34)	1.64 (0.57)
σ_{70-80}	0.17 (0.32)	-0.28 (0.59)	1.27 (0.16)	-0.29 (0.40)	1.03 (0.68)	1.03 (0.68)	1.23 (0.25)	-0.36 (0.23)	1.04 (0.31)	1.22 (0.38)	0.05 (0.18)	0.50 (0.32)	1.40 (0.52)	0.84 (0.34)	2.47 (0.30)	0.62 (0.79)	1.28 (0.16)	2.09 (0.37)	1.49 (0.28)	1.86 (0.76)	2.63 (0.36)	-0.14 (0.33)	1.49 (0.44)
σ_{81-88}	0.27 (0.28)	-0.03 (0.47)	1.37 (0.21)	-0.06 (0.33)	1.02 (0.51)	1.02 (0.51)	1.23 (0.25)	-0.33 (0.20)	1.03 (0.22)	1.20 (0.36)	0.16 (0.16)	0.54 (0.29)	1.33 (0.43)	0.86 (0.29)	2.24 (0.25)	0.68 (0.47)	1.24 (0.13)	2.08 (0.36)	1.39 (0.22)	1.48 (0.42)	2.44 (0.32)	-0.13 (0.33)	1.41 (0.37)
σ_{60-88}	0.16 (0.32)	-0.28 (0.59)	1.28 (0.17)	-0.29 (0.40)	1.03 (0.60)	1.03 (0.60)	1.22 (0.25)	-0.23 (0.22)	1.04 (0.28)	1.22 (0.38)	0.04 (0.18)	0.48 (0.33)	1.38 (0.50)	0.83 (0.35)	2.49 (0.30)	0.59 (0.61)	1.29 (0.16)	2.05 (0.35)	1.51 (0.29)	1.66 (0.58)	2.63 (0.36)	-0.15 (0.34)	1.51 (0.46)

Note: t-statistics in parentheses except the numbers in parentheses below the σ 's, which are standard errors. $\gamma_{ij} = \gamma_{ik} = \gamma_{kt} = \theta_{it} = -\theta_{kt}$. ADF_i = augmented Dickey-Fuller test for cointegration (see text), $i = A, B$, where A refer to the production function and B the cost share function. LM_i = Lagrangian multiplier test for first order serial correlation, $i = A, B$, $t(n-2)$ -distributed under the null of no serial correlation, where n is the number of observations (sample period minus one). LR_R = likelihood ratio test for symmetry restrictions, $c_2(k)$ -distributed under the null of structural stability, where k = 4 is the number of imposed restrictions. σ = elasticity of substitution between labour and capital over the specified periods. Estimation period 1960-88, except for New Zealand (1971-88), Denmark (1966-88) and Greece (1965-88).

critical value of 10 or 15 per cent of the "t-statistic" is more appropriate than the usual 5 per cent. At this critical level the null hypothesis of lack of co-integration is accepted in almost all the cases. The case for accepting the null, however, is not strong. The lack of co-integration implies that we do not have a long-run steady-state relationship between the variables involved in the equation which may reflect that capital services are not adequately measured. The Lagrange multiplier tests of first order serial correlation indicate the presence of first order autocorrelation. Some positive serial correlation is acceptable, and to be expected, in the co-integration equation

The imposed symmetry restrictions are rejected in half of the cases at the 1 per cent level. The restricted model, however, is employed for all countries because the unrestricted model gives parameter estimates with high standard errors and hence wide confidence intervals for the real wage gap. Disaggregation into manufactures and private services did not alleviate this problem.⁶ Tests of structural stability are not performed due to the short

6. The symmetry restrictions are usually not tested in the TL production function literature. Berndt and Christensen (1974) and Griffin and Gregory (1976) are exceptions. Although the symmetry restrictions are rejected in the study of Berndt and Christensen they proceed with the restricted model. Unfortunately, both studies test the symmetry restrictions by means of a F-test. The non-linear system implied by the usage of the SURE method in both studies render the power of the F-tests low, and hence increases the likelihood of accepting the null hypothesis when the alternative is true.

length of the sample period relative to the numbers of parameters to be estimated.

The estimates of the elasticity of substitution and the factor augmented bias in technological change are of special interest because they are both important determinants of the warranted income distribution.⁷ The estimates of σ are quite stable over time, but differ somewhat across countries. Note, however, that the standard errors, and hence the confidence intervals, of the estimates of σ are notably high. The estimates of the factor augmenting technological progress are capital augmenting, or Solow-neutral, for 12 countries and labour augmenting for four countries at the 5 per cent level.

4.2 Artus' CES Approximation

The estimates of the Artus' CES approximation are performed for manufacturing as well as for the private sector. The

7. In the traditional neoclassical literature on income distribution the elasticity of substitution has often been the focus parameter because of the CES technology assumption. In the TL technology formulation the elasticity of substitution parameter affects the warranted distribution of income more indirectly.

8. The severe diagnostic problems in the estimates of the equations (11) and (12) may not be a result of the estimating the Kmenta CES approximation alternative to a direct estimate of the CES production function. I attempted to estimate the CES production function directly, with and without δ changing, with and without a time trend, with and without δ estimated from equation (14) and with and without factor augmented technological progress. The parameter estimates were often of an unlikely magnitude and were highly sensitive to specification.

estimates with data from the manufacturing sector are performed to compare my estimates with Artus' estimates that are limited to the manufacturing sector. For manufacturing and private services equation (12) is estimated over the period 1960 to 1973 to provide equation (11) with coefficient estimates of δ_0 and δ_1 in accordance with the suggestion made by Artus (the estimation period terminates in 1969 for some countries Artus considers). For manufacturing, equation (12) is estimated over the whole sample period 1966-88. The Broyden-Fletcher-Goldfarb-Shanno non-linear algorithm with Artus' average coefficient estimates as starting values is employed in the estimation of equation (12). The estimates can be compared with the estimates obtained by Artus only approximately because his estimates cover different estimation periods and he uses efficiency adjusted gross capital stock amongst other things.

The estimates for the private sector are presented in table 2. Most of the coefficients are significant at the 5 per cent level. The parameter ρ in most cases is estimated to be in the neighbourhood of zero, implying a unity elasticity of substitution. The rate of Hicks-neutral technological progress, indicated by the coefficient on λ , is negative in nearly half of the cases, implying technological regress, which is at variance with other studies of technological progress. The negative coefficient estimate on the distributive parameter, δ_1 , obtained for

Table 2. Parameter estimates of Artus' CES approximation for private sector.
 (A) $\gamma = \ln \gamma + \lambda t + (1 - \delta_0 - \delta_1 t)l + (\delta_0 + \delta_1 t)k - 1/2\rho(\delta_0 + \delta_1 t)(1 - \delta_0 - \delta_1 t)(k - 1)^2 + \epsilon_1$
 (B) $S^L = (1 - \delta_0 - \delta_1 t) + \rho(\delta_0 + \delta_1 t)(1 - \delta_0 - \delta_1 t)(k - 1) + \epsilon_2$
 (C) $\delta = \beta_0 + \beta_1 t + \epsilon_3$, where $\delta = [w/r]/[(w/r) + (K/L)^2]$

	δ_0	δ_1	$\ln \gamma$	λ	ρ	LM_A	LM_B	LR_A	LR_B	ADF_A	LR_C
Canada	19.48 (58.63)	0.002 (1.42)	0.76 (3.21)	-0.221 (8.89)	-0.08 (4.57)	4.75	0.69	50.37	80.66	2.70	37.47
USA	0.01 (0.89)	0.004 (3.91)	0.06 (3.60)	0.005 (3.10)	0.42 (0.09)	3.61	0.40	15.15	112.64	4.01	38.62
Japan	-23.20 (70.88)	0.008 (1.41)	12.73 (4.04)	0.522 (0.54)	0.02 (1.55)	3.22	10.42	134.01	96.90	1.18	76.42
New Z	15.29 (80.91)	-0.002 (0.42)	0.08 (0.60)	-0.144 (8.52)	-0.18 (8.35)	0.03	2.73	-	-	3.19	-
Austra	-29.16 (87.02)	-0.017 (2.52)	-0.48 (0.96)	0.72 (10.29)	0.01 (1.37)	4.69	0.08	55.28	76.54	2.45	19.16
Austri	-11.84 (92.50)	-0.013 (7.34)	0.39 (0.39)	0.28 (3.74)	0.06 (1.88)	1.95	11.09	100.14	92.98	0.66	25.13
Belg	28.12 (261.05)	-0.016 (2.92)	3.31 (4.49)	-1.37 (14.23)	0.00 (0.70)	6.30	0.46	64.89	82.01	0.77	33.05
Denm	-27.54 (135.87)	0.003 (1.49)	4.68 (5.19)	0.01 (0.06)	0.07 (6.26)	9.00	1.69	-	-	2.18	-
Finl	-10.99 (73.92)	-0.020 (2.26)	-0.42 (0.68)	0.53 (4.87)	-0.02 (0.53)	8.46	1.16	76.82	82.64	2.57	39.81
France	-11.48 (106.80)	-0.006 (0.91)	-1.62 (3.72)	0.69 (10.46)	-0.03 (1.99)	9.28	2.03	80.82	88.33	1.82	26.59

Table 2 Cont.

Germ	98.94 (98.94)	-0.006 (1.14)	2.51 (2.10)	-1.92 (8.05)	0.04 (3.46)	4.33	1.46	78.68	99.70	2.66	50.57
Greece	29.66 (211.86)	-0.001 (1.76)	-1.08 (0.93)	-0.74 (2.77)	0.01 (0.56)	7.47	2.81	-	-	1.31	-
Irel	26.57 (101.23)	0.003 (0.23)	3.13 (3.45)	-1.61 (12.31)	0.01 (1.39)	6.61	0.72	74.40	63.22	2.12	30.30
Italy	-7.29 (40.10)	-0.025 (1.68)	-1.38 (1.38)	0.66 (5.44)	-0.15 (2.44)	7.01	1.73	91.97	100.39	1.97	35.39
Luxemb	0.48 (0.56)	-0.006 (2.61)	-0.07 (7.61)	0.01 (6.17)	-0.50 (1.35)	6.34	0.05	28.54	61.11	2.61	23.39
Neth	-16.30 (147.18)	0.020 (2.94)	3.96 (9.06)	-0.14 (1.57)	0.12 (8.16)	0.71	11.38	142.86	66.58	1.14	36.22
Norway	-11.34 (123.60)	0.002 (0.34)	1.63 (6.42)	0.06 (1.62)	0.17 (7.49)	4.96	10.41	143.14	56.46	1.62	28.66
Port	-18.74 (91.14)	-0.043 (4.87)	5.49 (4.55)	0.11 (0.46)	0.05 (4.08)	7.34	10.08	126.96	61.18	1.68	7.93
Spain	0.10 (0.40)	-0.019 (2.96)	-0.12 (4.11)	0.05 (20.49)	1.15 (6.81)	6.02	1.84	36.49	46.74	1.22	31.83
Sweden	1.11 (33.43)	-0.015 (3.17)	0.04 (2.73)	-0.01 (2.78)	-0.56 (1.60)	8.36	0.45	56.17	69.59	2.19	20.67
Switzl	17.07 (85.87)	-0.004 (1.12)	1.52 (4.20)	-0.47 (9.80)	0.00 (0.02)	6.80	0.02	50.78	91.57	3.71	43.30
UK	-14.36 (90.72)	-0.003 (0.52)	-0.21 (0.26)	0.62 (4.54)	-0.00 (0.02)	9.45	0.75	110.97	87.41	0.49	32.59

Note: t-statistics in parentheses. Eq. (B) estimated over the period 1960 to 1973 and Eq. (A) over the period 1960-88, except for New Zealand (1971-88), Denmark (1966-88) and Greece (1965-88), where both equations are estimated over the whole sample period. The reported parameters δ_0 , δ_1 stem from estimates of Eq. (B), whereas $\ln\gamma$, λ and ρ are estimates from Eq. (A). LM_i = Lagrangian multiplier test for first order serial correlation for $i = \text{Eq. (A), (B), (C)}$, $t(n-2)$ -distributed under the null of no serial correlation, where n is the number of observations (sample period minus one), $LR_i = \text{likelihood ratio test for structural break in 1974/75 for } i = 1, 2$, $\chi^2_{(j+2)}$ -distributed under the null of structural stability, where j is the number of estimated regression coefficients, and ADF_A = augmented Dickey-Fuller test for co-integration of Eq. (A). A "-" indicates a too short sample period for the LR test to be computed.

some countries is also remarkable and is opposite to its equilibrium path. This can be seen from the following. From the profit function we have the first order condition $(wL)/(rK) = (dQ/dL)L/((dQ/dK)K)$. Differentiating the CES production function with respect to L and K respectively, and isolating δ on the left hand side yields

$$\delta = [w/r]/[(w/r) + (K/L)^{1+\rho}]. \quad (14)$$

With $\rho = 0$ or 1 , δ has been increasing for all countries over the sample period. This indicates that the time trend in the estimates of equation (12) captures something which has nothing to do with d . More seriously, regression of δ , calculated from equation (16) with $r = 1$, on a constant and a linear time trend, shows structural instability for nearly all countries diagnosed by the likelihood ratio test LR_C in table 2. Hence, it is inappropriate to extrapolate δ_1 beyond 1973 with a time trend.

Nor are the diagnostic tests of the estimates of Artus' model encouraging. The ADF tests accept the null of unit-roots in the residuals at the 15 per cent level for nearly all countries and the ADF values in general are much lower than in the TL estimates. This suggests that a more reliable long-run relationship is obtained in the TL case. The residuals of the estimates of equation (11) exhibit severe first order autocorrelation. The presence of first order serial correlation is much less pronounced for the

residuals of the estimates of equation (12), however. Concerning parameter stability, a likelihood ratio test, alternative to the conventional F-test, is employed to test for structural stability since the F-test has a low power when the residuals are serial correlated. The stability test is performed with a breaking point in 1973/1974; a period where a relatively high and steadily GDP growth period, with a steady path in relative prices, was followed by a more turbulent environment. The null hypothesis of parameter stability of the estimates of equation (11) is rejected for all countries at the 1 per cent level. Finally, the estimates of equation (12) are tested for structural stability; that is whether or not it is appropriate to limit the estimation period to 1960 to 1973, as suggested by Artus, alternatively to the period 1960 to 1988. The tests strongly support Artus' suggestion to limit the estimation period to 1973.

The estimates for manufacturing are displayed in table 3. The coefficients in most cases are significant at the 5 per cent level. ρ is mostly positive, but small, implying an elasticity of substitution just below one. Technological regress is found for a third of the countries. For all countries where it is significant, δ_1 is positive as we would expect. The diagnostic tests indicate a misspecified model and/or bad data, although not to the same extent as the estimates for the private sector, composed of private services and manufacturing.⁸

Table 3. Parameter estimates of Artus' CES approximation for manufacturing.

(A) $y = \ln \gamma + \lambda t + (1 - \delta_0 - \delta_1 t)l + (\delta_0 + \delta_1 t)k$
 $- 0.5\rho(\delta_0 + \delta_1 t)(1 - \delta_0 - \delta_1 t)(k-l)^2 + \varepsilon_4$
(B) $s^L = (1 - \delta_0 - \delta_1 t) + \rho(\delta_0 + \delta_1 t)(1 - \delta_0 - \delta_1 t)(k-l) + \varepsilon_5$

	δ_0	δ_1	$\ln \gamma$	λ	ρ	LM_A	LM_B	ADE_A
Canada	-24.71 (90.69)	0.009 (3.66)	0.83 (1.68)	0.41 (5.30)	0.05 (3.74)	3.74	2.25	2.17
USA	-14.41 (97.84)	0.004 (1.67)	1.10 (2.83)	0.21 (2.91)	0.10 (3.62)	4.65	1.37	3.22
Japan	0.45 (0.70)	-0.007 (7.11)	0.03 (2.03)	0.05 (11.25)	0.21 (0.61)	5.54	5.67	1.36
New Zeal.	26.50 (34.07)	-0.009 (4.67)	2.48 (2.89)	-0.24 (2.43)	-0.20 (4.48)	2.73	0.76	2.10
Australia	-1.54 (2.66)	0.015 (0.59)	0.04 (0.95)	0.05 (7.09)	0.77 (3.03)	2.49	2.65	2.28
Belgium	14.20 (10.91)	0.040 (1.17)	1.90 (3.00)	-1.04 (6.82)	0.06 (2.07)	1.46	1.23	2.03
Denmark	-8.69 (50.83)	0.008 (6.49)	0.93 (4.30)	0.03 (0.85)	0.30 (8.14)	7.76	1.22	3.15
Finland	-17.05 (132.13)	0.010 (1.99)	0.88 (1.95)	0.48 (6.20)	0.03 (1.77)	4.51	2.19	3.77

Table 3 cont.

France	1.30 (17.37)	-0.006 (1.24)	0.12 (4.67)	-0.23 (3.36)	3.29 (2.02)	2.14	1.06	2.01
Germany	-31.72 (142.01)	0.003 (1.13)	2.79 (2.31)	0.41 (1.40)	0.05 (2.00)	5.54	3.36	2.37
Greece	-11.73 (112.23)	0.006 (2.47)	0.96 (1.36)	0.40 (2.61)	0.04 (0.92)	10.31	2.70	3.22
Ireland	39.95 (11.94)	0.029 (1.09)	4.90 (3.92)	-2.51 (14.36)	0.00 (0.96)	4.72	2.87	3.02
Luxembg	53.92 (10.21)	0.042 (0.55)	7.62 (3.68)	-2.76 (7.03)	0.00 (0.77)	5.54	2.05	1.71
Netherl	-0.57 (0.88)	-0.045 (0.57)	-0.28 (6.42)	0.15 (22.34)	-0.27 (4.22)	3.23	3.94	2.21
Norway	-16.51 (54.33)	0.010 (1.24)	-0.98 (2.40)	0.73 (11.74)	0.02 (2.93)	2.72	1.38	4.60
Portugal	30.42 (86.29)	0.013 (1.85)	-3.35 (2.02)	-0.94 (3.20)	-0.02 (1.79)	0.92	5.09	2.90
Sweden	-16.33 (66.98)	0.022 (5.95)	2.13 (2.31)	0.31 (1.52)	0.06 (2.27)	9.29	3.79	2.74
UK	-5.23 (5.85)	0.023 (0.86)	-0.05 (0.29)	0.19 (6.68)	0.06 (0.92)	3.76	2.94	2.78

Note: See note to table 2.

5 Comparison of the Wage Gaps

This section compares the real wage gap estimated under the various technology assumptions; (1) Artus' CES approximation; (2) TL technology; (3) CD technology; and (4) Bruno's CES formula. Estimation of the full employment marginal labour productivity under the CD technology and Bruno's formula follow the trend-through-peak method discussed in the data section in the previous chapter. Bruno's CES formula is computed with $\rho = 0.5$ in accordance with his own estimates. The real wage gap on average is normalized to zero in the (full employment) period from 1965 to 1969 except for two countries (1966-69 for Denmark and 1971 for New Zealand) in the estimates.

Table 4 displays the wage gap estimations in three periods. The magnitude of the real wage gap is remarkable diverse across methods. The wage gap is on the average lowest under CES technology, highest under TL technology and in the middle ground under CD technology. Under the CES technology assumption, the real wage gap is on average negligible in 1988, whereas it is 18.8 under the TL technology assumption. If the real wage gap is partly responsible for the high unemployment rate in the OECD countries, we would expect the real wage gap to be relatively high in 1988.

Table 4. The real wage gap for services and manufacturing under different technologies.

	1973				1979				1988			
	CD	BR	AR	TL	CD	BR	AR	TL	CD	BR	AR	TL
Canada	9	10	5	14	13	17	9	21	6	11	3	26
USA	2	2	3	7	4	1	1	12	1	-8	-15	20
Japan	19	-15	25	3	35	14	36	25	35	4	34	13
Australia	13	7	9	17	18	16	14	37	7	1	2	25
New Zeal.	-7	-4	-1	2	3	7	4	16	-15	-27	-15	28
Austria	24	17	15	25	35	23	25	32	29	22	18	29
Belgium	22	13	12	20	33	30	23	28	16	12	8	6
Denmark	-3	-13	-11	-14	4	5	1	-5	5	1	0	-1
Finland	12	8	8	18	14	16	10	15	6	10	5	17
France	6	-3	2	7	21	14	17	25	13	11	13	21
Germany	8	5	9	0	7	6	9	15	-2	-4	1	11
Greece	-4	-8	-4	4	29	5	23	30	41	10	35	46
Ireland	8	-5	-2	13	7	-8	-4	16	-6	-10	-14	6
Italy	6	5	6	16	11	8	11	26	-2	-5	-5	31
Luxemb.	15	1	-2	14	42	35	12	31	35	27	-5	24
Netherl.	18	16	17	24	26	25	24	32	13	9	12	22
Norway	11	17	12	12	17	21	18	15	20	33	21	21
Portugal	3	0	4	18	19	20	11	35	11	-4	-6	25
Spain	11	22	0	14	14	20	-5	14	-4	11	-26	0
Sweden	9	1	-	14	23	5	-	30	9	-23	-	28
Switzerl.	8	3	4	6	14	0	5	4	14	-4	6	9
UK	0	-6	-2	8	-4	-4	-2	7	-16	-17	-19	7
Average	8.3	3.3	5.2	11	17.5	12.5	11.5	22.0	9.8	2.7	2.5	18.8
S. Dev.	8.2	9.9	8.2	8.9	12.1	11.0	10.7	10.9	15.3	15	16.2	11.4

Note: CD = CD technology, BR = Brunos' CES approximation formula, AR = Artus' method and TL = TL technology. The "-" for Sweden is due to a wage gap exceeding its logical limit.

The real wage gap, under the different technology assumptions, are displayed in figures 1 to 3 for three important countries; that is Canada, France and Germany. Under all technology assumptions, the real wage gap increased strongly from the mid 1960s to the mid 1970s or mid 1980s in the French case. The path in the 1980s, however, is somewhat conflicting. The decline in the real wage gap is in the 1980s modest under the TL technology assumption compared to the other technologies.

6 Discrimination Between the Models

The previous section showed the real wage gap to be sensitive to technology assumption suggesting a selection of the better technology assumption is desired. Table 5 discriminates between the different technology assumptions. Discrimination between the CD and the TL case is done with a likelihood ratio test because the CD production function, unlike the CES production function, is nested within the TL model. The likelihood ratio test, LR_{CD} , in the last column of table 5 is significant at the 1 per cent level in nearly all cases, indicating that the TL technology assumption is likely to be the better technology assumption of the two.

The Akaike information criterion (AIC) is used to discriminate between Artus' CES approximation and the other technologies. I have refrained from employing non-nested tests since they are difficult, if not impossible, to

Figure 1. Wage Gap: Canada - 137 -

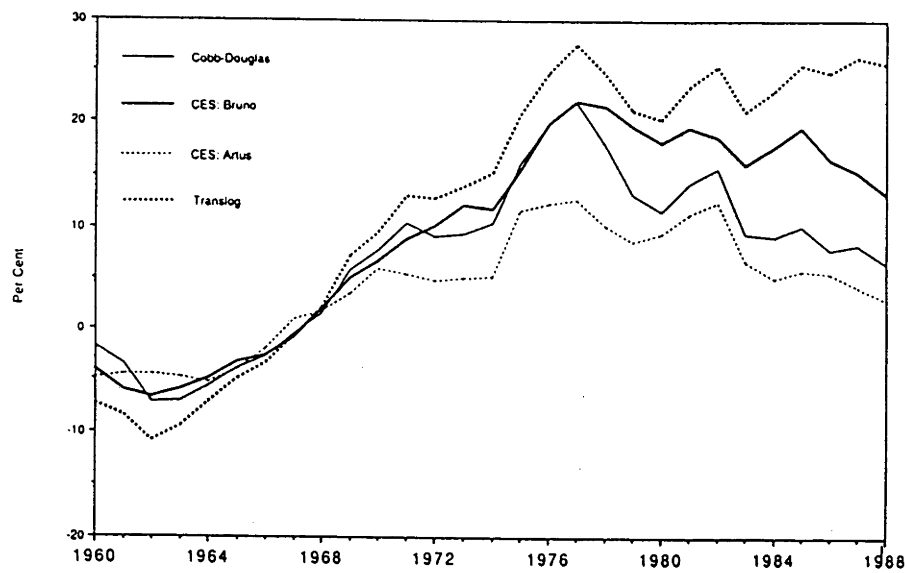


Figure 2. Wage Gap: Germany

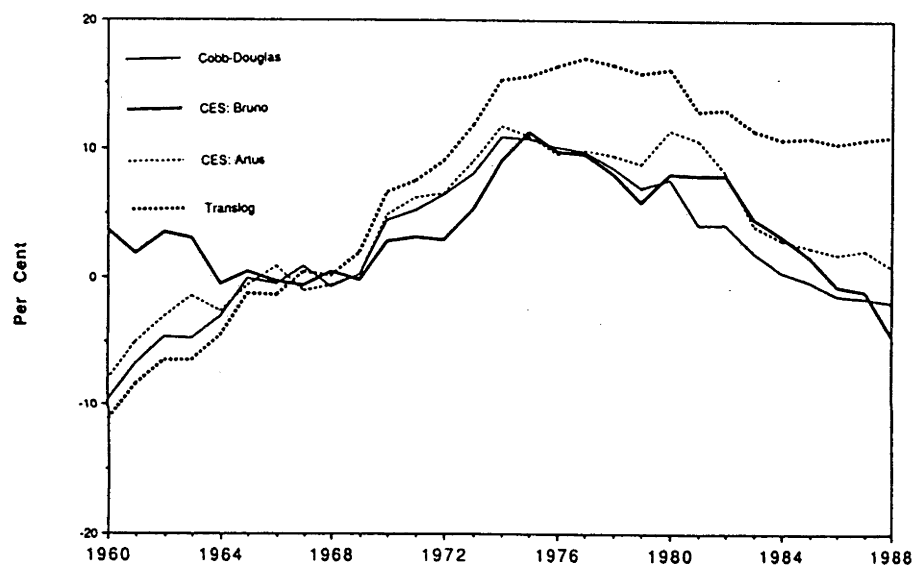


Figure 3. Wage Gap: France

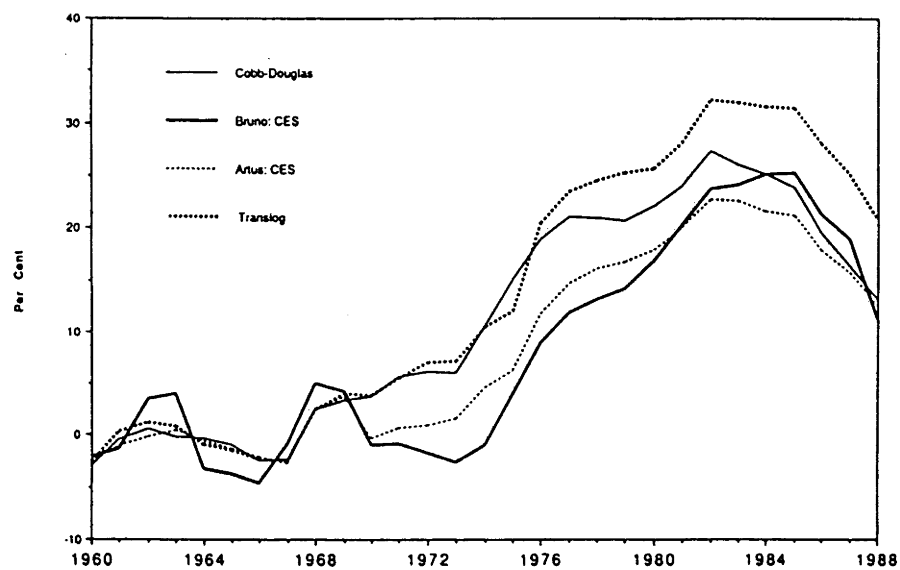


Table 5. Discrimination between technologies.

	CD _{AIC}	AR _{AIC}	TL _{AIC}	LR _{CD}
Canada	-7.40	-1.28	-7.69	18.27
USA	-7.46	-7.05	-7.45	24.94
Japan	-6.12	3.33	-6.25	46.98
Australia	-6.84	-0.19	-7.11	28.13
New Zeal.	-6.71	-2.13	-7.06	27.18
Austria	-5.29	-0.24	-6.31	55.10
Belgium	-6.52	0.54	-6.90	27.55
Denmark	-4.63	0.45	-8.07	78.89
Finland	-6.65	-0.13	-6.68	2.90
France	-8.28	-0.77	-8.76	30.74
Germany	-7.92	1.01	-8.60	31.03
Greece	-6.58	0.95	-7.00	23.76
Ireland	-6.18	0.95	-6.25	43.50
Italy	-6.20	-0.77	-7.22	58.29
Luxemb.	-7.01	-6.14	-7.17	27.84
Netherl.	-6.40	0.54	-6.86	48.72
Norway	-6.57	-0.49	-7.82	29.29
Portugal	-5.62	1.99	-6.04	30.45
Spain	-7.34	-0.94	-6.63	12.76
Sweden	-7.15	-6.29	-6.84	33.64
Switzerl.	-7.49	-0.74	-7.42	2.01
UK	-7.06	0.30	-7.24	29.00

Note: CD_{AIC} = AIC criterion with CD technology, AR_{AIC} = AIC criterion with Artus' method, TL_{AIC} = AIC criterion with TL technology and LR_{CD} = likelihood ratio test for CD technology, $\chi^2_{(6)}$ -distributed under the null of CD technology.

perform in the framework used above and their distributive properties are unknown. The lower AIC value under the CD and TL technology assumptions than under Artus' CES approximation in all cases suggest that the CD and TL technology assumptions are likely to be the better technology assumptions. This finding, combined with the findings that the estimates of Artus' CES approximation are likely to be misspecified suggests that not much, if anything, can be gained by using his intricate method compared to the simple CD technology case.

7 Concluding Remarks

This paper has derived and estimated the real wage gap under the CD, CES and TL technology assumptions for 22 OECD countries. Although the magnitude of the wage gap is fairly sensitive to technology assumption, the estimates clearly indicate the existence of significant a wage gap for most countries in the 1970s and the beginning of the 1980s. During the 1980s the wage gap has declined for all countries, and on average is negligible in 1988 under the CD and the CES technology assumptions. The decline in the wage gap under the TL technology assumption, in contrast, has been modest during the 1980s, and it still is high in 1988.

Finally, different model selection criteria suggests the TL technology assumption to be the superior of the technologies when the real wage gap is estimated.

DATA SOURCES

Gross operating surplus: NA and HS. Manufacturing industry for Greece, Ireland and Portugal: gross domestic product minus working hours multiplied by compensation to employees (as calculated above).

Interest rates: IFS.

Capital Stock: OECD: *Flows and Stocks of Fixed Capital*. The exceptions are the following. Denmark: Otto (1987). Italy: Modigliani, F., F.P. Schioppa and N. Rossi, 1986, Aggregate Unemployment in Italy, 1960-1983, *Economica*, 53, S245-273 (Data Appendix). Spain: Dolado, J. J., J. L. M. de Molina and A. Zabalza, Spanish Industrial Unemployment: Some Explanatory Factors, *Economica*, 53, S313-S334 (Data Appendix). Austria: Pichelmann, K. and M. Wagner, Labour Surplus as a signal for Real-wage Adjustment: Austria, 1968-1984, *Economica*, 53, S75-87 (Data Appendix). New Zealand, Ireland, Luxembourg, Portugal and Switzerland: inventory perpetual method (see text).

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CHAPTER 5

LABOUR DEMAND UNDER DIFFERENT TECHNOLOGY ASSUMPTIONS

ABSTRACT. Labour demand functions are in this chapter derived under different underlying identifying assumptions and the following technology assumptions: Cobb-Douglas, CES, constant relative elasticity of substitution and translog technology. The models are estimated for private services and manufacturing in 15 of our 22 countries and are discriminated between by nested tests, information criteria and the coefficient estimates. The chapter finds the wage elasticity of labour demand to be very sensitive to choice of technology and identifying assumption. Ironically, probably the most popular specification of labour demand is found inferior to the two most preferred labour demand specifications.

1 Introduction

Labour demand functions have always played a prominent role in theoretical and applied macroeconomics because they provide information about the relationship between employment on one side and factor prices, output prices and macroeconomic activity on the other side. Wage elasticities of labour demand have been parameters of especially concern; particularly in the wake of the wage explosion from the mid-1960s to the mid 1970s and the successive increase in unemployment in the OECD area. The evidence, however, indicates substantial disagreement about the magnitude of the elasticities and the reason for this is impossible to uncover due to different identifying assumptions and technology assumptions, sample period, sectoral and country coverage.¹ In fact, the choice of technology assumption and the selection of the cost minimizing or the profit maximizing approach are usually not discussed, if stated at all.

Whereas many flexible form production functions have been suggested the last two decades, the Cobb-Douglas (CD) and the constant elasticity of substitution (CES) are still the preferred technology assumptions in studies of labour demand. Most recent studies employ CD technology under profit maximization followed by CES technology under profit maximization.²

1. See Hammermesh (1976, 1986) for surveys of elasticities.

2. The following studies employ CD technology under the assumption of profit maximization: Andrews and Nickell

This chapter derives labour demand under profit maximizing and cost minimizing behaviour and under following technology constraints: CD, CES, constant relative elasticity of substitution (CRES) and translog (TL) technology.³ The derived labour demand functions are estimated for private services and manufacturing in 15 of our 22 OECD countries where capital stock is available on sectoral level over the period 1960 to 1988. Two questions are asked. First, what is the magnitude of wage elasticity of labour demand and how sensitive is it to the underlying technology and identifying assumptions. Second, which identifying and technology assumptions, when estimating labour demand functions, are most likely to represent the data generating process best. The latter question is especially important since specification of the labour demand function plays an

(1982), Bean et al. (1986), Bruno and Sachs (1985), Dolado et al. (1986), Hatton (1988), Jenkinson (1986), Layard and Nickell (1985, 1986), Nickell and Symons (1990), Pissarides (1991), Sneessens and Dreze (1986) and Symons and Layard (1984). The following studies employ CD technology under the assumption of cost minimisation: Clark and Freeman (1980), Franz and Konig (1986), Hickman (1987) and Nadiri and Rosen (1969, 1974). The following studies employ CES technology under the profit maximization assumption: Hall et al. (1989), Harris (1985), Lewis and Markepace (1981), Modigliani et al. (1986), Rosen and Quandt (1978) and Russel and Tease (1991). Most of multicountry nature have estimated labour demand functions derived under the assumption of profit maximization and CD technology so labour demand is a function of real product wage and capital stock (Bean et al. (1986), Bruno (1986), Bruno and Sachs (1985) and Symons and Layard (1984)). The capital stock in Bruno and Sachs (1985) and Symons and Layard (1984) is approximated by a linear and cubed time trend respectively. Why another labour demand specification in these studies has been chosen is puzzling.

3. See seminal papers by Cobb-Douglas (1928) (CD), Arrow et al. (1961) (CES), Hanoch (1971) (CRESH) and Christensen et al. (1971) (TL).

important role in the chapters 6 and 8. Although the TL technology assumption was found to be superior to the CD and CES technology assumptions in estimating the real wage gap, in the previous chapter, it does not automatically follow that the same holds true for estimations of labour demand. The data requirements are quite different when the real wage gap is estimated compared to estimation of labour demand.

The chapter is organized as follows. Section 2 derives labour demand under different identifying and technology assumptions. The econometric issues are discussed in section 3. Section 4 present the empirical estimates and section 5 discriminates between the models. Section 6 derives and discusses the wage elasticities under the different identifying assumptions and technology assumptions. Section 7 briefly discusses the principal findings of the chapter.

2 Labour Demand and Technology

This section derives labour demand under different identifying and technology assumptions. The existence of competitive markets is assumed throughout. Whereas this is presumably an unrealistic assumption the purpose of the study is to keep the analysis simple and close to the main stream literature for comparative purposes.⁴

4. Layard and Nickell (1986) estimate labour demand under assumption of a non-competitive goods market. In next chapter it is demonstrated that it may be difficult to get satisfactory results under the assumption of non-competitive goods market.

2.1 Cobb-Douglas Technology

Given the unrestricted CD production function $Q(L,K) = \Theta L^a K^b$, where Q is gross domestic product (GDP), L labour services, K capital services, and Θ , a and b are parameters. Denoting logs with small letters, the stochastic versions of the derived labour demand, under profit maximization and cost minimisation behaviour respectively, are given by⁵

Model 1

$$l = \alpha_0 + \alpha_1(w - p_q) + \alpha_2 k + \varepsilon_1, \quad \alpha_1 < 0, \quad \alpha_2 > 0, \quad (1)$$

and

Model 2

$$l = \beta_0 + \beta_1(r - w) + \beta_2 q + \varepsilon_2, \quad \beta_1, \beta_2 > 0, \quad (2)$$

where L is measured by working hours, W compensation to employees per working hour, P_q the value-added price-deflator and R user cost per unit of capital.⁶ The parameters are given by

5. See appendix for derivation.

6. Direct wages and output prices are instead of total labour costs and the value-added price deflator used frequently. Usage of direct wages is problematic as indirect labour costs have been increasing in proportion to total labour costs over the past decades and account for almost 50 per cent of total labour costs in most OECD countries (Swedish Employers' Confederation (1989)). If output prices are substituted for the value-added price-deflator the labour demand equation must include prices of intermediate products. By the same token, intermediate inputs have to be included in the labour demand function if output instead of GDP is used as dependent variable.

$$\begin{aligned}\alpha_0 &= 1/(a - 1)[- \log \Theta - \log a], \quad \alpha_1 = 1/(a - 1), \\ \alpha_2 &= b/(a - 1), \quad \beta_0 = -1/(a + b) \quad \beta_1 = b/(a + b), \\ \beta_2 &= 1/(a + b).\end{aligned}$$

The coefficient on capital stock in equation (1) is assumed to be positive as an increase in the capital stock increases the marginal productivity of labour.

2.2 CES Technology

The unrestricted CES production function is given by

$$Q(L, K) = \gamma[\delta L^{-\rho} + (1 - \delta)K^{-\rho}]^{-v/\rho},$$

where $\rho = (1 - \sigma)/\sigma$, where σ as the elasticity of substitution, v is the returns to scale parameter and δ the distributional parameter. The stochastic versions of the derived labour demand, under profit maximization and cost minimisation respectively, are given by

Model 3

$$l = \omega_0 + \omega_1(w - p_q) + \omega_2q + \varepsilon_3, \quad \omega_1 < 0, \quad \omega_2 > 0, \quad (3)$$

and

Model 4

$$l = \tau_0 + \tau_1(r - w) + \tau_2k + \varepsilon_4, \quad \tau_1, \tau_2 > 0. \quad (4)$$

The parameters are given by

$$\omega_0 = \sigma \log(\delta v \gamma) , \quad \omega_1 = - \sigma , \quad \omega_2 = (1 + \rho/v) / (\rho + 1) , \\ \tau_0 = - \sigma \log[(1 - \delta)/\delta] , \quad \tau_1 = - s , \quad \tau_2 = 1 .$$

2.3 Translog Technology

The translog cost function is given by

$$\begin{aligned} \log C(W, R, Q) = & \log \gamma_0 + \gamma_\theta \log Q + \gamma_w \log W + \gamma_r \log R \\ & + 1/2 \gamma_{ww} (\log W)^2 + 1/2 \gamma_{rr} (\log R)^2 \\ & + \gamma_{wr} \log W \log R + \gamma_{qw} \log Q \log W \\ & + \gamma_{qr} \log Q \log R + \gamma_{qq} (\log Q)^2 , \end{aligned}$$

where W is compensation per working hour and R user costs of capital. By applying Shepard's lemma we get the derived labour demand function

$$\begin{aligned} l = \delta \log C(W, R, Q) / \delta \log W = & g_w + \gamma_{ww} \log W + \gamma_{wr} \log R \\ & + \gamma_{qw} \log Q . \end{aligned}$$

The stochastic version of this equation is an unrestricted version of model 2

Model 2 (unrestricted)

$$l = \lambda_0 + \lambda_1 w + \lambda_2 r + \lambda_3 q + \varepsilon_5, \quad \lambda_1 < 0, \quad \lambda_2, \lambda_3 > 0. \quad (5)$$

For $\lambda_2 = -\lambda_3$, we have the cost minimizing derived labour demand function under CD technology, which will be called the *restricted version of model 2*.

2.4 Constant Ratios of Elasticity of Substitution Technology

The CRES production function is given by

$$F(K, L, Q) = D_L Q^{-e(L)d(L)} L^{d(L)} + D_K Q^{-e(K)d(K)} K^{d(K)} = 1,$$

where D_i , $d(i)$, and $e(i)$ are the distribution, substitution and expansion parameters respectively for $i = K, L$. The stochastic versions of the derived labour demand, under cost minimisation, is given by

Model 5

$$l = \varphi_0 + \varphi_1(r - w) + \varphi_2k + \varphi_3q + \varepsilon_7, \quad \varphi_1, \varphi_2, \varphi_3 > 0 \quad (6)$$

The parameters are given by

$$\begin{aligned} \varphi_0 &= a_1 \log(D_L d_L / D_K d_K), \quad \varphi_1 = 1 / (1 - d_L), \\ \varphi_2 &= a_1 (e_K d_K - e_L d_L), \quad \varphi_3 = (1 - d_K) / (1 - d_L). \end{aligned}$$

Model 5 is convenient because it contains models 2 and 4 as special cases and hence allows for nested tests to discriminate between models 2 and 4.

3 Econometric Issues

Data. The data employed are described in the chapters 3 and 4.

Stochastic Specification. Since equation (2) is the restricted form of equation (5), we only need to estimate equation (5) and test the restriction imposed by equation (2). Due to Clark and Freeman (1980), the coefficients on r and w in models 4 and 5 are also estimated unrestricted. Clark and Freeman have shown that estimates of restricted opposite signed coefficients on r and w are likely to result in a downward biased estimate of the wage elasticity. The point is that r has a higher standard deviation than w . This implies that models that relate demand for labour to relative factor prices essentially relate demand for labour to the price of capital rather than both costs of labour and capital. Since r probably is measured with a considerable error the wage elasticity is likely to be downward biased.

All models are estimated in log-levels with the dependent variable lagged one period to allow for lagged adjustment.⁷ The costs of using this simple adjustment mechanism is that

7. This dynamic specification is termed by Hendry et al. (1984) a reduced form or "dead start" equation. In a general framework where a general unrestricted form with lagged dependent and independent variables first is established, with "insignificant" variables sequentially restricted to zero afterwards, may be more suitable in many cases. In the present case with 29 observations available only for each country, the merits of a more unrestricted specification are disputable. Furthermore, the tables with the results would explode in size and be much less reader-friendly.

it forces the adjustment lag to be the same for all explanatory variables which seems reasonable. No matter whether income or capital stock is used as an explanatory variable, they both influence labour demand via the marginal productivity of labour condition. In the optimising framework used in this chapter the recruitment decision is independent of whether labour costs or the marginal productivity of labour has changed. The advantage of using this simple adjustment mechanism is that all results are first-round regressions; no pretesting and specification search have been conducted. The estimates are therefore not influenced by prior intentions. The models are estimated in log-levels because it is the long-run parameters that are of interest. Estimation in differences, alternatively, may give misleading results if the goods market is dominated by monopolistic competition on the goods market and if labour demand is dominated by changes of price mark-up over marginal cost over the business cycle.⁸ Since mark-ups fluctuate much over the business cycle, as shown by Bils (1987), short-run estimates are not likely to give unbiased parameter estimates.

Estimation Method. It is conceivable that the residuals in the estimates for private services and manufacturing are correlated because these sectors may simultaneously be off their notional labour demand schedule over the business cycle. Hence, a gain in efficiency may be obtained by

8. Labour demand under monopolistic competition is derived in the next chapter.

employing Zellner's iterative estimation procedure (SURE), where error correlations across the equations are allowed for.

The production and the labour demand decision is taken simultaneously and labour demand influences real wages via the labour demand schedule; that is w/p and q may not be weakly exogenous. Hence the three stage least squares estimation technique is employed.⁹ Following instruments for q are employed: GDP, changes in the inflation and cyclical adjusted fiscal balance in percent of potential GDP, monetary stock, $M1$, deflated by consumer prices and world trade volume. All variables are unlagged and lagged one period except GDP which is lagged only one period. Following instruments for w/p are employed: w/p in the other sector, the own sector w/p and real monetary stock. All variables are unlagged and lagged one period except the own sector w/p , which is lagged one period.

Diagnostic tests. Since 29 observations only are available for each country, the number of diagnostic tests have been kept to an absolute minimum. Lagrangian multiplier tests for first order serial correlation are performed by regressing

9. Since the labour demand functions and their attached production functions belong to the same system estimation of labour demand and the production function as a system with cross-equation restrictions imposed will give more efficient estimates in theory. The costs of employing this procedure is that the CES and CRES production functions need to be estimated by non-linear estimation technique, where parameter estimates are very sensitive to their starting values. Furthermore, it is not guaranteed that tests of cross equation constraints will be accepted.

the residual on a constant and its lagged value. Augmented Dickey-Fuller (ADF) tests for co-integration are computed as the estimate of μ_1 divided by its standard deviation from the regression $\Delta e_{it} = \mu_{i0} + \mu_{i1}e_{it-1} + \mu_{i2}\Delta e_{t-1} + \varepsilon_{it}$, where e_i is the residual from the estimate of the labour demand function. Finally, a likelihood ratio test for structural stability which is robust to the non-linear SURE estimation is performed for the whole system is estimated as

$$LR = n (\log[\hat{\Omega}_r] - \log[\hat{\Omega}_u]),$$

where $[\hat{\Omega}_r]$ and $[\hat{\Omega}_u]$ are the determinants of the estimated error covariance matrices for the restricted and unrestricted models, respectively, and n the number of observations. The break point is chosen to be 1974/75 for the following reasons. First, it is more likely that labour has been off the notional labour demand scheme in the more turbulent period after the first oil price shock than before it. Second, the "wage explosion" preceding the first oil price shock, and the subsequent slow-down in GDP growth, may have forced firms to reflect more upon changes in real wages in their labour recruitment decisions. Third, the speed of technological advances, which influences on labour demand are ignored in the estimations, probably slowed down after the first oil price shock. This may have affected labour demand positively or negatively dependent upon the technology parameters in the labour demand functions. This aspect is discussed further in chapter 8.

4 Empirical Results

The estimates of the models are presented in tables 1 to 5. The long-run coefficients in the tables are all computed as the short-run coefficient estimate divided by one minus the coefficient estimate on the lagged dependent variable. It is important to note the reported long-run wage coefficients are not elasticities, although they are usually interpreted in that way. This question is addressed in section 7. Differences in elasticities between sectors are also addressed in section 7.

Model 1 (CD production function under profit maximization). Estimates of model 1 are displayed in table 1. The coefficients in most cases have the expected sign; that is negative coefficient on real wages and positive coefficient on capital. The the magnitude of the long-run coefficient estimates differ widely across countries and between sectors. Since technologies are likely to be quite similar across countries this finding suggests that we cannot have much confidence in the results. Moreover, the coefficient estimates are not very significant.

The diagnostic tests in general suggest that the estimates are free of first order autocorrelation and that labour demand, on one side, and w/p and k , on the other side, are co-integrated. A structural break in the labour demand functions seems to have appeared in the period 1974/75 for all countries. Parameter instability is, however, not

Table 1. Parameter estimates of equation (1)

	Canada		USA		Japan		Australia		Belgium	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
$l_t = \alpha_0 + \alpha_1(w - p)_t + \alpha_2k_t + \alpha_3l_{t-1} + \varepsilon_{1t}$										
α_0	5.17 (3.94)	2.82 (3.76)	4.07 (2.17)	1.87 (2.40)	1.02 (0.64)	4.61 (3.80)	-0.45 (0.34)	1.11 (1.70)	2.67 (4.83)	-1.69 (1.03)
α_1	0.08 (0.78)	0.11 (1.15)	0.06 (0.32)	0.06 (0.53)	-0.01 (0.19)	-0.01 (0.49)	-0.32 (2.96)	-0.23 (3.55)	-0.13 (2.80)	-0.18 (2.61)
α_2	0.10 (1.07)	0.38 (4.39)	-0.03 (0.19)	0.18 (1.95)	0.01 (0.07)	0.08 (3.00)	0.40 (2.57)	0.26 (3.94)	0.01 (0.27)	0.19 (2.33)
α_3	0.44 (3.05)	0.37 (3.76)	0.72 (3.97)	0.78 (7.60)	0.92 (5.21)	0.59 (5.45)	0.65 (6.10)	0.66 (6.25)	0.72 (9.62)	1.01 (9.71)
w_{LR}	0.14 [0.51]	0.18 [0.30]	0.22 [2.71]	0.28 [2.27]	-0.15 [26.74]	-0.03 [0.68]	-0.90 [1.06]	-0.67 [0.95]	-0.49 [1.15]	9.18 [290.0]
k_{LR}	0.18 [0.16]	0.61 [0.19]	-0.12 [1.76]	0.83 [1.63]	0.06 [8.25]	0.21 [0.60]	1.12 [1.12]	0.75 [0.73]	0.05 [0.44]	-9.92 [284.5]
AIC	-6.53	-7.07	-6.16	-7.50	-6.99	-8.20	-6.42	-7.57	-7.45	-7.35
LM	1.16	0.82	0.47	1.35	0.98	1.70	-0.07	-1.10	-1.83	-1.60
ADF	-3.77	-3.51	-4.68	-3.49	-3.96	-2.81	-3.96	-4.87	-4.25	-3.66
LR	46.10		52.93		43.90		17.81		27.78	

	Finland		France		Germany		Ireland		Luxembourg	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
α_0	1.35 (0.81)	-2.06 (1.73)	-1.05 (1.87)	-0.03 (0.05)	3.64 (3.05)	5.54 (3.10)	1.51 (1.82)	1.41 (1.25)	0.69 (0.46)	-0.86 (1.49)
α_1	-0.13 (1.06)	-0.64 (3.39)	-0.18 (3.84)	-0.26 (4.52)	-0.32 (3.38)	-0.03 (0.27)	0.07 (0.72)	-0.06 (0.92)	-0.04 (0.90)	-0.11 (1.49)
α_2	0.14 (0.93)	0.64 (3.45)	0.18 (2.95)	0.20 (4.15)	0.30 (2.48)	0.07 (1.26)	-0.08 (0.85)	0.04 (1.01)	-0.00 (0.03)	0.05 (1.40)
α_3	0.69 (4.39)	0.44 (2.57)	0.89 (21.17)	0.78 (13.65)	0.40 (2.70)	0.51 (3.36)	0.89 (6.61)	0.82 (6.09)	0.91 (9.84)	1.04 (16.06)
w_{LR}	-0.42 [1.82]	-1.13 [0.82]	-1.63 [3.85]	-1.19 [1.35]	-0.53 [0.56]	-0.05 [0.67]	0.64 [11.08]	-0.32 [4.59]	-0.48 [10.45]	2.80 [40.83]
k_{LR}	0.46 [1.36]	1.13 [0.30]	1.58 [4.64]	0.90 [1.03]	0.50 [0.16]	0.14 [0.57]	-0.66 [5.94]	0.21 [4.28]	-0.03 [11.38]	-1.28 [40.14]
AIC	-6.76	-6.79	-8.23	-8.34	-6.80	-7.25	-6.90	-7.33	-7.18	-7.03
LM	-0.97	2.92	0.09	1.13	1.14	0.59	1.31	1.47	0.33	1.14
ADF	-3.54	-3.69	-4.37	-5.07	-5.11	-3.27	-2.76	-3.71	-3.75	-3.70
LR	41.70		20.15		15.71		32.82		27.80	

	Netherlands		Norway		Portugal		Sweden		UK	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
α_0	1.13 (1.69)	1.67 (2.90)	4.04 (1.56)	0.33 (0.24)	6.91 (3.53)	1.12 (0.96)	4.32 (1.78)	3.07 (2.21)	-0.05 (0.08)	3.09 (1.63)
α_1	-0.08 (1.16)	-0.05 (1.19)	0.13 (1.29)	0.07 (1.05)	0.08 (1.01)	-0.09 (1.34)	-0.08 (1.07)	-0.05 (0.98)	0.25 (1.71)	-0.45 (2.05)
α_2	0.03 (0.36)	0.18 (2.20)	-0.20 (1.29)	-0.09 (0.85)	0.08 (1.38)	0.10 (1.56)	-0.07 (0.70)	0.11 (2.49)	-0.43 (2.05)	0.18 (2.46)
α_3	0.86 (15.42)	0.68 (5.75)	0.81 (7.44)	1.07 (16.09)	0.24 (1.28)	0.79 (4.84)	0.68 (5.56)	0.59 (3.81)	1.18 (9.80)	0.68 (4.19)
w_{LR}	-0.59 [3.52]	-0.16 [1.26]	0.67 [2.71]	-0.92 [11.90]	0.09 [0.31]	-0.45 [3.92]	-0.24 [1.14]	-0.12 [0.90]	-1.41 [3.01]	-1.42 [2.05]
k_{LR}	0.19 [3.68]	0.57 [0.92]	-1.06 [4.81]	1.20 [12.20]	0.11 [0.05]	0.43 [3.42]	-0.22 [1.28]	0.27 [0.84]	2.43 [7.32]	0.58 [1.48]
AIC	-7.76	-7.79	-6.67	-7.21	-6.75	-6.18	-6.65	-6.94	-6.90	-6.52
LM	1.13	-0.04	-0.15	-0.37	-0.10	0.93	1.03	-0.66	1.77	-1.00
ADF	-4.02	-3.75	-4.24	-3.25	-2.94	-3.29	-5.43	-4.48	-4.88	-3.65
LR	40.83		57.41		37.71		23.62		32.77	

Note: asymptotic t-statistics in soft parentheses and asymptotic standard errors in square parentheses. i_{LR} is the long-run coefficient on the variable "i". $Man =$ manufacturing and $Ser =$ services. $LM =$ Lagrangian multiplier test for first order serial correlation, asymptotically $t(26)$ -distributed under the null hypothesis of no serial correlation. $ADF =$ augmented Dickey Fuller test for co-integration, $t(25)$ -distributed under the alternative hypothesis no co-integration (does not follow the student t-distribution). $LR =$ likelihood ratio test for structural stability over the period 1961-74 to 1975-1988, $\chi^2(k+2)$ -distributed under the null of structural stability of the system, where k in the number of regression coefficients. $AIC =$ Akaike information criterion. Estimation period 1961 to 1988. The long-run standard error for the variable "i" is asymptotic approximated by $var(i_{LR}) = var(i)/(1-\alpha_3)/(1-\alpha_3)^4 + 2cov(i, \alpha_3)/(1-\alpha_3)^3$.

limited to the CD profit maximization case but, as shown in the estimates below, is present in all the models. This suggests that parameter instability is not due to the identifying and the technology assumptions. Errors in variables is more likely to the major course of the parameter instability: The labour demand functions are derived under the assumption of full input utilization, defined as cost minimizing production point. Since labour and capital are quasi-fixed factors, it is unlikely that producers were on their notional capital and labour demand schemes in the 1974/75 and 1981/82 down-turns. The profit squeeze, furthermore, that peaked in the mid 1970s, may have made firms more real product wage conscious. In fact, the real wage elasticity tended to increase over the period 1961-1974 to 1975-1988 (estimates not shown here). A growth in technological advances may also have contributed to the structural break.

Model 2 (the CD or the TL production functions under cost minimisation). Estimates of model 2 are presented in table 2. The long-run coefficient estimates on w and q have the expected signs in nearly all cases, are significant at the 5 per cent level and do not differ much across countries. As may be expected, the coefficients on user cost are only significant at the 5 per cent level in half of the cases, probably because expected capital costs are poorly measured. Unless the coefficient estimates on w and r have low t -ratios, the restriction of equality between the coefficient on r and minus w is unambiguously rejected. Whether this

Table 2. Parameter estimates of equation (2)

$$l_t = \beta_0 + \beta_1 w_t + \beta_2 r_t + \beta_3 q_t + \beta_4 l_{t-1} + \varepsilon_{2t}$$

	Canada		USA		Japan		Australia		Belgium	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
β_0	6.94 (6.81)	7.87 (6.97)	9.11 (6.56)	1.90 (1.98)	8.80 (7.41)	2.08 (1.46)	7.54 (7.34)	4.95 (3.78)	4.91 (8.32)	6.01 (8.00)
β_1	-0.15 (3.50)	-0.20 (3.73)	-0.28 (4.33)	0.03 (0.42)	-0.16 (6.28)	0.02 (1.42)	-0.19 (4.65)	-0.17 (3.50)	-0.27 (7.13)	-0.22 (6.59)
β_2	0.07 (2.66)	0.03 (1.75)	0.10 (2.75)	-0.03 (0.94)	-0.01 (1.13)	-0.03 (2.76)	-0.01 (0.22)	0.04 (2.15)	0.03 (1.73)	-0.00 (0.17)
β_3	0.40 (6.35)	0.89 (6.40)	0.50 (5.98)	0.23 (1.96)	0.25 (5.81)	-0.03 (0.50)	0.54 (6.48)	0.70 (4.06)	0.26 (5.04)	0.77 (7.16)
β_4	0.26 (2.44)	0.08 (0.59)	0.22 (1.91)	0.80 (8.13)	0.30 (3.13)	0.86 (7.50)	0.15 (1.36)	0.37 (2.33)	0.50 (8.32)	0.21 (2.26)
w_{LR}	-0.20 [0.21]	-0.21 [0.19]	-0.35 [0.23]	0.13 [2.44]	-0.23 [0.23]	0.17 [6.17]	-0.22 [0.17]	-0.27 [0.46]	-0.53 [0.29]	-0.28 [0.18]
q_{LR}	0.53 [0.15]	0.96 [0.07]	0.64 [0.14]	1.15 [2.00]	0.36 [0.15]	-0.22 [5.80]	0.63 [0.11]	1.12 [0.18]	0.53 [0.18]	0.98 [0.08]
Wald	13.28	15.66	28.32	0.00	48.72	0.06	51.43	13.72	54.41	58.61
AIC	-7.17	-7.61	-6.92	-7.55	-7.99	-8.45	-7.17	-7.47	-7.92	-8.26
LM	0.77	0.02	1.21	0.94	0.44	0.20	-0.72	0.32	0.23	0.04
ADF	-3.14	-3.77	-2.97	-3.43	-6.01	-4.08	-4.32	-3.27	-2.65	-2.95
LR	32.93		49.45		53.21		24.98		44.78	

Table 2 Cont.

	Finland		France		Germany		Ireland		Luxembourg	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
β_0	1.11 (0.95)	1.54 (1.58)	3.50 (4.14)	3.61 (4.65)	9.83 (7.93)	9.44 (3.92)	0.95 (1.41)	3.37 (3.05)	1.30 (2.12)	0.21 (0.24)
β_1	-0.06 (1.09)	-0.16 (2.77)	-0.07 (3.43)	-0.13 (4.13)	-0.28 (6.53)	-0.04 (0.78)	-0.07 (1.45)	-0.08 (2.41)	-0.05 (2.11)	-0.05 (1.28)
β_2	-0.01 (0.46)	0.04 (2.12)	-0.01 (0.49)	0.04 (2.73)	0.00 (0.15)	0.03 (1.15)	0.01 (0.36)	0.08 (2.57)	-0.05 (2.64)	0.01 (0.56)
β_3	0.16 (1.42)	0.45 (2.89)	0.12 (3.40)	0.37 (4.05)	0.44 (6.23)	0.19 (1.85)	0.15 (2.24)	0.11 (1.99)	0.21 (3.34)	0.18 (2.39)
β_4	0.84 (7.29)	0.71 (6.41)	0.69 (9.15)	0.61 (7.12)	0.16 (1.52)	0.22 (1.17)	0.85 (12.16)	0.59 (4.60)	0.76 (11.12)	0.90 (6.70)
w_{LR}	-0.37 [4.69]	-0.53 [1.35]	-0.24 [4.69]	-0.32 [0.63]	-0.34 [0.19]	-0.05 [0.32]	-0.44 [2.93]	-0.19 [0.81]	-0.23 [1.15]	-0.54 [13.75]
q_{LR}	0.99 [4.73]	1.35 [1.12]	0.99 [4.73]	0.94 [0.35]	0.53 [0.10]	0.24 [0.33]	0.98 [2.99]	0.28 [0.71]	0.87 [1.26]	1.83 [13.59]
Wald	3.22	6.56	22.41	17.98	60.41	0.02	7.42	0.01	31.80	1.50
AIC	-6.71	-6.61	-8.38	-8.65	-7.45	-7.31	-7.04	-7.63	-7.63	-7.06
LM	0.23	0.04	1.24	1.59	1.77	1.45	0.88	1.06	-0.34	1.24
ADF	-2.65	-2.95	-3.65	-3.87	-4.40	-2.84	-2.51	-3.64	-4.49	-3.81
LR	44.78		54.34		24.21		38.37		67.10	

Table 2 Cont.

	Netherlands		Norway		Portugal		Sweden		UK	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
β_0	3.41 (4.67)	4.00 (3.15)	4.57 (4.55)	0.31 (0.30)	10.54 (6.46)	2.46 (2.25)	4.25 (2.57)	6.32 (4.87)	3.21 (4.10)	2.85 (1.48)
β_1	-0.20 (4.40)	-0.07 (1.79)	-0.08 (1.83)	0.02 (0.35)	0.03 (0.14)	-0.03 (1.31)	-0.10 (1.97)	-0.12 (4.14)	-0.08 (4.66)	-0.06 (1.41)
β_2	0.03 (1.12)	0.08 (2.39)	-0.03 (1.14)	0.01 (0.60)	-0.02 (2.08)	0.04 (3.24)	0.04 (1.27)	0.04 (3.12)	0.04 (0.40)	0.01 (0.85)
β_3	0.24 (3.54)	0.32 (2.80)	0.21 (2.01)	-0.06 (0.42)	0.28 (4.97)	0.04 (0.68)	0.05 (0.66)	0.77 (4.94)	0.23 (4.49)	0.24 (1.76)
β_4	0.64 (9.37)	0.53 (3.64)	0.45 (3.69)	0.99 (10.54)	-0.12 (0.69)	0.75 (7.63)	0.60 (3.81)	0.13 (0.86)	0.68 (10.57)	0.71 (4.86)
w_{LR}	-0.55 [0.61]	-0.15 [0.69]	-0.15 [0.44]	1.43 [487.1]	-0.03 [0.13]	-0.14 [1.62]	-0.25 [1.07]	-0.13 [0.22]	-0.27 [0.68]	-0.21 [1.77]
q_{LR}	0.69 [0.48]	0.68 [0.49]	0.38 [0.33]	-4.50 [486.8]	0.24 [0.11]	0.16 [1.69]	0.14 [0.91]	0.89 [0.15]	0.73 [0.59]	0.85 [1.79]
Wald	22.42	0.02	16.30	0.54	2.04	0.20	4.09	11.73	33.18	1.73
AIC	-8.20	-7.76	-7.01	-7.20	-6.90	-6.21	-6.57	-7.41	-7.41	-6.41
LM	0.78	-0.08	0.25	-0.56	-0.48	-0.33	2.47	-0.97	2.53	-0.22
ADF	-4.15	-3.65	-3.70	-3.58	-4.33	-4.36	-4.77	-5.43	-3.28	-2.51
LR	34.13		63.94		23.54		57.27		56.29	

Note: see note to table 1. Wald = Wald test for equality of β_1 and $-\beta_2$, $\chi^2(1)$ -distributed under the null hypothesis of equality.

implies rejection of CD technology in favour of TL technology or that r is poorly measured cannot be concluded. The important point is that the better estimates are obtained in the unrestricted case. The hypothesis of an income elasticity of one, that is constant returns to scale, cannot be rejected in most cases. That most of the income elasticity point estimates are below one may be due to increasing returns to scale, errors in measurement and/or the omission of variables for technological progress.¹⁰ The diagnostic tests, in general, give no indication of first-order serial correlation and the lack of co-integration.

Model 3 (CES production function under profit maximization). Table 3 presents the estimates of model 3. The long-run coefficients on the real wage, which is minus the elasticity of substitution, in most cases are in the range of minus 0.5 and minus 1. The long-run income elasticity is distributed around one (constant returns to scale). The long-run coefficient estimates are quite similar across countries. The diagnostic tests, in general, give no indication of first-order serial correlation and lack of co-integration.

Model 4 (CES production function under cost minimisation). The estimates of model 4 are shown in table 4. The coefficients on user cost have low t-statistics and their signs are often the opposite of the expected. When they are

10. Errors of measurement may bias the coefficient either way. Griliches and Hausman (1986) suggest a method that control for the bias by employing panel data. By applying their method to labour demand they find that the coefficient on income is downward biased.

Table 3. Parameter estimates of equation (3).

$$l_t = \omega_0 + \omega_1(w/p)_t + \omega_2q_t + \omega_3l_{t-1} + \varepsilon_{3t}$$

	Canada		USA		Japan		Australia		Belgium	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
ω_0	5.25 (5.04)	5.59 (4.60)	7.17 (5.66)	3.28 (2.86)	7.06 (4.90)	0.56 (0.37)	2.03 (2.84)	2.98 (2.99)	3.12 (6.32)	-0.39 (0.50)
ω_1	-0.38 (3.22)	-0.25 (2.21)	-0.52 (5.46)	-0.17 (1.01)	-0.23 (4.21)	0.02 (0.47)	-0.46 (5.70)	-0.26 (3.57)	-0.26 (5.06)	-0.33 (5.06)
ω_2	0.48 (4.99)	0.57 (5.19)	0.59 (6.04)	0.42 (2.52)	0.27 (4.24)	-0.02 (0.25)	0.50 (5.23)	0.37 (3.82)	0.16 (2.87)	0.51 (4.80)
ω_3	0.34 (3.34)	0.32 (4.61)	0.27 (2.52)	0.64 (4.94)	0.37 (2.87)	0.97 (7.07)	0.60 (7.63)	0.62 (5.35)	0.62 (9.88)	0.83 (13.37)
w_{LR}	-0.58 [0.31]	-0.37 [0.34]	-0.71 [0.29]	-0.49 [1.43]	-0.36 [0.39]	0.71 [141.5]	-1.16 [0.63]	-0.68 [0.87]	-0.67 [0.55]	-1.88 [2.10]
q_{LR}	0.73 [0.22]	0.82 [0.17]	0.82 [0.17]	1.18 [0.57]	0.43 [0.24]	-0.77 [137.6]	1.25 [0.42]	0.96 [0.56]	0.42 [0.34]	2.90 [2.03]
AIC	-7.27	-7.40	-7.00	-7.60	-7.57	-8.22	-6.86	-7.55	-7.66	-7.74
LM	0.82	-0.01	0.56	1.31	1.65	0.49	-1.73	-0.61	-2.09	-1.65
ADF	-2.51	-3.32	-3.74	-3.27	-3.80	-3.62	-3.92	-4.17	-4.08	-3.62
LR	23.28		43.64		47.87		8.77			22.41

Table 3 Cont.

	Finland		France		Germany		Ireland		Luxembourg	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
ω_0	1.87 (1.50)	3.82 (3.96)	1.25 (2.57)	1.01 (2.01)	5.89 (5.94)	7.23 (3.87)	1.12 (1.43)	1.06 (1.04)	-0.31 (0.47)	0.47 (0.88)
ω_1	-0.22 (2.16)	-0.51 (5.10)	-0.21 (4.24)	-0.20 (3.55)	-0.52 (5.96)	-0.08 (0.90)	-0.12 (1.26)	-0.09 (1.00)	-0.09 (3.44)	-0.18 (2.91)
ω_2	0.20 (2.03)	0.64 (5.29)	0.18 (3.41)	0.20 (3.10)	0.55 (5.03)	0.19 (2.26)	0.10 (1.11)	0.09 (1.03)	0.12 (1.99)	0.27 (3.50)
ω_3	0.71 (5.71)	0.36 (2.70)	0.82 (14.72)	0.85 (16.18)	0.34 (3.33)	0.39 (2.55)	0.82 (11.38)	0.84 (6.38)	0.96 (14.79)	0.80 (8.34)
w_{LR}	-0.77 [1.58]	-0.79 [0.44]	-1.17 [2.08]	-1.30 [2.53]	-0.78 [0.34]	-0.13 [0.44]	-0.66 [2.48]	-0.59 [5.79]	-2.61 [50.11]	-0.88 [2.37]
q_{LR}	0.69 [1.51]	0.99 [1.19]	1.05 [1.57]	1.31 [2.04]	0.82 [0.16]	0.31 [0.37]	0.58 [2.41]	0.61 [5.07]	3.41 [50.91]	1.32 [2.03]
AIC	-6.86	-7.05	-8.32	-8.40	-7.34	-7.33	-6.96	-7.37	-7.30	-7.29
LM	0.48	1.68	-0.23	1.53	1.11	0.77	0.89	1.08	0.04	1.67
ADF	-3.22	-3.60	-4.69	-5.17	-4.44	-3.08	-2.53	-2.76	-3.91	-3.85
LR	40.38		23.53		18.48		39.17		44.27	

Table 3 Cont.

	Netherlands		Norway		Portugal		Sweden		UK	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
ω_0	1.05 (1.90)	2.72 (2.80)	1.52 (2.27)	-0.45 (0.37)	7.95 (4.35)	1.81 (1.31)	2.27 (2.76)	6.74 (4.74)	1.76 (3.54)	8.19 (4.52)
ω_1	-0.14 (2.11)	-0.08 (1.41)	-0.40 (3.96)	-0.01 (0.10)	0.02 (0.37)	-0.11 (1.41)	-0.27 (3.09)	-0.12 (2.48)	-0.31 (6.91)	-0.99 (5.40)
ω_2	0.10 (1.29)	0.29 (2.17)	0.45 (3.45)	0.03 (0.24)	0.15 (2.69)	0.12 (1.62)	0.22 (2.24)	0.49 (4.70)	0.48 (6.46)	0.57 (5.87)
ω_3	0.86 (17.45)	0.65 (4.91)	0.61 (5.54)	1.02 (6.05)	0.18 (0.99)	0.78 (5.08)	0.69 (7.52)	0.18 (1.12)	0.68 (12.37)	0.17 (1.02)
w_{LR}	-0.95 [2.61]	-0.22 [1.22]	-1.02 [0.95]	0.33 [187.8]	0.03 [0.24]	-0.50 [3.50]	-0.86 [1.19]	-0.15 [0.26]	-0.96 [0.65]	-1.19 [0.43]
q_{LR}	0.71 [2.29]	0.84 [0.74]	1.15 [0.51]	-1.17 [195.2]	0.18 [0.26]	0.57 [2.93]	0.70 [0.83]	0.60 [0.16]	1.48 [0.39]	0.69 [0.17]
AIC	-7.78	-7.80	-6.97	-7.18	-6.82	-6.52	-6.77	-7.21	-7.59	-7.01
LM	1.08	-0.04	-0.48	-0.30	-0.02	0.67	1.27	-0.15	0.95	-0.63
ADF	-3.84	-3.59	-4.17	-3.46	-2.84	-3.48	-7.46	-3.90	-3.50	-3.55
LR	29.47		60.11		33.23		30.22			16.39

Note: see note to table 1.

Table 4. Parameter estimates of equation (4).

$$l_t = \tau_0 + \tau_1 w_t + \tau_2 r_t + \tau_3 k_t + \tau_4 l_{t-1} + \varepsilon_{4t}$$

	Canada		USA		Japan		Australia		Belgium	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
τ_0	4.22 (3.68)	0.63 (0.80)	6.60 (3.02)	1.34 (1.82)	4.62 (2.47)	5.40 (4.34)	4.14 (3.55)	2.13 (3.36)	4.42 (6.30)	-0.20 (0.18)
τ_1	-0.10 (1.14)	-0.08 (1.23)	-0.11 (1.03)	-0.07 (0.86)	-0.08 (1.56)	0.02 (1.23)	-0.12 (2.32)	-0.14 (4.27)	-0.19 (4.56)	-0.15 (3.18)
τ_2	0.01 (0.23)	-0.02 (0.78)	-0.00 (0.10)	-0.01 (0.27)	-0.03 (1.70)	-0.03 (3.34)	-0.04 (1.38)	0.01 (0.90)	0.02 (0.93)	-0.02 (0.96)
τ_3	0.39 (2.43)	0.57 (4.09)	0.28 (1.67)	0.32 (2.36)	0.09 (1.23)	0.05 (1.97)	0.51 (3.61)	0.60 (5.64)	0.13 (2.50)	0.42 (3.53)
τ_4	0.25 (1.37)	0.39 (3.30)	0.41 (2.01)	0.77 (7.96)	0.60 (3.08)	0.57 (5.42)	0.17 (1.03)	0.28 (2.06)	0.55 (0.55)	0.78 (10.75)
wLR	-0.12 [0.39]	-0.11 [0.34]	-0.18 [0.73]	-0.32 [1.96]	-0.19 [1.29]	0.04 [0.58]	-0.14 [0.26]	-0.20 [0.28]	-0.42 [0.47]	-0.71 [1.57]
kLR	0.52 [0.20]	0.95 [0.19]	0.47 [0.41]	0.37 [1.39]	0.23 [1.01]	0.12 [0.54]	0.61 [0.16]	0.83 [0.13]	0.30 [0.31]	1.93 [1.66]
Wald	2.24	3.13	2.25	1.85	5.26	1.65	17.07	24.68	24.00	15.01
AIC	-6.56	-7.25	-6.21	-7.60	-7.29	-8.40	-6.63	-7.78	-7.66	-7.40
LM	1.48	0.48	0.92	0.99	1.13	1.44	0.87	-0.43	-0.58	-1.16
ADF	-3.85	-3.63	-4.43	-3.70	-3.98	-2.87	-3.87	-3.89	-3.49	-3.06
LR	32.93		84.19		60.18		22.16		58.60	

Table 4 Cont.

	Finland		France		Germany		Ireland		Luxembourg	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
τ_0	1.13 (0.70)	0.86 (0.45)	1.43 (3.01)	2.08 (4.53)	7.13 (5.49)	7.68 (2.67)	3.17 (4.12)	3.20 (2.85)	0.75 (0.40)	-0.31 (0.34)
τ_1	0.10 (0.15)	-0.03 (0.46)	-0.06 (2.83)	-0.13 (4.45)	-0.21 (4.14)	-0.02 (0.29)	-0.09 (1.80)	-0.10 (2.20)	-0.03 (0.46)	-0.01 (0.16)
τ_2	-0.03 (1.19)	0.02 (0.79)	-0.00 (0.24)	0.03 (2.26)	-0.00 (0.01)	0.02 (0.82)	0.01 (0.22)	0.07 (2.28)	-0.05 (2.31)	-0.00 (0.12)
τ_3	0.01 (0.05)	0.08 (0.48)	0.11 (2.67)	0.30 (4.42)	0.31 (3.70)	0.09 (0.84)	0.21 (2.54)	0.11 (1.80)	0.10 (0.59)	0.01 (0.35)
τ_4	0.88 (6.27)	0.83 (7.56)	0.78 (12.37)	0.54 (5.57)	0.19 (1.24)	0.33 (1.69)	0.54 (4.46)	0.59 (4.34)	0.81 (8.89)	1.03 (8.28)
w_{LR}	0.83 [9.89]	-0.19 [3.99]	-0.30 [1.39]	-0.28 [0.50]	-0.26 [0.28]	-0.03 [0.41]	-0.20 [0.66]	-0.22 [0.90]	-0.15 [2.30]	0.08 [112.8]
k_{LR}	0.08 [9.06]	0.45 [3.94]	0.50 [1.17]	0.63 [0.31]	0.38 [0.15]	0.13 [0.48]	0.47 [0.42]	0.26 [0.76]	0.52 [3.07]	0.21 [111.8]
Wald	0.15	0.06	16.71	21.02	25.89	0.00	8.16	1.06	1.55	0.07
AIC	-6.71	-6.52	-8.32	-8.60	-6.89	-7.20	-7.00	-7.42	-7.34	-6.89
LM	1.09	2.24	0.07	0.54	1.64	1.30	2.32	2.02	0.19	1.09
ADF	-4.29	-4.13	-4.37	-4.59	-4.82	-3.02	-2.35	-3.00	-4.07	-3.46
LR	43.16		49.11		22.78		54.75		38.58	

Table 4 Cont.

	Netherlands		Norway		Portugal		Sweden		UK	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
τ_0	3.48 (4.69)	2.52 (2.23)	2.15 (0.98)	3.08 (1.40)	7.60 (4.56)	2.62 (2.33)	-0.12 (0.06)	-2.00 (1.52)	3.32 (3.05)	4.74 (1.83)
τ_1	-0.21 (4.23)	-0.47 (1.36)	-0.09 (0.91)	0.04 (1.29)	0.02 (0.74)	-0.03 (1.14)	-0.10 (1.34)	-0.40 (7.32)	-0.07 (2.41)	0.04 (0.76)
τ_2	0.01 (0.47)	0.05 (1.90)	-0.05 (2.28)	0.01 (0.52)	-0.02 (1.77)	0.04 (3.27)	0.04 (1.47)	0.03 (1.79)	-0.00 (0.34)	0.01 (0.44)
τ_3	0.23 (3.43)	0.19 (2.52)	0.22 (0.94)	-0.14 (1.49)	0.19 (2.99)	0.02 (0.41)	0.14 (0.90)	1.15 (8.00)	0.13 (1.49)	-0.08 (0.71)
τ_4	0.52 (5.75)	0.59 (4.16)	0.55 (4.91)	0.86 (6.92)	0.07 (0.32)	0.73 (7.55)	0.86 (7.14)	-0.06 (0.45)	0.70 (7.09)	0.65 (3.63)
w_{LR}	-0.44 [0.47]	-0.11 [0.93]	-0.21 [0.64]	0.06 [6.15]	0.02 [0.23]	0.15 [1.35]	-0.71 [6.79]	0.02 [0.13]	-0.25 [1.24]	0.02 [1.44]
k_{LR}	0.48 [0.31]	0.46 [0.78]	0.50 [0.60]	0.30 [6.81]	0.20 [0.19]	-0.10 [1.36]	1.01 [6.43]	-0.36 [0.11]	0.43 [0.98]	0.10 [1.70]
Wald	20.39	0.07	2.65	3.74	0.07	0.76	1.12	52.03	8.31	1.03
AIC	-8.28	-7.73	-6.93	-7.28	-6.82	-6.51	-6.42	-7.18	-7.01	-6.34
LM	1.18	0.01	0.01	-0.47	-0.32	-0.12	2.12	2.52	2.11	-0.49
ADF	-4.95	-3.59	-3.57	-3.39	-3.64	-4.22	-5.16	-3.20	-4.25	-3.21
LR	40.66		76.76		42.84		23.24			62.83

Note: see note to the tables 1 and 3.

significant at the 5 per cent level, the restrictions of equal, but opposite, signs of the coefficients on user and wage costs, are unambiguously rejected. The long-run coefficients on wages in most cases have the expected sign. The coefficients on capital are in general significant at the 5 per cent level, and the long-run estimates in the neighbourhood of 0.5, which corresponds to a elasticity of substitution of $2/3$ ($1/(1 + 0.5)$). By and large the diagnostic tests suggest that the equations are co-integrated and the residuals do not exhibit first order serial correlation.

Model 5 (CRES production function under cost minimisation). Table 5 presents the parameter estimates of model 5. The diagnostic tests and long-run estimates are not shown in the table since the functions are not globally valid in K in most cases (monotone and quasi-concave). Global validity, among other things, requires the coefficient on K to be positive (Hanoch (1971)).

5 Discrimination Between the Models

Discrimination between the nested models is done by employing nested tests whereas discrimination between the remaining models are done by comparing the reliability of the estimates and the Akaike Information Criterion (AIC). The diagnostic tests are not used to discriminate between the models because they give almost the same results across models. Non-nested model selection criteria are not employed

Table 5. Parameter estimates of equation (6).

$l_t = \varphi_0 + \varphi_1 w_t + \varphi_2 r_t + \varphi_3 k_t + \varphi_4 q_t + \varphi_5 l_{t-1} + \varepsilon_{6t}$	Canada		USA		Japan		Australia		Belgium	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
φ_0	7.51 (6.70)	6.53 (3.41)	9.06 (5.78)	1.31 (1.27)	12.58 (8.36)	1.43 (0.98)	7.74 (6.47)	2.56 (1.90)	4.81 (7.72)	5.22 (4.11)
φ_1	-0.11 (1.77)	-0.21 (3.90)	-0.30 (3.79)	-0.13 (1.28)	-0.26 (6.58)	0.02 (1.44)	-0.18 (4.45)	-0.15 (3.70)	-0.25 (6.47)	-0.23 (5.96)
φ_2	0.06 (2.32)	0.03 (1.38)	0.10 (2.90)	0.00 (0.07)	0.01 (0.46)	-0.02 (2.12)	-0.00 (0.17)	0.02 (0.93)	0.02 (1.36)	-0.00 (0.25)
φ_3	-0.13 (0.78)	0.16 (0.91)	0.05 (0.43)	0.50 (1.96)	0.16 (2.90)	0.02 (0.72)	-0.06 (0.33)	0.56 (3.19)	-0.10 (1.22)	0.07 (5.21)
φ_4	0.44 (5.24)	0.76 (3.78)	0.49 (5.70)	-0.10 (0.48)	0.27 (6.69)	-0.08 (1.32)	0.57 (4.51)	0.08 (0.34)	0.35 (4.23)	0.69 (5.21)
φ_5	0.31 (2.21)	0.07 (0.57)	0.21 (1.43)	0.72 (7.37)	-0.10 (0.70)	0.91 (7.41)	0.17 (1.37)	0.25 (1.79)	0.53 (7.35)	0.27 (2.39)
$\varphi_3=0$	0.60	0.84	0.19	3.84	8.39	0.52	0.11	10.22	1.50	0.50
$\varphi_4=0$	27.49	14.29	32.54	0.22	44.81	1.75	20.34	0.12	17.92	27.14

Table 5 Cont.

	Finland		France		Germany		Ireland		Luxembourg	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
φ_0	2.78 (1.65)	6.91 (3.23)	3.46 (2.36)	3.14 (4.28)	10.64 (8.76)	15.78 (3.73)	1.98 (1.53)	3.41 (3.03)	0.28 (0.16)	4.62 (4.10)
φ_1	0.00 (0.05)	-0.06 (0.94)	-0.07 (3.15)	-0.15 (4.89)	-0.27 (6.66)	0.13 (1.33)	-0.01 (1.78)	-0.09 (2.31)	-0.08 (1.37)	-0.03 (1.10)
φ_2	-0.03 (1.13)	0.02 (0.87)	-0.01 (0.49)	0.04 (2.93)	-0.00 (0.20)	0.05 (1.77)	0.02 (0.45)	0.07 (2.57)	-0.05 (2.50)	0.02 (1.25)
φ_3	-0.26 (1.15)	-0.52 (2.68)	-0.00 (0.03)	0.21 (2.59)	-0.32 (2.81)	-0.47 (2.13)	0.11 (0.91)	0.05 (0.66)	0.08 (0.55)	-0.27 (4.80)
φ_4	0.23 (1.52)	0.82 (3.98)	0.12 (1.33)	0.19 (1.79)	0.74 (6.05)	0.61 (2.85)	0.10 (0.87)	0.08 (1.19)	0.19 (3.10)	0.81 (5.64)
φ_5	0.93 (1.65)	0.62 (5.95)	0.70 (9.38)	0.49 (5.12)	0.32 (2.97)	0.04 (0.15)	0.69 (3.94)	0.57 (4.19)	0.81 (10.02)	0.36 (2.37)
$\varphi_3=0$	1.34	7.16	0.00	6.71	7.94	4.54	0.83	0.44	0.31	23.05
$\varphi_4=0$	2.31	15.85	1.78	3.18	36.63	8.14	0.77	1.42	9.60	31.86

Table 5 Cont.

	Netherlands		Norway		Portugal		Sweden		UK	
	Man	Ser	Man	Ser	Man	Ser	Man	Ser	Man	Ser
φ_0	3.51 (4.78)	3.65 (2.46)	4.39 (1.72)	3.36 (1.47)	10.74 (6.58)	2.80 (2.36)	1.31 (0.46)	1.24 (1.01)	1.60 (1.92)	6.35 (2.41)
φ_1	-0.21 (4.33)	-0.07 (1.74)	-0.09 (0.94)	0.02 (0.42)	0.01 (0.27)	-0.04 (1.52)	-0.08 (1.21)	-0.39 (9.05)	-0.02 (1.00)	-0.00 (0.05)
φ_2	0.02 (1.04)	0.07 (2.23)	-0.03 (1.12)	0.01 (0.70)	-0.02 (2.15)	0.05 (3.32)	0.20 (0.78)	0.04 (2.85)	0.01 (0.71)	0.02 (1.01)
φ_3	0.08 (0.82)	0.05 (0.33)	0.03 (0.11)	-0.17 (1.47)	-0.07 (0.79)	-0.13 (0.79)	0.12 (0.53)	0.92 (7.35)	-0.36 (3.70)	-0.36 (2.37)
φ_4	0.18 (1.72)	0.26 (1.11)	0.21 (1.71)	0.07 (0.42)	0.33 (3.69)	0.22 (0.93)	-0.06 (0.53)	0.60 (4.49)	0.43 (5.91)	0.56 (2.94)
φ_5	0.59 (6.49)	0.53 (3.61)	0.44 (3.57)	0.84 (6.17)	-0.09 (0.50)	0.81 (6.84)	0.77 (6.89)	-0.31 (2.94)	0.86 (11.44)	0.47 (2.41)
$\varphi_3=0$	0.68	0.11	0.01	2.19	0.62	0.63	0.28	54.02	13.66	5.63
$\varphi_4=0$	2.96	1.24	2.95	0.17	13.62	0.86	0.27	20.20	34.92	8.68

Note: see note to table 1. $\varphi_3 = 0$ and $\varphi_4 = 0$ are Wald test of the null hypothesis that the coefficients on capital and income respectively are equal to zero, $\chi^2(1)$ -distributed under the null.

because the known tests are not robust in non-linear estimates (Pagan and Wickens (1989)).

Nested tests. Model 2 and 4 are nested within model 5. Wald tests of parameter restrictions are displayed in table 5. The null hypothesis of zero (or negative) coefficient on the capital stock is rejected in four of the 30 cases considered at the 1 or 5 per cent level (the critical values are 6.64 and 3.84 respectively). For income, the null hypothesis is rejected in 21 cases. This result suggests that model 2 is better than model 4.

Discrimination between the non-nested models. Model 4 is ruled out in the nested tests above and model 5 is ruled out because it is not globally valid. Hence we are left with three models; that is model 1, 2 and 3. The AIC, displayed in the original tables, slightly favours model 2 over model 3, while model 1 clearly is the least favoured of the three: the average AIC is -7.107 for model 1, -7.358 for model 3 and -7.403 for model 2. If, however, we exclude the estimates where the coefficient on user cost is negative and significant at the five per cent level, in contrast to the theory, in model 2, the average AIC slightly favours model 3 over model 2. Since the coefficient estimates of model 2 are additionally more diverse across countries than technology is likely to justify, this specification can be ruled out as the preferred specification. Hence, model 3 is the preferred model.

6 Long-Run Wage Elasticities of Labour Demand

The parameter of chief interest is the long-run wage elasticity. The wage elasticity consists of a movement along the isoquant and a movement of the isoquant. The former is the substitution effect and the latter the output or scale effect. The scale effect is negative: An increase in W , for instance, tends to push W/P_Q upward which lower labour demand via lower output.¹¹ The composite wage elasticity of labour demand is given by

$$\eta_{LL} = dl/dw = \delta l/\delta w|_Q + \delta l/\delta q \delta q/\delta p \delta p/\delta w,$$

which, with sign reversal to certify a positive elasticity, under the assumption of linear homogeneity reduces to

$$\eta_{LL} = - (1 - S_L)\sigma - S_L\eta, \quad (8)$$

where S_L is the share of labour in total costs and η the scale elasticity; that is the own-price elasticity of demand for Q .¹² $-(1 - S_L)\sigma$ under the different technology assumptions is identified $\alpha\sigma$

Model 1. - $(1 - S_L)\sigma = - 1/\alpha_1$ since σ is restricted to one

Model 2. - $(1 - S_L)\sigma = - \beta_1$ assuming $a + b = 1$

11. With a multiple input production function consisting of weakly separable subfunctions, the wage elasticity is furthermore affected by the subfunction output effect holding total output constant. This effect allow inputs to be adjusted to the cost-minimizing levels. See Berndt and Wood (1979) for an exposition.

12. See Hammermesh (1986) for a proof.

Model 3. - $(1 - S_L)\sigma = - (1 - S_L)\omega_1$

Model 4. - $(1 - S_L)\sigma = - (1 - S_L)\tau_1$.

Next, consider the scale effect. Some effort has been made to estimate the own-price elasticity on macro level (see references in Hammermesh (1976)). A price increase, for instance, affects output via different propensity to consume between different groups, the Pigou effect, deteriorating of external competitiveness, and monetary crowding out (leftward shift in the LM-curve). The reliability of macro price elasticity of demand estimates, however, are deemed to be of very low value. The effect of external competitiveness and monetary crowding out on output, for instance, depends much on whether the authorities accommodate the price rise or not by monetary and exchange rate policies. Furthermore, the Pigou effect, which is the demand effect via the impact of a changed net asset position on consumption, is likely to change much over time due to changes in net asset position of the private sector. Due to these problems the wage elasticities are presented under the assumption of *constant output*.

Table 6. Average long-run wage elasticities: - $(1 - S_L)\sigma$.

Model 1		Model 2		Model 3		Model 4	
Man	Ser	Man	Ser	Man	Ser	Man	Ser
3.84	2.38	0.29	0.14	0.44	0.41	0.09	0.07

Table 6 presents the absolute value of estimates of wage elasticity of demand on average across countries. $1 - S_L$ is set to 0.50 in manufacturing and 0.75 in services. The dynamic unstable estimates, where the coefficient on the lagged dependent variables exceed one, are excluded. The long-run wage elasticities differ widely between the models, which underscores the importance of the right choice of model. The wage elasticity in the preferred model 3 is 0.44 for manufacturing and 0.41 for services.

A final question concerns the sensitivity of elasticities to specification. That wage elasticities differ under different technology assumptions may be expected as a result of the sensitivity of shape of the labour demand curve to technology. The sensitivity of the estimates to underlying identifying assumption, but the same technology assumption, is more worrisome. Does it mean that the whole set of assumptions identified with neoclassical production theory are rejected? Probably not. It might be the specification of the model. It might be with the data and the way it is constructed. Data on capital services and user costs are known to be poor. Hicks-neutral technical change has been assumed, and might not be valid either. Another serious problem is the aggregation over inputs and over firms.

7 Concluding Remarks

This chapter has derived, estimated and compared labour demand with different underlying technology and identifying

assumptions for private services and manufacturing. The estimations of the labour demand functions demonstrate that wage elasticities of demand are very sensitive to different underlying technology and identifying assumptions.

Discrimination between models suggested that labour demand derived under the assumptions of CES technology and profit maximization is likely to be the best specification, followed by the translog cost minimisation approach. Ironically, the most popular model of labour demand; that is the Cobb-Douglas profit maximization approach, was found to be the third best specification. The finding that labour demand derived under the CES technology assumption under profit maximization is likely to give the best results is encouraging because the data requirements are much less demanding than they are in the other model specifications.

The average wage elasticity of labour demand across countries is estimated numerically to be 0.44 for manufacturing and 0.41 for private services in the preferred model. This findings is in the upper range of other estimates surveyed by Hammermesh (1986).

APPENDIX: Derivation of Labour Demand Under Different Technology Assumptions

CD Technology

Profit maximization:

$$\max \pi = P_Q \Theta L^a K^b - W L - R K,$$

where π is the profit, then

$$\delta \pi / \delta L = P \Theta a L^{a-1} K^b - W = 0,$$

which gives equation (1).

Cost minimisation:

$$\min c = W L + R K = W L + \Theta^{-1/b} Q^{1/b} L^{-a/b},$$

where c are total costs, then

$$\delta c / \delta L = W - a/b R \Theta^{-1/b} Q^{1/b} L^{-(a+b)/b},$$

which gives equation (2).

CES Technology

Profit maximization:

$$\max \pi = P \gamma [\delta L^{-\rho} + (1 - \delta) K^{-\rho}]^{-\nu/\rho} - W L - R K,$$

then,

$$\begin{aligned} \delta \pi / \delta L &= P \gamma [\delta L^{-\rho} + (1 - \delta) K^{-\rho}]^{-\nu/\rho-1} \nu \delta L^{-\rho-1} - W \\ &= P Q^{\rho/\nu+1} \nu \delta L^{-\rho-1} - W = 0, \end{aligned}$$

which gives equation (3).

Cost minimisation:

$$\min c = W L + R K \quad \text{s.t.} \quad \gamma [\delta L^{-\rho} + (1 - \delta) K^{-\rho}]^{-\nu/\rho},$$

which gives the ratio of the first order conditions

$$W/R = \delta L^{-\rho-1} / [(1 - \delta) K^{-\rho-1}],$$

which gives equation (4).

CRES Technology

Cost minimisation:

$$\min c = W L + R K$$

$$\text{s.t. } D_L Q^{-e(L)d(L)} L^{d(L)} + D_K Q^{-e(K)d(K)} K^{d(K)} = 1,$$

which gives the ratio of the first order conditions

$$W/R = D_L d_L v^{-e(L)d(L)} L^{d(L)-1} / D_K d_K v^{-e(K)d(K)} K^{d(K)-1}$$

which gives equation (6).

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CHAPTER 6

THE RISE IN THE UK UNEMPLOYMENT: THE SEARCH FOR AN EXPLANATION

Abstract. The model used by Layard and Nickell to account for changes in unemployment is suggested to be incomplete as a result of unrealistic underlying assumptions and cross-equation constraints, inconsistency, and inadequate estimation method. An alternative approach, that circumvent some of the problems which encounter the Layard-Nickell approach is suggested as a tool to account for the unemployment path. Dynamic simulations with the model suggest that wage stickiness, persistence and low GDP growth all have played role in the UK unemployment increase from 1967 to 1983.

1 Introduction

In the seminal papers by Layard and Nickell (1985a; 1985b; 1986) a structural model which accounts for "exogenous" factors that may have caused the rise in the unemployment rate in the UK since 1967 is derived. The model has gained wide popularity as a tool used to account for the unemployment path in OECD countries (Bean et al. (1986), Dolado et al. (1986), Huay and Groenewold (1989), Pehkonen (1989), and Pissarides (1991)). In order to account for the unemployment path Layard and Nickell (LN) derive a reduced form unemployment equation from estimates of three equations: A labour demand equation, a price equation and a wage equation. Simulations of the reduced form equation then allow LN to decompose the causes of unemployment changes into changes in each "exogenous" factor.

The model suggested by LN is important because it sheds light on factors that may have contributed to the rise in UK unemployment; an exercise that has important policy implications. However, this chapter argues that in many respects the LN model is an inadequate tool to account for a given unemployment path for the following reasons. First, LN impose estimation restrictions that are unlikely to hold. Some of the restrictions imply that changes in technological progress and capital stock do not influence the unemployment path; only wage push factors, beyond

productivity, and cyclical changes in GDP are allowed to affect the unemployment path. Second, labour supply is assumed to be exogenous and hence cannot be a factor that has contributed to changes in unemployment. Third, the estimation method suggested by LN is inadequate and their results change a great deal when a better estimation method is used.

The purpose of this chapter is threefold. First, I discuss the theoretical content and underlying assumptions in the LN model. Second, I examine the sensitivity of parameter estimates both to the model specification and the estimation method, using the LN (1986) data. Third, an alternative model of unemployment that avoids some of the shortcomings of the LN model is suggested and simulated.

The chapter is organised as follows. Section 2 presents and discusses the LN equation system. The reduced form employed by LN to account for the rise in the unemployment is discussed in section 3 and the empirical estimates of the LN model, using different estimation methods and model specifications, are presented in section 4. An alternative approach to account for the rise in unemployment is suggested and estimated in section 5. Conclusions are addressed in section 6.

2 The Layard-Nickell Model

In this section the structural equations employed by LN in their 1986 paper are briefly presented.

2.1 Structural Model

LN derive the following equation system

Labour demand

$$N = f^1(W/P, \sigma^e, A, K) \quad (1)$$

- + + +

Price-setting

$$P/W = f^2(\sigma^e, K/N, P/P^e, A) \quad (2)$$

? - - ?

Wage-setting

$$W/P = f^3(\sigma^e, A, P/P^e, N/L, Z, K/L, P^W/P^O) \quad (3)$$

? + - + + + +

where

N = labour demand, measured as the number employed males
and females

L = labour force

W = compensation to employees per hour worked

P = value-added price deflator

- σ^e = deviation of expected aggregate demand from potential (full utilization of resources) output
- A = labour augmenting technical progress
- K = capital stock
- p^e = expected value-added price deflator
- p^w = world manufacturing prices
- Z = wage push factors such as mismatch, the replacement ratio and an index of union power
- p^o = output prices.

Equations (1) to (3) are derived as follows. *The labour demand* function is derived under the assumptions of profit maximizing behaviour, Cobb-Douglas technology and imperfect competition. The labour demand function departs from the perfect competition case by the expected demand variable σ^e , derived from an equation where the price mark-up on marginal cost is dependent upon the business cycle via the product demand elasticity.¹ The effect of σ^e on employment

1. Capital stock, the marginal user costs and the marginal wage rate are assumed fixed when the labour demand is derived. Labour demand is presumably derived as the following: given the profit maximization problem

$$\max p^o Y - W N - R K$$

where R is cost of capital, p^o output prices and Y GDP. The first order condition for profit maximization is $p^o = \delta(W N + R K)/\delta Y$, assuming constant output prices. Under imperfect competition and constant factor prices we get

$$p^o = \mu \delta(W N + R K)/\delta Y = \mu W \delta N/\delta Y + \mu R \delta K/\delta Y,$$

where μ is the price mark-up. Assuming that $\delta K/\delta Y$ is zero and the homogeneous Cobb-Douglas production function, $Y = (AN)^d K^{1-d}$, then

$$p^o = \mu W / (A^d a N^{d-1} K^{1-d}).$$

depends on whether the price mark-up on marginal cost is countercyclical or procyclical. If the price mark-up on marginal cost is procyclical than the business cycle has a positive impact on employment and vice versa. LN assume σ^e to have a positive impact on labour demand. The term "A" is included to account for labour augmenting, or Harrod-neutral, technical progress and it is expected to affect employment positively.²

Isolating N on the left hand side and taking logs gives

$$n = -1/(d-1)\log d + 1/(d-1)\log \mu + d/(d-1)\log A \\ + k + 1/(d-1)(w - p^0).$$

The value-added price-deflator is employed for p^0 , since raw materials are not included in the production function. If $\delta K/\delta Y$ is different from zero there is not an easy solution to the optimization problem. Even in the short-run $\delta K/\delta Y$ cannot be assumed fixed since firms have the possibility to rent vehicles and other mobile machinery. Assuming that user costs and wage to vary as a consequence of changing Y complicates the derivation of labour demand even more. As shown by Bils (1987), the marginal wage is very sensitive to cyclical fluctuations.

2. The term A is not Harrod-neutral technical progress, as noted by LN, but Hicks-neutral technical progress. Factor augmenting technical progress cannot be identified when the elasticity of substitution is unity, as under the Cobb-Douglas technology assumption, demonstrated by Sato (1970). This can be seen from the following. Given the homogeneous Cobb-Douglas production function $Y = (AN)^a K^{1-a}$; then $A = Y^{1/a} N^{-1/a} K^{-(1-a)/a}$. This is equivalent to $\log A = 1/a[\log Y - a \log N - (1-a)\log K]$, which is the formula used by LN to estimate "labour augmenting" technical progress. Now assume that B is Solow-neutral, or capital augmenting, technical progress so $Y = N^a (BK)^{1-a}$. Then $B = Y^{1/(1-a)} N^{-a/(1-a)} K^{-1}$, which implies that $\log B = 1/(1-a)[\log Y - a \log N - (1-a)\log K]$. This expression only differs from Harrod-neutral technical progress by a constant.

The price equation is derived from the pricing rule that prices are mark-ups on expected marginal costs.

The wage equation encompasses four possible mechanisms by which wages are being determined: Demand and supply of labour in a competitive market, independently by firms, independently by unions and by bargaining between firms and unions.

2.2 Stochastic Specification

Denoting logs with lowercase letters, LN specify equations (1) to (3) stochastically as³

$$\begin{aligned}
 n_t &= \alpha_0 + \alpha_1 n_{t-1} + \alpha_2 n_{t-2} + \alpha_3 (w_{t-1} - p_{t-1}) \\
 &+ \alpha_4 (p_t^* - p_t^o) + \alpha_5 AD_t + \alpha_6 WT_t + \alpha_7 a_t \\
 &+ (1 - \alpha_1 - \alpha_2) k_t + \varepsilon_{t1}, \\
 \alpha_3 < 0; \alpha_4, \alpha_5, \alpha_6, \alpha_7 > 0; (1 - \alpha_1 - \alpha_2) > 0,
 \end{aligned} \tag{1a}$$

$$\begin{aligned}
 (p_t - w_t) &= \beta_0 + \beta_1 (p_{t-1} - w_{t-1}) + \beta_2 \Delta^2 w_t + \beta_3 \Delta^2 w_{t-1} \\
 &+ \beta_4 \sigma_t^e + \beta_5 (k_t - n_t) + \beta_6 a_t + \varepsilon_{t2}, \\
 \beta_2, \beta_3, \beta_5 < 0; \beta_4 > 0; \beta_6 > \text{ or } < 0,
 \end{aligned} \tag{2a}$$

$$\begin{aligned}
 (w_t - p_t) &= \gamma_0 + \gamma_1 MM_t + \gamma_2 p_t + \gamma_3 v_t (p_t^m - p_t^o) \\
 &+ \gamma_4 \Delta (v_t (p_t^m - p_t^o)) + \gamma_5 UP_t + \gamma_6 u_t
 \end{aligned}$$

3. Other specifications estimated by LN are not considered because they are not employed by LN to account for the rise in unemployment rate.

$$\begin{aligned}
 & + \gamma_7 t_{1t} + \gamma_8 t_{2t} + \gamma_9 t_{3t} + \gamma_{10} IPD \\
 & + \gamma_{11} (k_t - l_t) + \gamma_{12} a_t + \varepsilon_{t3}, \quad (3a) \\
 & \gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_7, \gamma_8, \gamma_9, \gamma_{11}, \gamma_{12} > 0; \\
 & \gamma_6, \gamma_{10} < 0,
 \end{aligned}$$

where,

WT = deviation of world trade from its trend

AD = inflation and cyclical adjusted fiscal balance as a percent of potential GDP

MM = job mismatch measured as the absolute change in the proportion of employees in industry relative to the absolute change in total employment

ρ = replacement ratio

IPD = income policy impulse dummy equal one in 1976 and 1977, zero elsewhere

v = ratio of imports to GDP

p^m = import prices

UP = union wage mark-up over non-union employees

U = male unemployment rate

t_1 = employment tax borne by the firm

t_2 = income tax rate

t_3 = indirect tax rate

ε_i = zero-mean, finite-variance stochastic term.

$\Delta^2 w_t$ = acceleration of the rate of change in wages as a proxy of the price expectational errors

In equation (1a) the variables WT, AD and (P^*/P^0) are proxies for cyclical movements in price mark-ups over marginal costs. The terms $\Delta^2 w_t$ and $\Delta^2 w_{t-1}$ in equation (2a) replace the price expectation error, (P/P^e) , from equation (2), assuming price expectation errors are positively correlated with accelerations in the rate of change in wages. The Z term in equation (3) is replaced by MM, ρ , UP, t_1 , t_2 , t_3 and IPD in equation (3a) as discussed in the previous section. The log of N/L in equation (3) is approximated as minus the unemployment rate, U. The long-run coefficient on the capital stock variable in equation (1a) is restricted to one as implied by the derived labour demand under the homogeneous Cobb-Douglas technology assumption and profit maximization.

LN impose four cross-equation restrictions on the system

$$\beta_5/(1-\beta_1) = (1 - \alpha_1 - \alpha_2)/\alpha_3 \quad (4)$$

$$- 1 - \beta_6/(1 - \beta_1) = (1 - \alpha_1 - \alpha_2)/\alpha_3 \quad (5)$$

$$- \gamma_{11} = (1 - \alpha_1 - \alpha_2)/\alpha_3 \quad (6)$$

$$- \gamma_{12} = \alpha_7/\alpha_3 \quad (7)$$

The restrictions given by equations (4) and (5) ensure consistency in the model since the price and the labour demand equations are derived from the same system. The restrictions given by equations (6) and (7) ensure the existence of a solution to the model and are discussed in section 3.

2.3 Comments on the Model

Employment equation: First, LN employ a labour demand function derived under Cobb-Douglas technology but for a number of reasons a CES technology may be better: It is less restrictive and GDP appears as a explanatory variable instead of the capital stock. The capital stock and the flow of services from the stock are very difficult to measure.⁴ The empirical results, presented below, clearly favour the CES over the Cobb-Douglas derived labour demand function.

Second, in the stochastic specification, LN include three cyclical shift variables directly in the equation instead of σ^e that appears in the theoretical specification. This substitution gives rise to a number of problems. The competitiveness variable, $(p^* - p^0)$, which is employed as a cyclical shift variable and exhibited in their figure 9a, Layard and Nickell (1986), is highly trended. Hence, this variable is not likely to account for cyclical changes in price mark-ups over costs. Furthermore, the fiscal stance variable, AD, cannot *a priori* be assumed to move in a

4. The CES derived labour demand under profit maximization was in chapter 5 found to perform best of the labour demand functions considered. The Cobb-Douglas derived labour demand under profit maximization is found not to perform well.

procyclical fashion. If fine tuning works perfectly, it will move in a countercyclical fashion.

Finally, as will be demonstrated in the empirical section, the parameter estimates of the model are very sensitive to whether cyclical shift variables or σ^e is included directly in the estimated equation. As shown below the conclusions and parameter estimates obtained by LN are very dependent on the cyclical demand variables that are included in the equations.

Third, price mark-ups on marginal costs are assumed to move in a *pro-cyclically* fashion which implies that σ^e has a positive impact on employment. Other researchers, however, who have directly focused their studies on variations of the mark-up over the cycle, conclude that the mark-up behaves in the opposite way to that hypothesized by LN. Bils (1987), Rotemberg and Saloner (1986) and Price (1991), for instance, find that mark-ups typically fall during booms. Since the empirical estimates of the LN model show that mark-ups move procyclically and have contributed much to the higher unemployment it is likely that the proxy variables LN employ for σ^e do not measure mark-up effects but is perhaps measuring Keynesian demand shifts. In other words, many of the cyclical variables should be included in the model in their own right.

Price equation: This equation is derived from the condition marginal revenue = marginal costs. Once marginal cost is determined a price mark-up over marginal cost is appended to marginal cost. Prices thus depend on expected output demand and the marginal costs. Expected output demand is modelled differently between employment and price equations. In the price equation, expected output is modelled as potential output, where potential output is defined as full employment output: $y^{pot} = (L^f)^a K^{1-a}$. In the employment equation, on the other hand, expected output is modelled as an extrapolative expectation formation process embedded in the dynamic specification of the model. It is not clear why the modelling of expected output should differ in the two equations. Moreover, the output expectations mechanism hypothesized in the price equation is unlikely to hold. It states that output is expected to increase at a pace compatible with full employment output. If that is the case UK producers output expectations have been consistently wrong since 1967, when UK unemployment first began to increase. A study by Madsen (1992) suggests that production expectations are more likely to be regressive or to follow a combined regressive and second order error learning process.

3 Accounting for the Rise in Unemployment in the LN Model

To account for the unemployment path LN substitute the wage equation (3a) for $(w - p)$ in the employment equation (1a)

and compute the long-run solution. Ignoring time subscripts and noting that $1 - n$ is approximately equal to U , we get

$$\begin{aligned}
 (1 - \alpha_1 - \alpha_2)U + \alpha_3\gamma_6u = & - (\alpha_0 + \alpha_3\gamma_0) - \alpha_4(p^* - p^0) \\
 & - \alpha_5AD - \alpha_6WT - (1 - \alpha_1 - \alpha_2 + \alpha_3\gamma_{11})(k - 1) \\
 & - (\alpha_7 + \alpha_3\gamma_{12})a - \alpha_3[\gamma_1MM + \gamma_2\rho + \gamma_3v(p^m - p^0) \\
 & + \gamma_4\Delta(v(p^m - p^0)) + \gamma_5\dot{UP} + \gamma_7t_1 + \gamma_8t_2 + \gamma_9t_3 \\
 & + \gamma_{10}IPD + \gamma_{12}a], \tag{8}
 \end{aligned}$$

where changes in the unemployment rate can be accounted for by shifts in the "exogenous" variables.

It can now be seen that the restrictions (6) and (7) are imposed to ensure that the sum of the coefficients on $k - 1$ and "a" in equation (8) are zero so $k - 1$ and "a" do not influence unemployment. Without these restrictions, LN argue, the increase in the K/L-ratio and in the efficiency of labour, "a", would otherwise put a persistent upward or downward pressure on U . The restriction that unemployment cannot be affected by the ratio of the capital stock to the *labour force* is unduly restrictive and it is not clear how such a mechanism would operate in a real economy. Any relationships between the labour force, the capital stock and unemployment are fundamental issues which need to be addressed rather than assumed away. The restriction given by (6) effectively rules out changes in labour supply, and its relationship to the capital stock, as a source of unemployment in the long-term. To put the point another way

the model should be specified to allow an exogenous change in the labour force to affect unemployment if that is what the data indicate. In the LN model any exogenous increase in the labour supply depress the real wage sufficiently through the wage equation that the additional labour force is just employed through the labour demand function and unemployment does not change. That exactly the right magnitude for the wage change should occur *stands in sharp contrast to New Keynesian economics and in contrast to LN emphasis on wage push factors affecting the real wage in the long-run.*

The argument against the restriction given by equation (6) can more formally be put in the following way. Equation (8) can be rewritten as

$$(1 - \alpha_1 - \alpha_2 - \alpha_3\gamma_{11})U + \alpha_3\gamma_6u = - \alpha_3\gamma_{11}(k - n) - (1 - \alpha_1 - \alpha_2)k + (1 - \alpha_1 - \alpha_2)l + X, \quad (8a)$$

where X is a vector of the wage push and cyclical demand variables

$$X = - (\alpha_0 + \alpha_3\gamma_0) - \alpha_4(p^* - p^0) - \alpha_5AD - \alpha_6WT - (\alpha_7 + \alpha_3\gamma_{12})a - \alpha_3[\gamma_1MM + \gamma_2\rho + \gamma_3v(p^m - p^0) + \gamma_4\Delta(v(p^m - p^0)) + \gamma_5UP + \gamma_7t_1 + \gamma_8t_2 + \gamma_9t_3 + \gamma_{10}IPD + \gamma_{12}a].$$

Now assume that the log of labour supply, l , is a function of variables contained in the vector Z . Then $U = 1 - n = Z - n$ and equation (8a) becomes

$$(1 - \alpha_1 - \alpha_2)U + \alpha_3\gamma_6u + \alpha_3\gamma_6u = -\alpha_3\gamma_{11}(k - n) \\ - (1 - \alpha_1 - \alpha_2)k + (1 - \alpha_1 - \alpha_2)Z + X. \quad (8b)$$

Assuming that X is constant unemployment increases with higher labour supply, Z , and falls with an increase in capital labour ratio since $\alpha_3 < 0$. A higher capital stock, k , on the other hand, lowers unemployment via higher marginal productivity of labour and hence increased labour demand. From this it can be seen that if labour supply is a function of Z the restriction given by equation (6) is not necessary. A secular increase in K , for instance, need not put a persistent downward pressure on unemployment because labour supply may have increased meanwhile. In equation (8b) unemployment changes as a result of changes in labour supply, productivity, cyclical demand, capital stock and wage push variables.

Hence one consequence of the restriction (6) is that changes in capital stock do not affect unemployment. An increase in capital stock, for instance, increases the marginal productivity of labour and hence the demand for labour. However, the increased marginal productivity of labour increases wages, via the wage equation, to such an extent that unemployment remains unaltered. Therefore,

unemployment only can change as a result of changes in wage push factors and in cyclical changes in price mark-ups on wages. A change in demand, that influences demand for labour via a change in the marginal productivity of labour, cannot influence unemployment in the model.

What does the restriction (6)* means in practical terms? It means that the effect of *trend* GDP growth slow-down that occurred after 1973, in most OECD countries, cannot have affected the unemployment path in the model. GDP only can affect unemployment *cyclically* in the model via the σ^e term. Hence, alone wage push factors, beyond productivity, are able to affect the *trend* unemployment path. This, in turn, implies that the *trend* unemployment path approximately is dependent upon the real wage gap path under the Cobb-Douglas technology assumption since the coefficient on the productivity term is close to unity in the wage equation. Since the chapters 2 and 3 in the thesis demonstrate the inability of the real wage gap to explain the secular rise in the unemployment in OECD countries not much confidence can be given to the LN model. Moreover, LN could have taken a much shorter route by regressing the unemployment rate on the real wage gap and a cyclical GDP variable and the real wage gap on wage push factors.

Finally, the restriction given by equation (7) implies that income growth caused by Hicks-neutral technical progress cannot affect the unemployment path. Increased marginal

productivity of labour, induced by technological progress for instance, does not affect unemployment because of increased real wages.

Statistically, the restriction given by equation (6) is justified by LN as it cannot be rejected at the 5 per cent level (the restriction given by (7) is not considered as the variable "a" is excluded in their final estimates). This result occurs because the coefficient on the capital stock in the unrestricted estimates of the employment equation has a high standard error, which gives room for a wide confidence interval, as shown in the empirical estimates below.

In order to account for the rise in unemployment over certain time intervals, LN estimate the change in U from equation (8) given the change in the "exogenous" variables over the same time intervals. The time intervals considered are 1954-64, 1965-72, 1973-77 and 1978-81. Usage of equation (8) over these short time intervals is strictly speaking inaccurate as equation (8) imposes a long-run solution. The dynamic adjustment due to changes in "exogenous" factors do not conclude within the time intervals considered. In their labour demand function, for instance, only 0.66 per cent of the dynamic adjustment has taken place after three years.

Note that the price equation is not used to account for unemployment, but estimated in conjunction with the employment and the wage equations; probably to gain efficiency which may work through two channels. One channel is via the cross-equation restrictions (4) and (5) and the other is the use of generalized least squares, where the efficiency of the parameter estimates increases with the number of equations included in the system. Since the cross equation restrictions (4) and (5) implicitly impose the restriction that the different expectations formation mechanism in the price and labour demand equations are the same these restrictions are likely to lower the efficiency of the estimates.

4 Empirical Estimates of the LN Model

In this section the sensitivity of the LN parameter estimates to cross-equation restrictions and to the estimation method is assessed first. Then we test the sensitivity of the parameter estimates in the labour demand to different specifications.

4.1 Sensitivity of Parameter Estimates to Cross-equations Restrictions and Different Estimation Method

LN estimate equations (1a), (2a) and (3a) by three stage least squares (3SLS) under the non-linear cross equation restrictions (4) to (8). It is not clear why LN employ 3SLS

as an alternative to the instrument variable method (IV) or 2SLS. 3SLS is a potentially dangerous estimator to use because the parameter estimates are very sensitive to misspecification in contrast to OLS, IV or 2SLS (see for instance Rao (1974)). If one equation in the 3SLS system is misspecified it feeds through the whole system and parameter estimates of the other equations will be affected.

In order to assess the sensitivity of the parameter estimates to the estimation method and the imposition of cross-equation constraints, the LN model is estimated in five different ways: (i) 3SLS with cross-equation restrictions imposed (original LN estimates); (ii) 3SLS without cross-equation restrictions imposed; (iii) 2SLS with cross-equation restrictions imposed; (iv) 2SLS without cross-equation restrictions imposed; (v) 3SLS with cross-equation constraints imposed, employing the general to specific procedure with the 5 per cent bench-mark level. This estimate will shed light on to the extent to which the LN parameter estimates will change with a consequent model reduction procedure. The LN estimation strategy has not been consequent in the sense that some variables have been deleted due to "insignificance" and others have not, and it is not clear in which sequence the coefficient restrictions of zero have been imposed.

The results of estimating the models are presented in table 1. The 2SLS estimate with cross-equation restrictions are not displayed because convergence was not obtained after 260 iterations and the parameter values did not seem to converge but to fluctuate around constant means. The original LN estimates from their tables 4 to 6 (1986) are presented in the first column of the table. Replication of the LN model with their data gave approximately the parameter estimates obtained by LN. Note that the diagnostic tests reported in table 1 do not correspond to the tests reported by LN. The tests LN report are inappropriately calculated from single equation estimates.

The results indicate the following. The cross-equation restriction given by equation (4) is rejected at the 5 per cent level, suggesting that the estimates should have been performed without this restriction. Presence of first order serial correlation in the labour demand equation in the original LN estimates indicate specification problems. Relaxing the imposed restrictions in the original LN estimates, shown in the third column of table 1, changes the parameter estimates. However, the parameters in the wage equation, that are essential to account for the unemployment change in the LN model, do not change much. Major changes in the parameter estimates and higher standard errors result when we move from the unrestricted 3SLS estimates to the unrestricted 2SLS estimates. The coefficients on capital stock, real product wage and

Table 1. Parameter estimates of the LN model.

	3SLS Rest. ¹	3SLS Rest. ²	3SLS Unrest. ³	2SLS Unrest. ⁴
<i>Employment:</i>				
Const.	2.570 (4.9)	1.814 (4.7)	2.442 (3.3)	2.793 (2.6)
n_{t-1}	1.057 (8.2)	0.785 (1.7)	0.727 (9.4)	0.712 (6.3)
n_{t-2}	-0.361 (2.6)		0.002 (2.2)	0.001 (0.6)
k	0.304	0.215	0.179 (3.0)	0.005 (0.0)
$*(w-p)_{t-1}$	-0.285 (4.9)	-0.213 (5.0)	-0.171 (3.0)	-0.008 (0.1)
$*(p^w-p^o)_t$	0.0667 (3.2)		0.043 (1.5)	-0.049 (1.0)
AD	0.718 (3.6)	0.805 (4.6)	0.593 (3.4)	0.737 (2.2)
WT	0.0686 (1.9)	0.138 (3.4)	0.157 (3.7)	0.168 (2.8)
S.E.	0.0077	0.0102	0.0001	0.0001
LM	1.87	1.93	0.99	1.22
<i>Prices:</i>				
Const.	-4.180 (4.2)	0.002 (0.5)	0.128 (2.1)	0.016 (2.2)
$(p-w)_{t-1}$	0.544 (5.0)	0.584 (6.5)	0.904 (9.7)	0.990 (9.2)
$*\Delta^2(w_t)$	-0.336 (4.2)		-0.019 (4.2)	-0.020 (4.0)
$*\Delta^2(w_{t-1})$	-0.242 (3.8)		0.010 (2.3)	0.006 (0.7)
$*\sigma$	0.038 (2.1)		0.002 (1.9)	0.002 (1.4)
$*(k-1)_t$	-0.486	-0.021 (4.2)	-0.002 (0.3)	0.004 (0.6)
S.E.	0.0150	0.0013	0.0000	0.0000
LM	1.24	0.82	1.26	1.74
<i>Wages:</i>				
Const.	8.410 (9.0)	8.838 (53.5)	0.081 (5.8)	4.633 (0.7)
$*u_t$	-0.062 (4.4)		-0.079 (4.9)	-0.115 (2.0)
MM_t	0.039 (3.3)	0.029 (3.0)	0.048 (6.1)	0.054 (2.1)
$*p_t$	0.182 (1.5)	0.002 (1.9)	0.002 (1.9)	0.008 (1.2)
$*v(p^m-p^o)_t$	0.499 (2.5)		-0.115 (0.6)	-0.093 (0.1)
$*\Delta(v(p^m-p^o)_t)$	0.419 (2.0)		-0.157 (0.6)	0.616 (0.6)
$*UP_t$	0.085 (4.1)	0.058 (2.9)	0.087 (3.5)	0.147 (1.4)
t_{1t}	0.179 (0.9)		0.010 (0.0)	0.701 (0.6)
IPD	-0.021 (1.7)		-0.009 (0.8)	-0.030 (1.0)
$*(k-1)_t$	1.070	1.008	1.133 (13.2)	0.891 (2.4)
$*\sigma_t$		0.055 (2.4)		
S.E.	0.0145	0.0317	0.0002	0.0008
LM	1.31	1.93	0.69	1.03

Table 1 Cont.

Wald(R ₁)	5.18	7.18
Wald(R ₂)	0.42	1.14
Wald(R ₃)	1.01	3.65
BP (DIAG)	17.66	9.69
t(L ^d) ^P	0.09	0.58
t(L ^d) ^W	0.09	1.09
t(P) ^L	0.48	0.32
t(P) ^W	0.01	1.41
t(W) ^L	0.87	2.62
t(W) ^P	0.38	0.11

Note: t-statistics in parentheses. LM is a Lagrangian multiplier test of first order serial correlation, $t(26)$ -distributed under the null of no serial correlation. Wald(i) is the Wald test for the parameter restriction R_i , $\chi^2(1)$ -distributed under the null of the imposed restriction. $R_1: \beta_5/(1-\beta_1) = (1 - \alpha_1 - \alpha_2)/\alpha_3$, $R_2: -\gamma_{11} = (1 - \alpha_1 - \alpha_2)/\alpha_3$, R_3 : Coefficient on capital stock in labour demand = $(1 - \alpha_1 - \alpha_2)$. BP(DIAG) is the Breusch Pagan test of the unrestricted form for diagonal covariance matrix $\chi^2(0.5m(m-1))$ -distributed under the null of diagonal covariance matrix, where m is the number of equations. $t(j)^L = t$ -test for zero residual from equation i in the j 'th equation, where $i, j = L^d, P$ and W , where L^d = labour demand equation, P = price equation and W = wage equation. Variables with an asterisks are instrumented.

1. Original NL estimates; 3SLS and cross-equation restrictions.
2. General to specific; 3SLS and cross-equation restrictions.
3. 3SLS without cross-equation restrictions.
4. 2SLS without cross-equation restrictions.

competitiveness, in the labour demand equation, become insignificant at the 5 per cent level. The coefficients on union mark-up, replacement ratio, the income policy dummy, and the import price shocks in the wage equation also become insignificant.

The 3SLS estimates with cross-equation restrictions imposed using the general to specific procedure are presented in the second column of table 1. The estimates are performed without the restriction given by equation (4) since it is rejected. The estimates are quite different from the LN estimates; especially the estimates of the wage equation. Although σ^e is significant in the wage equation it is dropped in the LN estimates (σ^e appear in equation (3) but not in its stochastic specification (3a)). It is not clear why σ^e is dropped in their estimates of the wage equation. Employers' labour taxes, the ratio of domestic to import prices and the income policy dummies are all insignificant.

To shed light on the efficiency gain from employing 3SLS as an alternative to 2SLS, two statistical tests are performed. It is worth noting that these tests do not indicate whether the efficiency gain is "false" or "true" but only whether the residuals are contemporaneously correlated. In the first test a Breusch-Pagan Lagrange multiplier (LM) test for diagonal covariance matrix is performed (Breusch and Pagan (1980)). The LM test for the unrestricted 2SLS LN estimates is $\chi^2(3) = 17.66$ and $\chi^2(3) =$

9.69 for the reduced 2SLS unrestricted LN model. Hence, the hypotheses of zero off diagonal elements are rejected at the 5 per cent level but not at the 1 per cent in the latter case. This indicates that efficiency may be gained by the use of 3SLS. In the second test, the residuals from the other two estimates in the unrestricted 2SLS system are tested for significance in the third equation. The t-statistics of the residuals, shown in the columns 1 and 2 of table 1 all are insignificant, except for one case, suggesting the lack of contemporaneous correlation in the residuals and hence no efficiency gain by employing 3SLS.

Overall this section has demonstrated that the parameter estimates of the LN model are very sensitive to estimation method, cross-equation restrictions and choice of model reduction procedure. It is of especially concern that the model is upheld by their estimation method and the cross-equation restrictions and that most parameter estimates become insignificant if 2SLS is employed and the cross-equation restrictions are relaxed.

4.2 Sensitivity of Parameter Estimates to Specification of the Labour Demand Function

Since LN find that cyclical demand factors in the labour demand function account for 6.56 per cent points of the 7.00 per cent points increase in the male unemployment rate in the UK over the period 1975-79 to 1980-83, it is of

importance to elaborate on the sensitivity of the parameter estimates of the labour demand function to different model specifications. Different specifications of labour demand are estimated with real product wages, σ^e and capital stock or GDP as explanatory variables. The simplest possible dynamic specification, where the dependent variable is lagged one period, is chosen to save degrees of freedom and to avoid specification search. The deviation of the log of GDP from its logarithmic time trend is used as a proxy for σ^e . The estimate of σ^e provided by LN is not used since it contains a time trend, and σ^e is only supposed to account for cyclical movements in the price mark-up over marginal costs. The generated regressors problem by the inclusion of σ^e generated from another regression is ignored.

The estimates are presented in the upper half of table 2. The first model in table 2 (Model 1) uses real wages, σ^e and capital stock as explanatory variables as in the LN labour demand function. Only σ^e is significant, at the 5 per cent level and first order serial correlation is present at the 5 per cent level. If the capital stock is deleted from this equation real wages remain insignificant and first order serial correlation is still present (Model 2). With only real wages and capital stock as explanatory variables both are insignificant and the residuals still exhibit first order serial correlation (Model 3). Employment of GDP instead of capital stock does not change the outcome (Model 4). Assuming CES technology and perfect

Table 2. Single equation parameter estimates.

	Employment				Work. Hours	
	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
Const.	4.79 (2.18)	4.04 (2.83)	0.93 (0.61)	4.94 (1.89)	1.23 (0.96)	3.25 (1.91)
n_{t-1}	0.52 (2.45)	0.59 (3.97)	0.93 (6.57)	0.55 (2.35)	0.81 (5.27)	0.71 (5.21)
$*(w-p)_t$	0.16 (0.59)	0.01 (0.52)	0.11 (0.46)	0.28 (0.61)	-0.40 (2.10)	-0.56 (2.05)
k_t	-0.14 (0.56)		-0.13 (0.59)			
$*y_t$				-0.33 (0.59)	0.49 (1.96)	0.66 (1.88)
$*\sigma_t$	0.44 (2.86)	0.44 (3.49)		0.62 (1.74)		
LM	4.61	3.05	2.18	2.45	1.56	1.32
	Labour Supply				Wages	
	Mod 7	Mod 8			Mod 9	
Const.	-5.80 (8.08)	-4.82 (12.39)		Const.	5.74 (2.19)	
$*w^{disp}_t$	0.20 (0.86)			$(w-p)_{t-1}$	0.48 (2.06)	
$*w^{disp}_{t-1}$	-0.26 (1.27)			MM_t	0.04 (2.36)	
MMA_t	0.01 (4.34)	0.004 (20.36)		$*(y-n)_t$	0.72 (2.17)	
$*n_t$	0.53 (7.53)	0.44 (11.24)		$*u_t$	-0.08 (2.74)	
LM	1.43	3.49		$*UP_t$	0.10 (1.85)	
				LM	0.30	

Note: see note to table 1.

competition implying that labour demand becomes a function of real wages and GDP gives more encouraging results. The coefficients are all significant at the 5 per cent level, have the expected signs and the residuals are free of first order serial correlation (Models 5 and 6). The only difference between model 5 and 6 is that model 6 uses working hours as dependent variable whereas model employs employment as the dependent variable.

Two conclusions can be drawn from these estimates. First, σ^e dominates labour demand to such an extent that other variables in the equation lose importance/significance. This indicates that σ^e is likely to capture the effect of capital stock or GDP on labour demand. Hence, the coefficient on σ^e is likely to exaggerate the effects of cyclical changes in price mark-ups over wages on labour demand if it at all captures the cyclical impact of mark-ups on unemployment as previously discussed. Second, the CES derived labour demand function gives better results than the Cobb-Douglas derived labour demand function. This is probably a result of the less restrictive character of the CES production function and that capital stock, the services from which are difficult to measure, is not needed as regressor.

These results have strong implications for the LN estimates. Since the CES derived labour demand function under perfect competition in the goods market gave the best

results of the models considered it would be logical to include this equation in the LN model. If this is done changes in σ^e do not have any impact on the unemployment path in equation (8) and only wage push factors can influence unemployment. This finding furthermore reinforces the argument put forth in the previous section that it is inappropriately to assume that capital stock cannot affect the unemployment path.

5 An Alternative Approach to Account for the Unemployment Path

This approach employs a labour demand and a wage equation in much the same way as LN but adds a labour supply equation. The addition of a labour supply equation allows us to focus especially on this factor as a cause of unemployment. The estimates are then used to simulate the rise in unemployment.

5.1 Stochastic Specification and Empirical Estimates

The following stochastic equations are estimated

$$\begin{aligned}(n_t + h_t) &= \omega_0 + \omega_1(n_{t-1} + h_{t-1}) + \omega_2(w_t - p_t) \\ &+ \omega_3 y_t + \varepsilon_{t4}, \quad \omega_2 < 0; \omega_3 > 0, \quad (9)\end{aligned}$$

$$\begin{aligned}
 (w_t - p_t) &= \tau_0 + \tau_1 (w_{t-1} - p_{t-1}) + \tau_2 p_t + \tau_3 UP_t \\
 &+ \tau_4 u_t + \tau_5 (y_t - n_t) + \tau_6 MM_t + \tau_7 v_t (p^m \\
 &- p^o_t) + \tau_8 t_{1t} + \tau_9 t_{2t} + \tau_{10} t_{3t} + \varepsilon_{t5}, \quad (10) \\
 &\tau_2, \tau_3, \tau_5, \tau_6, \tau_7, \tau_8, \tau_9, \tau_{10} > 0; \tau_4 < 0,
 \end{aligned}$$

$$\begin{aligned}
 (l_t - pop_t) &= \phi_0 + \phi_1 n_t + \phi_2 MMA_t + \phi_3 w^{disp}_t \\
 &+ \phi_4 w^{disp}_{t-1} + \varepsilon_{t6}, \quad (11) \\
 &\phi_1, \phi_2, \phi_3, \phi_4 > 0,
 \end{aligned}$$

where MMA is the accumulated value of mismatch, MM,⁵ POP the working age population, H weekly hours worked, and w^{disp} is real disposable income; that is direct wages after the deduction of direct taxes and deflated by consumer prices.

Equation (9) is the CES labour demand under profit maximization and perfect competition. Equation (10) is a wage equation quite similar to the LN wage equation and consistent with the labour demand function where income is substituted for the capital stock and labour supply conditioned upon the variables given by equation (11).⁶

5. Mismatch is estimated following LN as the absolute value of the expression

$$(N^{Ind}_t - N^{Ind}_{t-1}) / (N^{Tot}_t - N^{Tot}_{t-1}),$$

where the superscripts Ind and Tot refer to the industry and whole economy, respectively.

6. Strictly this requires population as explanatory variables in the wage equation. This variable is, however, not considered since the wage equation already has a large number of included explanatory variables.

Derivation of the wage equation is shown formally in next chapter. The coefficient on the Y/N -ratio is equal to $1/\sigma$ if the real wage follows its warranted path, where σ is the elasticity of substitution between capital and labour. To use Y/N instead of K/N in the wage equation gives an econometric advantage. Since the standard deviation of K is much lower than the standard deviation of N or L , the coefficient on either the K/N -ratio or the K/L -ratio is likely to reflect the influence of L on W/P . The standard deviation of Y , in contrast, is not much different from the standard deviation of N and better estimates should attain.

The labour supply, given by equation (11), follows a standard labour supply model except for inclusion of the variable MMA to account for the persistence effect in labour supply and mismatch between labour demand and supply. The persistence effect is suggested by Clark and Summers (1982). According to Clark and Summers, individuals who entered the labour market under an economic upturn tend to remain in the labour force after they are laid off under a down-turn. The mismatch between labour demand and supply affects labour supply as the following. The decline in manufacturing employment after the two oil price shocks, for instance, has been found to have contributed to the increased unemployment in Australia and the OECD countries respectively (Gregory (1990) and Glyn and Rowthorn (1988)). The decline in manufacturing employment has created a pool of unemployed blue collar workers who have not been able to

find employment in the service sector, which to a large extent has recruited female labour from outside the labour force.

The use of MMA in the labour supply function unrealistically assumes that the labour force does not adjust to a structural shift over time. It is, however, difficult to build a more sophisticated adjustment pattern into a model for a single country and with only a few observations available. In contrast to the labour demand and wage equations, the speed of adjustment due to changes in the explanatory variables over time cannot be assumed to be similar for each variable in the labour supply equation. Hence, the dependent variable is not lagged in the stochastic specification. It is assumed that labour supply reacts to employment and structural shifts immediately, whereas it may take some time before a change in real disposable income affects the decision to join the labour force.

The general to specific method is employed in the empirical estimates with 5 per cent as the bench-mark level. The estimates of equations (9) to (11) are presented as models 6 to 9 in table 2. The estimate of labour demand has been discussed in the previous section. The results of estimating labour supply is given as model 8 in table 2. The real disposable income is insignificant and the variables MMA and n are highly significant and with the

right signs. The coefficient on n is 0.44 which is small compared to the estimates in chapter 8 of the thesis. The presence of first order serial correlation may suggest misspecification. Due to the lack of a better alternative, however, the estimate will be maintained to account for the rise in unemployment.

The estimate of the wage equation is presented as model 9 in table 2. All variables have the expected sign. Assuming that the elasticity of substitution between capital and labour is below or equal to one, the coefficient estimate on the Y/N -ratio of 0.72 suggests that real wages do not catch-up with the change in the marginal productivity of labour. This implies that the impact of a rise in the GDP on employment is positive and not neutral as assumed in the LN model.

5.2 Accounting for the Unemployment Path

The identity $U = (L - N) * 100 / L$ is employed to account for the unemployment path. The estimated wage equation is substituted into the labour demand equation so employment is expressed as a function of the "exogenous" variables in the dynamic simulations. Similarly, the labour demand estimates are substituted for N in the labour supply equation. The idea is then to simulate a hypothetical unemployment path assuming a continuation of the existing conditions in the full employment period 1953 to 1966. In

the first step, the hypothetical path of the "exogenous" variables are computed as follows: The growth in GDP, POP, accumulated mismatch, MMA, and labour productivity, Y/N, are assumed to follow the average growth rates in the full employment period. Similarly the average value of the level of mismatch, weekly hours worked, and union mark-up observed in the full employment period are assumed to hold in the unemployment period. In the second step, the estimated equations of labour demand and supply are dynamically simulated with the hypothetical path in the "exogenous" variables. The lagged dependent variables are initially set equal to their actual values in 1966. Decomposing the causes of the unemployment path is computed as the difference between the unemployment rate simulated with the actual values and the hypothetical values of the "exogenous" variables. The model is first simulated with the actual variables. Subsequently it is simulated with the hypothetical path of one of the "exogenous" variables and the contribution to unemployment as a result of this variable is computed. This procedure is followed for all "exogenous" variables.

The factors that may have contributed to the unemployment path are presented in table 3. Income and productivity are merged under the heading of GDP in the table since they are closely related. GDP growth is not decomposed into factor usage and technological progress since it is difficult to isolate the contributions of each variable separately in

Table 3. Accounting for the change in the unemployment rate for males.

	1953-66 to 1967-74	1967-74 to 1975-79	1975-79 to 1980-83	Total
Mismatch (MM)	0.34	0.08	0.49	0.91
Wage inflexibility (UP)	1.60	0.57	0.71	2.88
Persistence (MMA)	0.47	1.16	1.13	2.76
Population (POP)	1.63	0.59	0.77	2.99
Hours (H)	-0.92	-0.26	-0.26	-1.44
GDP (Y)	0.94	1.60	2.59	5.13

Total	4.06	3.74	5.43	13.15
Actual	1.94	3.01	7.00	12.95

the estimations. This aspect is discussed further in chapter 8.

Wage push factors and population growth contribute most to the unemployment increase from 1953-66 to 1967-74. After the first oil price shock, however, the persistence effect of unemployment, and especially low GDP growth, take over as the most important factors contributing to the unemployment growth. Looking at the period from 1966 gives the following dynamic picture: Wage push factors and population growth initiated the first modest rise in unemployment. The strong rise in unemployment after 1973 and 1979, however, was fuelled by structural shifts in labour demand and low GDP growth. Fewer weekly working hours have tended to lower unemployment during the whole period. The result that wage push factors have not played a role in explaining the increase in the male unemployment rate after the first oil price shock is consistent with the finding of the previous chapters that the real wage gap has not changed much after 1974 for the UK.

My results in table 4 are compared to the results obtained by LN. Labour supply factors have contributed much to the rise in unemployment over the period in my estimates whereas LN assume labour supply to be exogenous. Therefore, wage push and demand factors have played a smaller role in my estimates a larger role in the LN estimates. In the last

Table 4. Comparison of causes of the changes in the unemployment rates in table 3 with the results of Layard and Nickell.

	1953-66 to 1967-74	1967-74 to 1975-79	1975-79 to 1980-83	Total
LN results:				
Wage push factors	1.55	2.77	1.19	5.63
Demand factors	0.12	0.54	6.56	7.22

Total	1.67	3.31	7.75	12.85

Table 3:				
Wage push factors	1.94	0.65	1.20	3.79
Demand factors	0.94	1.60	2.59	5.13
Labour supply factors	2.10	1.75	1.90	5.75
Hours (H)	-0.92	-0.26	-0.26	-1.44

Total	4.06	3.74	5.43	13.23

Actual	1.94	3.01	7.00	12.95

period considered lower demand virtually explains all the rise in the unemployment in the LN estimates.

6 Concluding Remarks

This chapter has discussed the model suggested by Layard and Nickell (1985a; 1985b; 1986) to account for the unemployment path. It is suggested that the model is in many respects inadequate. Theoretically, the model is derived under an unfounded set of implicit assumptions and with cross-equation restrictions imposed that are unlikely to hold. Empirically, their estimates are found to be upheld by an inadequate estimation method. A change in econometric method result in major changes in the outcome of the LN model.

An alternative approach, building on the framework suggested by LN, is suggested. The model is simple and circumvents some of the problems encountered by the LN model. Simulations with "exogenous" factors that might have caused the rise in the UK unemployment demonstrate that wage push factors and wage stickiness fuelled the modest rise in the unemployment rate from 1966 to 1973. Structural shifts in labour demand and low growth in GDP, however, have been the most important factors behind the strong rise in unemployment after the first oil price shocks.

DATA SOURCES

All data from data appendix in LN (1986) except following series. Population in working age: *OECD Labour Force Statistics (LFS)*. GDP price deflator: *OECD National Accounts (NA)*. GDP: *NA*. M1: *IMF International Financial Statistics, Yearbook (IFS)* line 34. Direct wage costs: average monthly earnings in all industries; *IFS*. Consumer prices: *IFS*. Weekly hours worked: *ILO Year Book*.

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CHAPTER 7

TESTS OF NEW KEYNESIAN THEORIES OF UNEMPLOYMENT

Abstract. New Keynesian theories of unemployment predict that wage stickiness has increased over the past 30 years, especially in the wake of the first oil price shock, and the wages are most sticky in countries with the highest rate of unemployment. The validity of the predictions are tested using data for 20 OECD countries. The majority of the tests reject the predictions made by the New Keynesian theories of unemployment.

1 Introduction

New Keynesian theories of unemployment, including efficiency-wage models, union bargaining models, insider-outsider theories and implicit contract theories have gained popularity in the wake of the seemingly persistent and high unemployment in most OECD countries. Common for these theories is the proposition that institutional factors have rendered real wages more sticky, and hence less responsive to unemployment, in the past two decades. Once wages are driven above their full employment levels they are slow to adjust downward. The strength of the wage-unemployment trade-off may, as a logical consequence of these theories, have declined in the past decades; especially in the wake of the first oil price shock when unemployment started to increase significantly in all OECD countries. The theories furthermore predict real wages to be most sticky in the countries with the highest unemployment rate.

This chapter tests New Keynesian theories of unemployment via wage equations employing data for our 20 OECD countries (the data period is too short for New Zealand and Denmark). I test whether the wage restraining nature of unemployment has declined over time, especially since 1974, whether unemployment exerts the strongest negative pressure on wages in the countries with the lowest unemployment rate and whether the temporary unemployment component has a

stronger negative impact on wages than the persistent unemployment component.

Section 2 briefly presents the New Keynesian theories of unemployment tested in this chapter and section 3 outlines a wage equation employed to test them. The models used to test these theories are discussed in section 4. Section 5 discusses the econometric method and presents the empirical estimates. Pooled time-series and cross-section estimates are presented in section 6. The results in this study are compared to the results of other studies in section 7. Section 8 briefly summarises the finding of the study.

2 New Keynesian Theories of Unemployment

Some of the New Keynesian theories of unemployment were discussed in chapter 2. The most important content of them is briefly described below. Efficiency-wage theories assume that worker productivity is a function of wages (Stiglitz (1986)). Unemployment may exist because from the firms' point of view it is optimal to keep wages above the market clearing level to prevent workers from shirking, to lower labour turnover, to attract a high quality labour force and to increase worker morale. In the union bargaining model by McDonald and Solow (1981), the firm and the union act as a bilateral monopoly. If in response to shifts in demand both sides decide to share gains from trade, the outcome will usually be one of large employment fluctuations and small

real wage fluctuations. Insider-outsider theories assume that wages are set by insiders (employed) whose interests are presented by the unions (Gregory (1982); Blanchard and Summers (1986); Lindbeck and Snower (1986)). A negative shock to the economy has long-term effects as unemployed workers forego the opportunity to maintain skills and lose contact with the labour market. Moreover, the insiders have bargaining power over outsiders due to turnover costs, training costs and firing costs. Implicit contract theories assume that it is optimal for firms and workers to arrange implicit contacts to minimize the income variability of workers since they are more risk averse than employers (Gordon (1990)). The outcome is sticky wages that prevent the labour market from clearing after an adverse demand shock.

3 The Wage Adjustment Model

The wage equation derived by Gordon (1987a) is used to test real wage flexibility. Output is assumed to be a function of labour inputs, L , and a multiplicative factor Θ , composed of productivity, capital and materials

$$Q_t = \Theta_t Q(L_t), \quad Q' > 0. \quad (1)$$

Under the assumptions of profit maximization and perfect competition given the production function, labour demand is

$$L_t^d = L^d(W_t/P_t^{VA}, \Theta_t), \quad L_t^{d'}(W_t/P_t^{VA}) < 0, \quad L_t^{d'}(\Theta_t) > 0, \quad (2)$$

where W is compensation to employees and P^{VA} the value-added price-deflator. Note, that the arguments in labour demand are expectational parameters, but written as actual values to keep the exposition close to Gordon's. Supply of labour is assumed to be a positive function of real take home pay

$$L_t^s = L^s(W_t^{dir}(1 - t_t)/PE_t^{CPI}), \quad L_t^{s'} > 0, \quad (3)$$

where W^{dir} is direct wage payments, t_t the average direct tax rate on income and PE^{CPI} the expected consumer prices. The excess demand for labour is assumed to be a ratio of labour demand and labour supply

$$x_t = L_t^d / L_t^s. \quad (4)$$

With lowercase letters denoting logs, the equations (2) and (3) inserted in (4) can be rearranged to give

$$w_t = w_t(x_t, p_t^{VA}, pe_t^{CPI}, \theta_t, t_t, \zeta_t), \quad (5)$$

$$\begin{aligned} w_t'(x_t) &> 0, \quad w_t'(p_t^{VA}) > 0, \quad w_t'(pe_t^{CPI}) > 0, \quad w_t'(\theta_t) > 0, \\ w_t'(t_t) &> 0, \quad w_t'(\zeta_t) > 0, \end{aligned}$$

where ζ_t is pay-roll taxes to account for the wedge between W^{dir} and W .

3.1 Stochastic Specification of Wage Equation

The following stochastic specification of equation (5) is employed as a point of departure to test the New Keynesian theories of unemployment

$$w_t = \lambda_0 + \lambda_1 w_{t-1} + \lambda_2 U_t + \lambda_3 \theta_t + \lambda_4 p_t^{VA} + \lambda_5 \zeta_t + \lambda_6 t_t + \lambda_7 \tau_t + e_t, \lambda_2 < 0, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7 > 0. \quad (6)$$

where τ present the wedge between p^{VA} and p^{CPI} , that is terms-of-trade and indirect taxes, U is the unemployment rate as a proxy of excess demand for labour and e_t a zero-mean finite-variance disturbance term. The simple partial adjustment mechanism, with the dependent variable lagged one period, is assumed in order to save degrees of freedom. The underlying assumption of equal speed of adjustment to innovations in the dependent variables is, however, not too restrictive since all explanatory variables influence wages at the same time. Price expectations are embedded in the partial adjustment mechanism, which may also reflect the inertia in the wage adjustment process due to institutional arrangements. Trend productivity is employed for θ since wages are assumed not to be influenced by temporary fluctuations in productivity caused by labour hoarding and other cyclical influences.

4 Models Used to Test for Real Wage Rigidity

Six models are employed to test the validity of the New Keynesian theories of unemployment. Four timeseries models are estimated for individual countries. The coefficient estimates from these models are used in two cross-section models.¹

4.1 The Timeseries Models

Model 1. This model tests whether the unemployment rate exerts a stronger downward pressure on wages over the period 1961-73 than over the period 1974-89 by employing the following spline function

$$w_t = \alpha_0 + \alpha_1 w_{t-1} + \alpha_2 U_t^A + \alpha_3 U_t^B + \alpha_4 p^{VA}_t + \alpha_5 \theta_t + \alpha_6 \zeta_t + \alpha_7 t_t + \alpha_8 \tau_t + e_{1t}, \quad (7)$$

and to define the null hypothesis as $H_0: \alpha_2 = \alpha_3$, and the alternative as $H_1: \alpha_2 < \alpha_3$,

1. Branson and Rotemberg (1980) and Gordon (1987b) have less formally tested whether an excess demand for labour place a lower pressure on wages after 1970 (Branson and Rotemberg) and 1980 to 1984 (Gordon) for a smaller country sample. Since they use GDP (Branson and Rotemberg) and the deviation of "natural" to actual GDP (Gordon) as excess demand proxies, these tests may not serve as very powerful tests of New Keynesian theories of unemployment. As pointed out by Sachs (1980), the productivity slow-down in the wake of the first oil price shock has resulted in a GDP that indicate looser labour markets than actually exist, and hence bias the estimates in favour of less real wage flexibility in the second period.

where U^A is the unemployment rate from 1961 to 1973 and 0 thereafter and U^B the unemployment rate from 1974 to 1989 and 0 before then. The null hypothesis is that unemployment abruptly ceased to put a sufficient downward pressure on wages after the first oil price shock.

Model 2. This model tests whether the unemployment rate exerts decreasing levels of pressure on wages in the period from 1962 to 1989

$$w_t = \beta_0 + \beta_1 w_{t-1} + \beta_2 U_t + \beta_3 \text{time} * U_t + \beta_4 p^{VA}_t + \beta_5 \theta_t + \beta_6 \zeta_t + \beta_7 t_t + \beta_8 \tau_t + e_{2t}, \quad (8)$$

and to define the null hypothesis as $H_0: \beta_3 = 0$, and the alternative as $H_1: \beta_3 > 0$.

The time variable takes the value 1 in 1962, 2 in 1963 etc. The model assumes that the bargaining strength of insiders relative to outsiders has risen and/or the disutility of being unemployed, due to lower opportunity costs of being unemployed, has been falling in line with the increased unemployment in the OECD countries. The test is more powerful than the test in model 1 in the sense that institutional factors that have weakened the effect of unemployed on wages are likely to have changed smoothly over time. Model 1, on the other hand, may be more powerful than model 2 in the sense that persistence in unemployment

was initiated by an adverse shock and an eventual rise in the real wage rigidity in the 1970s.

Model 3. This model tests for persistence in unemployment; that is whether unemployment is path dependent. According to the hysteresis hypothesis (insider-outsider models), the long-term unemployed, due to human capital depletion, exert a weaker downward pressure on wages than those who are temporary unemployed.² Equally, persistence may be generated in efficiency wage models if the efficiency of outsiders is dependent upon lagged unemployment or if wage adjustment to shocks is slow. The theories hence predict the temporary unemployment component, U^t , to exert a stronger downward pressure on wages than the persistent unemployment component, U^p , in the stochastic equation

$$w_t = \gamma_0 + \gamma_1 w_{t-1} + \gamma_2 U^p_t + \gamma_3 U^t_t + \gamma_4 p^{VA}_t + \gamma_5 \theta_t + \gamma_6 \zeta_t + \gamma_7 t_t + \gamma_8 \tau_t + e_{3t}, \quad (9)$$

and to define the null of hysteresis as $H_0: \gamma_2 = \gamma_3$, and the alternative as $H_1: \gamma_2 > \gamma_3$.

The persistent unemployment component is estimated as the predicted value of unemployment in the second-order autoregressive process

2. Although hysteresis is frequently assumed to be synonymous with persistence the two terms are conceptionally different. Hysteresis requires that $d = 1$ in the equation $U_t = dU_{t-1} + Z_t + e_t$, whereas persistence requires $0 < d < 1$.

$$U_t = \eta_0 + \eta_1 U_{t-1} + \eta_2 U_{t-2} + e_{4t}, \quad (10)$$

and the temporary element is the residual, e_{4t} . The AR(2) decomposition is employed since the often more preferred ARMA process requires unemployment to be differenced to obtain stationarity. Since the estimations are performed in levels the ARMA decomposition is unwarranted.³

Model 4. The most obvious way to test whether unemployment benefits push wages upwards, as predicted by union bargaining models and shirking efficiency wage models, is to include replacement ratios in the wage equations and then test their statistical significance. Since replacement ratios are not available for all countries, cover different periods and are only readily available up to 1984, the residuals, obtained in the preceding models, are regressed on the replacement ratios. The test is conservative as some of the impact on wages benefits may have been picked up by some of the regressors in the wage equations.

3. Some may be tempted to estimate an ARIMA process and subsequently integrate the predicted change in the unemployment rate to obtain the predicted unemployment rate. The stochastic residuals, using this procedure, will, however, generate random walk predictions of the unemployment rate.

4.2 The Cross-Country Models

Model 5. This model tests whether wages are most rigid in the countries with the highest unemployment rate following the two-step procedure used by Grubb et al. (1983), Alogoskoufis and Manning (1988) and Klau and Mittelstat (1986). In the first step a wage equation is estimated for each country. The unemployment rate, averaged over a certain period, is subsequently regressed on the estimated coefficients on U_i , where the subscript "i" refers to country i. The following equation is estimated

$$U_{xi} = v_0 + v_1 WR_i + e_{5i}, \quad (11)$$

and the null hypothesis is specified as $H_0: v_1 = 0$, and the alternative $H_1: v_1 > 0$.

The unemployment variable U_{xi} is defined as the average rate of unemployment for country i over the period x. WR_{xi} is the estimate of the long-run coefficient on the unemployment rate over the same period, for country i, in models 1 to 3.

This is a very weak test of New Keynesian theories because it omits the channels whereby wage rigidity may be passed on to unemployment and assumes unemployment to be due only to wages in excess of their market clearing levels. More seriously, discouraged worker effects tend to be most

pronounced in low unemployment countries, that is labour force participation tend to mimics employment, also when employment is declining. Hence, a given rise in the unemployment in Austria, Switzerland and Japan, for instance, indicates a looser labour market relative to the same rise in unemployment in other OECD countries. Because of this effect, the coefficients on the unemployment rates in the wage equations numerically become higher for these countries and therefore tends to establish a statistical significant relationship between cross-country unemployment rates and the wage rigidity coefficients. To overcome this problem the change in the unemployment rate from 1962-73 to 1974-89 is additionally regressed on the change of the coefficient on unemployment from 1962-73 to 1974-89 in model 1.

Model 6. This test relates the cross-country wage rigidity to the real wage gap. Assuming that the proportion of the real product wage, in excess of the marginal productivity of labour, in country i is a function of its unemployment rate multiplied by its wage rigidity coefficient we get⁴

$$w_i - p^{VA} - \theta_i = W^x = \kappa_0 + \kappa_1 WR_i U_i,$$

and assuming WR to be constant, then

4. This is in fact a wage equation with homogeneity in productivity and prices imposed.

$$\Delta W^x_{xi} = \kappa_0 + \kappa_1 WR_{xi} \Delta U_{xi} + e_{6i}, \quad (12)$$

and to define the null hypothesis as $H_0: \kappa_1 = 0$, and the alternative as $H_1: \kappa_1 > 0$,

where W^x is the real wage gap under a Cobb-Douglas technology. The model is estimated in differences to remove individual heterogeneity.

5 Empirical Estimates

5.1 Econometric Issues

Levels or differences. Models 1 to 3 are estimated in levels for several reasons. First, estimation in differences usually requires a dynamic specification that demands a larger number of observations than are available on an annual basis. Second, estimating in differences imposes the restriction of same speed of adjustment over time of the dependent variable to changes in the explanatory variables unless an error correction model is employed. It is conceivable that wages may have adjusted to price changes with different time lags due to periods of incomes policy and other wage restraining measures. The dynamics of the ratio between long-term and short-term unemployed over the business cycle may additionally render the pace of wage adjustment to changes in the unemployment rate rather unstable. Third, Coe (1985) finds changes in

the unemployment rate to be insignificant in wage equations specified in differences, which render tests of New Keynesian theories of unemployment inconclusive.⁵ Fourth, estimations in differences tend to suppress relations among variables at say business-cycle frequencies in the relatively short time period considered here.

Estimating in levels with series containing unit roots may give spurious relationships in the Granger-Newbold sense. If the variables in the regression, however, are co-integrated, the relationship is likely to be non-spurious (Engle and Granger (1987)). As a consequence, Dickey-Fuller tests for co-integration are performed.⁶

Functional form. All variables, except U , are log-linear. Some authors, in the Phillips curve literature, have employed $1/U$ instead of U as a regressor, because unemployment cannot become less than zero, and hence must approach zero as excess demand approaches infinity. The slow-down in the growth of the unit labour costs after the

5. The wage equation is frequently estimated in differences with the exception of the unemployment term, which is maintained in levels as in the Phillips curve framework. Since the unemployment rate is integrated of an order which is higher than zero such a regression is likely to give biased parameter estimates and render inferences invalid. The hypothesis of non-stationary rate of unemployment was accepted by augmented Dickey-Fuller tests for integration, even at the 20 per cent critical level.

6. Dickey-Fuller tests may gain power if they are augmented with lags of the dependent variable, provided that the lags are significant (Engle and Granger (1987)). Since the lagged variables were insignificant, at the 5 per cent level, in nearly all the cases a Dickey-Fuller test is performed in all cases.

mid 1970s suggests that even a high unemployment rate may put significant downward pressure on wages, which opposes the use of $1/U$, where changes in U , when U is high, do not have much impact on wages. Comparing estimates with U and $1/U$ in the wage equation, Coe (1985) obtains better estimates when U is employed. The results are better in terms of serial correlation and the root mean squared error in the forecast period.

Estimation method. Instruments are used for the unemployment rate and the value-added price-deflator since the unemployment rate is likely to be a function of wages and prices are mark-ups on wages. The instruments used for the unemployment rate are the unemployment rate lagged one period and contemporaneous and lagged values of the cyclical and inflation corrected fiscal balance in per cent of potential GDP, monetary stock, $M1$, deflated by consumer prices, a quantity index of OECD exports and a time trend. The instruments used for the value-added price-deflator include the value-added price-deflator lagged one period and contemporaneous and lagged values of $M1$ and consumer prices.

The general to specific method is employed to gain efficiency with 10 per cent significance as the bench-mark level. Coefficients with signs opposite to the expected

sign are deleted.⁷ This only occurred for τ in a few occasions and may suggest that nominal wage rigidity has prevented wages to decline in response to declining terms-of-trade. Estimates with τ decomposed into an increasing and a decreasing component, however, did not change the sign of the coefficient on τ . The maximum likelihood estimator, that takes first order serial correlation into account, is employed in the estimates with first order serial correlation.

Diagnostic tests. Three diagnostic tests are performed: Dickey-Fuller tests for co-integration, a Lagrange multiplier test for first order serial correlation and Ramsey's RESET test of the power three for functional form/misspecification. Note that the RESET and the DF tests may not be valid in the instances where the maximum likelihood algorithm, to account for first order serial correlation, is employed.

Data. Wages and the value-added price-deflator are measured as compensation to employees in manufacturing and private services and are detailed in chapter 2. The unemployment rate is the OECD standardized unemployment rate for 15 of the countries from 1966; the non-standardized unemployment rate is employed for the remaining countries and the period not covered by the standardized unemployment rate. Trend

7. The conclusions remain unaltered with "wrong" signed variables included.

productivity is estimated as a steady exponential growth between the bench-mark years 1960, 1973, 1979 and 1989. Although higher frequency data would allow more satisfactory dynamic specifications, annual data have the advantage over higher frequency data that it filters out undesirable noise. The sources and estimation of the different tax rates are described in the data appendix.

5.2 Empirical Results

Results of the diagnostic tests in the models 1 to 3. Overall the diagnostic tests, presented in the tables 1 to 3, suggest that specification problems are present but not too severe to jeopardize inferences drawn from the estimates.⁸ The Dickey-Fuller tests suggest that the variables are co-integrated. The maximum likelihood procedure is used in about a third of the estimates. Though the maximum likelihood procedure gives more precise parameter estimates, it may not correct for the specification problems that are likely to be present in the estimates with first order serial correlation in the residuals. The RESET tests suggest functional form problems in 40 per cent of the instances at the 5 per cent level, which is likely to be due to the real wage "explosion" from the mid 1960s to the mid 1970s.⁹

8. Note that the diagnostics tests that are most likely to indicate specification problems are employed.

9. In the RESET tests the predicted values of wages of the power of three is included in an additional regression of the wage equation and tested for significance. Since both

Model 1. The results of estimating equation (2) are presented in table 1. The coefficient estimates have the expected magnitudes. The coefficient on U^B is negative and significant for 6 of the 20 countries, indicating some trade-off between unemployment and wages after 1974. The trade-off, however, is much stronger and clearly evident before 1974 with the coefficients on U^A significantly negative for 17 countries. The Wald tests reject the hypothesis of equality of U^A and U^B for 11 countries at the 5 per cent level ($\chi^2(1)_{0.05} = 3.84$), with $\alpha_3 > \alpha_2$ in all cases. These results indicate that unemployment has declined as an effective equilibrating factor on the labour market after 1974, which concurs with the predictions made by the New Keynesian theories of unemployment.

Model 2. The results of estimating model 2 are presented in table 2. The chief parameter of interest, namely β_3 , is significantly negative for 9 countries and significantly positive for only one country, at the 5 per cent level. This large fraction of negative coefficients allows us to reject the alternative hypothesis that the New Keynesian theories are true. The results are at variance with the results of estimating model 1 and suggest the wage flexibility profile may have been cyclically behaved.

the actual and the predicted values of wages rose strongly in the "wage explosion" period, but the actual wages outpaced the predicted wages, we may expect the RESET tests to be significant.

Table 1. Parameter estimates of model 1. $w_t = \alpha_0 + \alpha_1 w_{t-1} + \alpha_2 U_t^A + \alpha_3 U_t^B + \alpha_4 \theta_t + \alpha_5 p_t^{VA} + \alpha_6 \zeta_t + \alpha_7 \tau_t + \alpha_8 \tau_t + e_{1t}$

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	$\chi^2 (\alpha_2 = \alpha_3)$	RESET	DF	AC(1)
Can	-2.05 (5.81)	0.47 (4.55)	-0.013 (2.86)	-0.003 (0.68)		0.54 (4.26)		0.42 (7.41)		12.83**	3.99*	3.81*	0.94
USA	-1.45 (4.10)	0.71 (7.88)	-0.009 (2.60)	-0.001 (0.20)		0.26 (2.45)		0.35 (4.86)		15.57**	1.38	6.18**	1.06
Jap#	-7.78 (7.57)	0.12 (1.33)	-0.020 (0.95)	-0.001 (0.06)	0.82 (6.30)	1.06 (4.85)	0.56 (3.66)			0.85	4.01*	3.11	1.97*
Aus1#	-6.35 (6.27)	0.35 (2.63)	-0.010 (1.52)	0.005 (0.75)	0.90 (3.02)	0.50 (3.60)	0.48 (2.18)	0.11 (1.32)		4.47*	7.08**	3.55*	1.50
Ausi	-8.83 (18.66)		-0.055 (3.12)	0.005 (0.24)	1.09 (10.98)	0.92 (7.32)	0.89 (9.70)			15.23**	4.36*	5.00**	0.07
Bel	-5.73 (3.91)	0.69 (6.14)	-0.027 (2.84)	-0.011 (1.26)	0.32 (1.44)			0.56 (6.00)	0.82 (2.19)	2.66	6.09*	5.73**	0.76
Den	-5.13 (18.03)		-0.010 (0.81)	0.007 (2.37)	1.16 (15.96)	0.93 (34.81)				2.42	1.14	4.06*	0.40
Fin	-9.18 (22.32)		-0.023 (2.96)	0.015 (2.65)	1.09 (8.58)	0.80 (13.78)	0.84 (6.58)	0.13 (2.34)		19.57**	10.70**	3.75*	0.89
Fra	-5.15 (5.21)	0.90 (12.37)	-0.046 (5.98)	-0.022 (2.38)	0.41 (2.85)				1.17 (4.68)	15.71**	13.12**	5.90**	0.89

Table 1 Cont.

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	$\chi^2(\alpha_2=\alpha_3)$	RESET	DF	AC(1)
Ger#	-7.27 (9.75)		-0.020 (2.16)	-0.004 (0.80)	1.03 (6.04)	0.94 (5.50)	0.50 (2.93)			3.12	14.17**	3.32	1.91*
Gre	-0.80 (1.22)	0.54 (4.03)	-0.027 (4.77)	-0.005 (0.52)	0.50 (3.17)			0.24 (1.67)		2.67	1.34	4.31**	0.16
Ire	-2.63 (4.53)	0.56 (2.49)	-0.022 (4.29)	-0.018 (2.51)		0.51 (2.20)		0.37 (4.76)	0.23 (1.52)	0.49	0.28	5.71**	0.54
Itl	-5.71 (3.18)	0.39 (1.63)	-0.032 (2.46)	-0.020 (1.23)	0.99 (4.21)	0.65 (4.35)			0.46 (1.36)	7.40**	0.89	5.22**	0.09
Net	-7.06 (6.46)	0.68 (10.33)	-0.039 (3.39)	0.003 (0.83)	1.00 (4.44)		0.81 (4.14)			12.83**	7.03**	4.17**	0.77
Nor	-4.19 (4.74)	0.30 (1.98)	-0.072 (3.72)	-0.046 (3.01)	0.83 (4.94)	0.72 (4.44)				4.23*	1.02	5.85**	0.86
Por	-2.88 (4.35)	0.67 (6.47)	-0.060 (4.11)	-0.015 (2.46)	0.45 (2.66)	0.27 (2.72)			0.59 (1.96)	11.94**	0.08	6.64**	1.35
Spa#	-6.57 (5.76)	0.18 (1.59)	-0.008 (1.35)	-0.001 (0.30)	1.35 (4.25)	0.59 (4.77)		0.21 (2.34)		1.32	2.87	3.73*	0.02

Table 1 Cont.

	α_0	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	$\chi^2 (\alpha_2=\alpha_3)$	RESET	DF	AC(1)
Swe	-7.73 (6.34)	0.34 (3.67)	-0.045 (4.73)	-0.029 (3.65)	1.14 (7.76)	0.45 (6.04)	0.68 (3.67)			6.92**	0.20	6.56**	1.33
Switz#	-4.45 (8.77)	0.31 (4.31)	-0.126 (1.59)	-0.065 (1.92)	0.85 (6.62)	0.78 (7.85)				0.52	2.13	4.88**	0.13
UK	-4.81 (11.33)	0.14 (1.43)	-0.002 (0.04)	0.012 (0.43)	0.77 (8.13)	0.83 (7.64)	0.24 (3.87)			0.08	2.02	5.95**	0.34

Notes: t-statistics in parentheses. AC(1) = Lagrange multiplier test for first order serial correlation, $t(n-1)$ -distributed under the null of no serial correlation, where n is the number of observations. DF = Dickey-Fuller test for co-integration, $t(n-k)$ -distributed (not conventional student t-distribution) under null of no co-integration, where k is the number of explanatory variables incl. the constant term. $\chi^2(\alpha_2=\alpha_3)$ is a Wald test for equality of the coefficients on the unemployment rate in the two periods 1961-73 and 1974-89, $\chi^2(1)$ -distributed under the null of structural stability. RESET is Ramsey's functional form test with the power of three, $F(2, n-k-1)$ -distributed under the null hypothesis of correct functional form. Estimation period 1961-89 except for Denmark (1967-89) and Greece (1966-89).

*: Significant at the 5 per cent level (coefficients in equations excluded).

**: Significant at the 1 per cent level (coefficients in equations excluded).

#: Corrected for first order autocorrelation by maximum likelihood.

Table 2. Parameter estimates of model 2. $w_t = \beta_0 + \beta_1 w_{t-1} + \beta_2 U_t + \beta_3 time * U_t + \beta_4 p^{VA}_t + \beta_5 \theta_t + \beta_6 \zeta_t + \beta_7 t_t + \beta_8 \tau_t + e_{2t}$

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	RESET	DF	AC(1)
Can#	-7.68 (6.55)	0.18 (2.94)	0.017 (2.83)	-0.001 (3.82)	1.14 (3.85)	0.87 (10.82)	0.29 (2.47)	0.12 (1.99)		17.80**	3.59*	1.60
USA	-1.78 (4.60)	0.46 (4.08)	-0.015 (2.17)	0.001 (2.41)		0.50 (4.17)		0.43 (5.71)		3.64*	3.97*	1.10
Jap#	-9.81 (14.21)		0.080 (2.68)	-0.004 (3.98)	0.93 (14.31)	1.33 (14.18)	0.52 (3.69)	0.18 (1.73)		0.34	4.07*	0.68
Aus1#	-6.65 (6.59)	0.39 (2.77)	0.024 (1.56)	-0.001 (1.42)	0.47 (1.75)	0.59 (3.57)	0.78 (4.35)	0.19 (2.45)		18.46**	4.47**	1.24
Ausi	-12.67 (17.05)		-0.020 (0.73)	-0.001 (0.75)	0.92 (7.93)	1.26 (7.37)	0.84 (6.88)		0.40 (1.52)	2.20	5.51**	1.50
Bel	-10.15 (4.71)	0.41 (2.00)	0.023 (1.51)	-0.002 (2.87)	0.40 (2.16)	0.76 (2.41)		0.45 (2.86)	1.44 (3.60)	5.87**	5.13**	0.15
Den	-5.16 (14.02)		0.010 (1.10)	0.000 (0.22)	1.14 (8.80)	0.96 (12.75)				2.00	3.71*	0.70
Fin#	-7.39 (12.82)		-0.026 (1.42)	0.002 (1.62)	0.83 (5.35)	0.93 (12.54)	0.60 (4.63)	0.14 (1.87)		5.57*	4.55**	0.52
Fra#	-5.48 (18.93)		0.071 (6.23)	-0.003 (8.93)	0.78 (7.46)	1.34 (19.32)				0.21	4.36**	0.90
Ger#	-7.35 (9.70)		0.028 (2.82)	-0.002 (4.79)	1.08 (8.90)	1.05 (8.21)	0.37 (1.82)			14.11**	4.03*	0.37

Table 2 Cont.

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	RESET	DF	AC(1)
Gre	-10.28 (4.02)	0.41 (3.57)	0.064 (2.67)	-0.003 (3.22)	1.62 (3.62)	0.66 (5.43)	0.29 (2.07)	0.23 (1.36)		3.77*	4.50**	0.18
Ire	-6.41 (6.82)	0.46 (2.69)	0.036 (2.38)	-0.002 (5.32)	1.11 (6.58)	0.61 (3.33)			0.23 (1.76)	3.10	5.04**	0.05
Itl	-3.14 (3.11)	0.52 (3.05)	-0.060 (2.09)	0.000 (0.24)	0.64 (3.27)	0.54 (3.32)				5.75**	4.31**	0.64
Net#	-8.04 (8.07)	0.36 (3.56)	0.031 (3.62)	-0.001 (3.50)	1.22 (5.58)	0.46 (4.49)	0.60 (3.22)			0.24	4.05*	1.01
Nor	-4.24 (3.87)	0.39 (2.60)	-0.013 (0.40)	-0.001 (1.12)	0.78 (4.22)	0.69 (3.71)				0.28	4.79**	0.18
Por	-1.48 (6.31)	0.91 (21.15)	-0.045 (1.77)	0.002 (1.30)					1.11 (6.37)	1.08	5.57**	1.34
Spa	-6.19 (7.62)	0.21 (2.16)	0.018 (3.04)	-0.001 (5.09)	1.38 (6.60)	0.65 (7.93)				0.25	5.16**	0.65
Swe	-8.58 (6.33)	0.32 (3.05)	-0.049 (1.30)	0.000 (0.49)	1.15 (6.77)	0.45 (4.47)	0.87 (4.42)			2.65	4.69**	0.48
Switz#	-4.40 (8.93)	0.32 (4.61)	-0.044 (0.56)	-0.001 (0.46)	0.84 (6.96)	0.76 (7.94)				1.92	4.87**	0.22
UK	-5.46 (22.13)		-0.006 (0.84)	0.000 (1.46)	0.85 (12.87)	0.97 (48.48)	0.31 (3.64)			2.88	5.88**	0.41

Notes: See notes to table 1.

Identification of the time profile is addressed in section 6 by employing pooled time-series and cross-section data.

Model 3. The results of estimating model 3 are presented in table 3. The Wald tests reject the hypothesis of equality between γ_2 and γ_3 for 4 countries at the 5 per cent level, with $\gamma_2 < \gamma_3$ in all the cases. The temporary unemployment component is negative and significant, at the 5 per cent level, in 4 instances and the persistent unemployment component is significant in 10 instances. Overall, the results reject the alternative hypothesis of persistence in unemployment.

Model 4. The last three columns in table 4 present the F-tests of correlating the residuals of the models 1 to 3 with the replacement ratios. Significance, at the 5 per cent level, is obtained only in four of the 45 cases considered, with two wrong signed. Consequently, wage aspiration is not likely to be a positive function of benefit levels as predicted by shirking efficiency wage and union bargaining models.

Model 5. Table 5 presents the t-statistics of the coefficient on WR. There is no significant correlation between the unemployment rate and the wage stickiness across countries, even at the 10 per cent level, no matter which period the estimates cover, which coefficient

Table 3. Model 3. $w_t = \gamma_0 + \gamma_1 w_{t-1} + \gamma_2 u^p_t + \gamma_3 u^t_t + \gamma_4 p^{VA}_t + \gamma_5 \theta_t + \gamma_6 \zeta_t + \gamma_7 t_t + \gamma_8 \tau_t + e_{3t}$

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	γ_8	$\chi^2 (\gamma_2=\gamma_3)$	RESET	DF	AC(1)
Can#	-5.28 (4.27)	0.21 (2.77)	-0.007 (1.43)	-0.008 (1.92)	0.55 (1.89)	0.85 (8.60)	0.33 (2.05)	0.18 (2.54)			0.07	2.19	3.77* 1.65
USA	-2.13 (6.07)	0.50 (4.56)	-0.005 (1.14)	0.003 (0.83)		0.54 (4.22)		0.42 (5.25)			2.78	7.58**	4.05* 1.29
Jap#	-9.36 (11.87)		-0.019 (0.71)	-0.009 (0.48)	0.88 (12.00)	1.35 (15.26)	0.67 (3.57)				0.21	5.05*	3.30* 2.24*
Aust1#	-6.89 (6.19)	0.48 (3.29)	-0.006 (0.70)	0.004 (0.66)	0.64 (2.09)	0.43 (2.86)	0.77 (4.34)	0.16 (1.76)			2.89	7.25**	4.66** 0.29
Aust1	-10.66 (16.00)		-0.039 (2.09)	-0.005 (0.23)	0.98 (9.50)	1.17 (9.96)	0.86 (8.57)			0.37 (1.75)	2.70	0.94	5.77** 0.67
Bel#	-5.93 (4.04)	0.88 (20.00)	-0.025 (3.58)	-0.012 (1.60)				0.52 (4.47)		1.15 (2.80)	2.46	0.97	6.67** 1.57
Den	-4.95 (12.97)		0.008 (2.25)	0.013 (2.60)	1.10 (11.26)	0.96 (29.09)					0.95	1.36	4.50** 0.10
Fin#	-8.05 (13.99)		0.012 (1.45)	0.004 (0.56)	0.87 (6.17)	0.96 (16.93)	0.63 (4.78)	0.16 (2.40)			1.14	5.14*	4.70** 0.11
Fra	-3.09 (3.88)	0.70 (4.95)	-0.065 (8.76)	-0.013 (1.07)	0.35 (2.56)	0.64 (3.33)					33.00**	6.94**	3.50* 1.66
Ger#	-7.70 (6.56)	0.19 (1.58)	-0.017 (3.35)	-0.003 (0.61)	0.84 (3.97)	0.70 (4.88)	0.76 (4.33)	0.10 (1.47)			9.44**	11.52**	3.47* 1.65
Gre	-4.51 (2.83)	0.64 (3.57)	-0.001 (0.09)	0.027 (1.30)	0.82 (2.00)	0.34 (1.61)		0.19 (1.35)			3.05	0.11	4.05* 0.33

Table 3 cont.

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	γ_8	$\chi^2(\gamma_2=\gamma_3)$	RESET	DF	AC(1)
Ire	-2.75 (4.55)	0.59 (2.84)	-0.020 (3.84)	-0.023 (2.29)		0.49 (2.15)		0.38 (4.57)	0.23 (1.67)	0.08	0.13	5.26**	0.36
Itl	-3.75 (4.41)	0.40 (2.53)	-0.054 (5.36)	-0.020 (1.09)	0.75 (4.32)	0.66 (4.42)				4.66*	0.87	3.31*	1.60
Net#	-8.01 (6.23)	0.53 (4.82)	0.005 (1.11)	0.012 (2.19)	0.93 (3.31)	0.27 (2.43)	0.94 (5.07)			2.98	0.05	4.05*	0.92
Nor	-3.66 (3.76)	0.46 (31.89)	-0.039 (1.78)	-0.049 (0.43)	0.72 (2.78)	0.57 (3.29)				0.29	1.27	5.50**	0.48
Por	-2.19 (4.06)	0.82 (8.27)	-0.015 (1.83)	-0.017 (1.14)	0.14 (4.58)			1.33 (4.58)		0.03	1.83	5.52**	0.59
Spa	-5.94 (6.12)	0.23 (1.86)	-0.003 (0.68)	0.007 (1.24)	1.14 (4.38)	0.59 (5.40)		0.24 (1.99)		6.52*	3.93*	3.79*	0.24
Swe	-8.94 (6.24)	0.32 (2.57)	-0.029 (1.83)	-0.031 (2.83)	1.17 (5.88)	0.47 (4.45)	0.90 (4.41)			0.01	2.00	4.65**	0.41
Switz#	-4.28 (8.28)	0.32 (4.33)	-0.065 (1.97)	-0.043 (0.90)	0.80 (6.17)	0.78 (7.67)				0.34	2.37	4.67**	0.23
UK#	-8.86 (8.96)	0.10 (1.69)	-0.001 (0.39)	0.001 (0.32)	0.92 (12.40)	0.87 (14.96)	0.22 (4.42)		0.33 (1.96)	0.35	0.26	5.26**	0.51

Notes: See notes to table 1. $\chi^2(\gamma_2=\gamma_3)$ is a Wald test of equality of the parameter estimates of γ_2 and γ_3 , $\chi^2(1)$ -distributed under the null of equality. Estimation period 1962-89 for estimations with a first order autoregressive process in the unemployment rate and 1963-89 for estimations with a second order autoregressive process in the unemployment rate, except Denmark (1967-89) and Greece (1967-89).

Table 4. Tests for unity of long-run price level, estimates of persistence in unemployment, $U_t = \eta_0 + \eta_1 U_{t-1} + \eta_2 U_{t-2} + e_t$, and tests for influence of benefits on wages.

	$\chi^2[1/(1-d_{t-1})] = 1]$			Persistence			F (Ben)		
	Mod1	Mod2	Mod3	η_0	η_1	η_2	Mod1	Mod2	Mod3
Can	0.32	0.57	0.37*	0.38(0.81)	0.95(14.70)		0.43	2.55	4.21*
USA	0.66	1.54**	5.92**	1.02(1.48)	0.82(7.42)		-0.05	1.40	-0.00
Jap	1.53**	12.66**	15.63**	0.09(0.83)	0.97(17.56)		-0.36	-0.41	-0.08
Aust1	6.68**	0.13	3.02	0.38(1.52)	0.96(19.52)		0.52	1.06	0.20
Aust1	0.37	1.58	2.06	0.03(0.22)	1.01(19.76)		-	-	-
Bel	2.67*	1.80	2.46	0.38(1.26)	0.97(23.19)		0.71	1.95	0.46
Den	5.79**	0.30	1.12	0.77(1.54)	0.91(11.45)		0.01	0.02	-0.02
Fin	11.18**	0.93	0.47*	0.58(2.01)	0.87(11.73)		-	-	-
Fra	15.71**	24.23**	6.34*	0.24(1.82)	1.01(44.00)		-0.88*	-4.82*	-0.59
Ger	0.09	0.17	0.59	0.24(1.27)	0.98(20.17)		15.48**	2.05	0.68
Gre	0.96	3.91*	0.95	0.40(1.58)	1.67(10.77)	-0.75(4.73)	-	-	-
Ire	1.64	5.37*	3.66	0.32(1.03)	1.60(8.65)	-0.62(3.12)	-	-	-
It1	1.93**	1.95**	2.54**	-0.11(0.48)	1.05(33.92)		0.36	0.45	0.49
Net	12.82**	11.29*	6.99**	0.29(1.46)	1.57(9.51)	-0.61(3.67)	-0.80	0.51	0.28
Nor	1.13**	4.90*	0.87	-0.01(0.02)	1.04(7.43)		-0.02	-0.81	-0.08
Por	11.94**	0.54*	1.66*	0.40(1.31)	1.34(6.99)	-0.42(2.19)	-	-	-
Spa	5.36**	6.23**	6.16**	0.40(1.20)	1.02(31.93)		-0.48	-0.33	-3.73*
Swe	93.97**	19.86**	48.81**	0.54(1.94)	0.74(5.77)		0.50	2.06	1.52
Switz	3.58	4.62*	4.57*	0.11(1.00)	1.40(7.98)	-0.45(2.40)	1.12	0.99	0.90
UK	0.70	2.45	6.12	0.58(1.57)	1.40(7.57)	-0.49(2.65)	-1.32	-1.06	-0.55

Notes: See notes to table 1. $\chi^2[1/(1-d_{t-1})] = 1]$ is a Wald test for unity long-run coefficient on prices, $\chi^2(1)$ -distributed under the null of unity, where d is the coefficient on the lagged dependent variable. F(Ben) is a F-test for replacement ratios explaining the residuals in the models 1 to 3, $F(1,n-k)$ -distributed under the null of no correlation. A minus in the front of the F-test indicates a negative relationship. A "-" indicates that replacement ratios not are available. The estimation period for the F(Ben) tests are from 1962 to 1984 except for Australia (1977-84), Belgium (1964-82), Netherlands (1967-84), Spain (1973-84) and Switzerland (1975-84).

Table 5. t-ratios of v_1 in model 4: $U_{xi} = v_0 + v_1 WR_{xi} + e_{5i}$

Regressor	$u_{1961-73}$	$u_{1974-89}$	$u_{1961-89}$	$\Delta u_{1973-89}$	$\Delta u_{61-73/74-89}$
Model 1:					
$WR_1(1974-89)$		0.45		-0.22	
$WR_1(1961-73)$	0.93			-0.12	
$WR_1(61-73/74-89)$					-0.27
Model 2:					
$WR_1(t = 1)$	0.04				
$WR_1(t = 8)$	0.16				
$WR_1(t = 15)$		0.59		1.06	
$WR_1(t = 21)$		0.59		1.05	
$WR_1(t = 28)$		0.60		1.04	
Model 3:					
$\alpha_u(\text{pers})$	0.28	-0.10	0.13	-0.27	
$\alpha_u(\text{temp})$	0.44	0.30	0.55	0.10	

Notes: $t = 1$ in 1962, 2 in 1963 etc.

Table 6. t-ratios of κ_1 in model 5:

$$\Delta W^X_x = \kappa_0 + \kappa_1 WR_{x1} \Delta U_{xi} + e_{6i}.$$

Model 1:	$x = 1961-73$		$y = 1974-89$	
	-----		-----	
	0.21		-0.15	
Model 2:	$t = 15$		$t = 21$	$t = 28$
	-----		-----	-----
	0.95		0.97	0.99
Model 3:	$x = 1961-89$			

	Persistent		Temporary	
	-----		-----	
	0.31		0.95	

Notes: See notes to table 5.

estimates are used and whether changes or levels are employed. Hence, the alternative hypothesis is rejected.

Model 6. The t-ratios of estimating model 6 with coefficient estimates from models 1 to 3 are presented in table 6. In none of the considered cases are the coefficients on $WR_{xi}\Delta U_{xi}$ significant, even at the 10 per cent level. The real wage gap has therefore not increased mostly in countries with the strongest degree of real wage rigidity and the predictions made by the New Keynesian theories consequently are rejected.

6 Pooled Cross-Section and Time-Series Analysis

The seemingly contradictory results obtained from estimating model 1, which suggests that wages became more rigid after 1973, and model 2, which suggest wages have become more flexible over time, requires a closer look at the time profile of wage rigidity. The identification of wage rigidity year for year requires the usage of pooled time-series and cross-section estimates. If the almost simultaneous rise in the unemployment across countries has been due to, or partly due to, increased real wage rigidity, the degree of real wage rigidity may have followed almost the same path across countries. The "wage flexibility" path, presented by the parameter ϕ , is traced out estimating the equation

$$\Delta(w)_i = \varphi_{0it} + \sum_{j=1962}^{1988} \varphi_{j} \Delta(U_i) + \Delta(Z)_i + e_{it}, \quad (13)$$

where j takes the value 1 for a particular year, and zero elsewhere, and Z_i is a vector of all the other variables, for country i , that are contained in the wage equation (for instance equation (6)). Since the unemployment experiences have been different across countries, estimates are performed for two country groups of equal size divided after the average unemployment rate over the period 1974 to 1989. The data is transformed to growth rates (the unemployment rate is measured in differences) in order to remove part of the heterogeneity across countries. Feasible generalized least squares is employed to account for the rest of the heterogeneity across countries, since the hypothesis of homogeneity was rejected at the 5 per cent level using the OLS dummy variable method.¹⁰ The fixed effect model is used as the Lagrange multiplier test rejected the hypothesis for a random effects model at the 5 per cent level.¹¹

The results are presented in table 7. Tracing the development of the real wage rigidity parameters over time does not shed much light on the variant results of

10. A lagrange multiplier test for homogeneity, $\chi^2(9)$ -distributed under the null of homogeneity, gave the values 101.71 and 24.33 for the low and the high unemployment group respectively when the OLS estimator is used. The test statistics fell to 9.33 and 6.53, respectively, with estimates from the generalized least squares.

11. The Lagrange multiplier test for random effect model, $\chi^2(1)$ -distributed under the null of a random effects model, is 4.66 for both country groups.

Table 7. Parameter estimates of pooled cross-section and time-series.

	Low unempl ¹	High unempl ²
$\Delta(w)_{t-1}$	0.237 (5.57)	0.155 (3.59)
$\Delta(p^{VA})_t$	0.814 (14.0)	0.900 (15.9)
$\Delta(\Theta)_t$	0.862 (7.65)	1.576 (9.12)
$\Delta(\zeta)_t$	0.600 (11.6)	0.272 (5.80)
$\Delta(t)_t$	0.048 (2.32)	0.121 (4.28)
$\Delta(\tau)_t$	0.199 (3.64)	0.196 (3.29)
$\Delta(U)_{t,1962}$	2.715 (0.58)	-0.418 (0.53)
$\Delta(U)_{t,1963}$	-3.620 (0.85)	-2.463 (1.08)
$\Delta(U)_{t,1964}$	0.713 (0.10)	-1.953 (1.46)
$\Delta(U)_{t,1965}$	-1.432 (0.27)	0.307 (0.25)
$\Delta(U)_{t,1966}$	-4.341 (1.06)	-2.922 (2.24)
$\Delta(U)_{t,1967}$	-1.174 (1.09)	-0.462 (0.33)
$\Delta(U)_{t,1968}$	-0.676 (0.42)	-1.938 (1.41)
$\Delta(U)_{t,1969}$	0.138 (0.09)	-2.568 (1.43)
$\Delta(U)_{t,1970}$	-4.697 (2.71)	-0.420 (0.63)
$\Delta(U)_{t,1971}$	-1.651 (0.73)	-2.141 (2.10)
$\Delta(U)_{t,1972}$	1.676 (0.65)	1.465 (1.13)
$\Delta(U)_{t,1973}$	-0.458 (0.10)	1.465 (1.14)
$\Delta(U)_{t,1974}$	-3.101 (1.72)	1.592 (1.19)
$\Delta(U)_{t,1975}$	1.385 (2.34)	1.252 (3.73)
$\Delta(U)_{t,1976}$	-2.238 (2.34)	-0.247 (0.34)
$\Delta(U)_{t,1977}$	-3.259 (3.91)	-2.780 (2.73)
$\Delta(U)_{t,1978}$	-4.621 (3.23)	-2.400 (2.79)
$\Delta(U)_{t,1979}$	-3.120 (2.03)	-1.100 (1.37)
$\Delta(U)_{t,1980}$	-1.004 (0.68)	-0.862 (1.50)
$\Delta(U)_{t,1981}$	-0.964 (0.84)	-0.911 (2.68)
$\Delta(U)_{t,1982}$	-0.985 (1.36)	-0.130 (0.42)
$\Delta(U)_{t,1983}$	-1.119 (1.94)	-1.152 (1.78)
$\Delta(U)_{t,1984}$	-0.712 (0.41)	-0.907 (1.88)
$\Delta(U)_{t,1985}$	0.494 (0.18)	-0.580 (0.83)
$\Delta(U)_{t,1986}$	-2.484 (1.64)	-0.457 (0.33)
$\Delta(U)_{t,1987}$	-2.216 (1.28)	-0.574 (0.51)
$\Delta(U)_{t,1988}$	0.188 (0.14)	-0.189 (1.98)

Notes: t-statistics in parentheses.

1. Japan, Australia, Austria, Finland, Germany, Norway, Portugal, Sweden and Switzerland.

2. Canada, USA, Belgium, France, Ireland, Italy, Netherlands, Spain and UK.

estimating models 1 and 2 and may to some extent reflect different time paths of the real wage flexibility across countries. The estimates, however, provide us with useful information. First, the degree of wage flexibility in the low unemployment countries fluctuated around a constant mean up to about 1980. Thereafter, unemployment ceased to put a downward pressure on wages. Second, the highest, and most significant, degree of real wage flexibility in the high unemployment countries, prevailed in the period from 1977 to 1984 and agree with the hypothesis that the persistent unemployment component plays an important role in exerting a downward pressure on wages.

Since the results above suggest a change in the wage behaviour after 1977 in the countries with the highest rate of unemployment, model 1 was estimated with 1976/1977 as split period. With this split period, most of the coefficients on the rate of unemployment over the period 1961-76 became insignificant, even at the 10 per cent significance level (the results are not shown here). In the few cases where the coefficients on the rates of unemployment were significant, unemployment exerted a stronger downward pressure on wages after 1977 than before 1976.

7 Comparison With the Findings of Other Authors

The rejection of the hypothesis that the unemployment rate is highest in countries with the most rigid real wages is at variance with the finding of Grubb et al. (1983); Alogoskoufis and Manning (1988) and Klau and Mittelstadt (1986).¹² The disagreement may be explained by the following. First, other studies use manufacturing wages and not wages in the non-agricultural private sector. For the US, Hall (1975) finds wage stickiness to differ widely across sectors with services being the sector with the highest degree of wage flexibility. Second, the wage elasticity with respect to prices is restricted to one in Grubb et al. (1983) and Alogoskoufis and Manning (1988).¹³ As indicated in the first three columns in table 4, the restriction of $p^{VA} = 1$ is rejected in nearly half of the cases at the 5 per cent level. The implications of imposing the homogeneity restrictions are biased parameter estimates and the imposition of co-integration.¹⁴ Third, indirect

12. Other authors apply an other measure of real wage rigidity, where inflationary innovations may have real effects on employment via slow wage adjustment to price increases (Branson and Rotemberg (1980); Klau and Mittelstadt (1986); Bruno and Sachs (1985)). In this chapter real wage rigidity corresponds to the coefficient on the unemployment rate in the wage equation, and is termed real wage rigidity following Grubb et al. (1983).

13. Alogoskoufis and Manning (1988) estimate the wage equation with an accelerating expected price term to account for lagged wage adjustment to prices. This element, however, is not likely to affect the argument below.

14. The bias of restricting the long-run coefficient on value added prices to unity can be computed as the following. Let the wage equation for simplicity be given by

$$w_t = \alpha_1 U_t + \alpha_2 p_t^{VA} + e_t.$$

taxes, terms-of-trade, direct taxes and pay-roll taxes are not included in their models. Hence, their parameter estimates may embody an omitted variables bias to the extent that the time trend, that is included in most studies, does not account well for the omitted variables. Fourth, the estimates of Grubb et al. (1983) and Coe (1985) may be biased since the estimates are performed with unemployment rate is measured in levels and the remaining variables measured as growth rates.

The evidence that real wages probably have not become more rigid over time is at variance with the hypothesis that the non-accelerating inflation rate of unemployment, NAIRU, has increased. Most studies find NAIRU to track the actual unemployment rate closely (Coe (1985); Adams et al. (1987)). Since the unemployment rate has increased over the

Rearranging yields

$$(w/p^{VA})_t = a_1 U_t + (a_2 - 1)p^{VA}_t + e_t.$$

If the term $(a_2 - 1)$ is omitted, the least-squares estimator of a_1 is

$$\begin{aligned} \text{est}(a_1) &= \Sigma(w/p^{VA})_t U_t / \Sigma U_t^2 \\ &= \Sigma(a_1 U_t + (a_2 - 1)p^{VA}_t + e_t)_t U_t / \Sigma U_t^2 \\ &= a_1 + (a_2 - 1)\Sigma p^{VA}_t U_t / U_t^2 + \Sigma e_t U_t, \end{aligned}$$

then the expected value of the estimate of a_1 is

$$E(\text{est}(a_1)) = a_1 + (a_2 - 1)b_{12},$$

where b_{12} is the regression coefficient in the regression where p^{VA}_t is regressed on U_t . If $a_2 < 1$, the estimate of a_1 is downward biased since U_t and p^{VA}_t are likely to be positively correlated.

past two decades in all of the OECD countries, the NAIRU estimates imply that unemployment has declined to put a sufficient downward pressure on wages and that the persistent component of unemployment does not affect wages to the same extent as the temporary component of unemployment.

Why do the estimates of an increasing NAIRU and its implications for the wage equation not concur with the results of this chapter? When NAIRU is estimated as the unemployment rate free of cyclical influences, from an estimate where the unemployment rate is regressed on cyclical and structural factors, it is not surprising that it gravitates towards the actual rate of unemployment over time. In the other commonly used method, a price and wage equation are estimated and solved for the unemployment rate which is consistent with a stable rate of inflation. Most of these estimates are likely to be biased because important variables are often left out of the price and wage equations. In fact, the assumption of an increased NAIRU over the past 15 years or so is at variance with the declining real wage gap, found in the chapters 2 and 3, since the mid 1970s for most OECD countries because NAIRU to a large extent reflects the real wage gap (Adams et al. (1987)).

8 Conclusions

Most of the evidence in this chapter does not suggest that real wages have become more sticky over the past three decades in the OECD countries in contrast to the predictions made by the New Keynesian theories of unemployment. The time-series tests of whether wages have become more rigid or flexible over time, however, give results that to some extent depend on which model is employed and the choice of the split period in the spline function. This underscores the pitfalls of using only one model to test New Keynesian theories of unemployment.

Decomposition of unemployment into a persistent and a temporary component gave the result that temporary fluctuations in unemployment exert a lower downward pressure on wages than persistent unemployment for a high fraction of countries, which is the opposite of the predictions made by insider-outsider models and efficiency wage models of unemployment. This result is further supported by the pooled time-series and cross-section estimates. Finally, the failure of unemployment to put the strongest downward pressure on the warranted real product wage in the countries with the highest degree of real wage flexibility is furthermore evidence against the New Keynesian theories of unemployment.

DATA SOURCES

The wedge between consumer prices and the value-added price-deflator is computed as the ratio between the two. Direct taxes are calculated as General Government direct tax and other contributions receipts divided by GDP, from OECD's *National Accounts (NA)*. Pay-roll taxes are computed as compensation to employees *NA* divided by direct wages in the non-agricultural sectors from ILO's *Year Book*. Replacement ratios are from Chan-Lee et al. (1987).

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CHAPTER 8

HOW MUCH HAVE WAGES, MISMATCH, INCOME AND PRODUCTIVITY CONTRIBUTED TO UNEMPLOYMENT IN THE OECD COUNTRIES?

Abstract. A model to simulate changes in unemployment under different paths' of "exogenous" variables is established for 20 countries to assess factors that may have been responsible for the rise in unemployment since 1973 and why unemployment experiences have differed across countries. The simulations suggest that changes in the combined effects of aggregate demand and productivity and mismatch have been the most important factors contributing to the rise in unemployment since 1973. These factors also explain some of the cross country differences in unemployment rates.

Following the seminal paper of Layard and Nickell (1986) several country studies have attempted to account for the rise in the rate of unemployment, especially in the special issue of *Economica* on unemployment in 1986. In these studies the rise in the unemployment rate in the OECD countries since the first oil price shock has been found to be a result of too low GDP growth and changes in wage push factors which have driven the wage upward in excess of its equilibrium level. Two problems are encountered in these studies. First, the Layard and Nickell model is inadequate in many respects as discussed in chapter 5. Second, studies of individual countries cannot be easily used to account for the cross country differences in unemployment experiences.

This chapter develops a model to shed light on factors that may have been responsible for the rise in the unemployment over time and the different unemployment experiences across countries. The model is in many respects similar but more detailed and less restrictive than the model suggested in the latter part of chapter 6. The model consisting of labour demand, labour supply and wage setting is estimated to simulate the unemployment path for each country in two experiments with different sets of assumptions about changes in the "exogenous" variables determining the rate of unemployment. In the first experiment an unemployment path after 1973 is simulated with most of the "exogenous" variables assumed to grow at the yearly average growth rate

from 1961 to 1989 for the individual countries. The simulated unemployment path is then compared with the actual unemployment path. Hence, the contribution to the change in the unemployment rate as a result of the slow-down of the GDP after 1973, for instance, can be uncovered. In the second experiment the "exogenous" variables for the individual countries are assumed to follow the average value of other OECD countries. Comparing the path of the actual unemployment rate with the unemployment path simulated with every "exogenous" OECD variable gives an indication to the extent to which diverse paths' of the "exogenous" variables have been responsible for the different unemployment experiences across countries.

This model differs from that of Layard and Nickell (1986) (LN) in the following respects. First, the supply of labour is endogenous, whereas it is treated as an exogenous factor in the LN model. Second, changes in GDP and productivity have long-term effects in this model, whereas they cannot affect the unemployment rate in the LN model. Third, no cross-equation restrictions are imposed on the model in contrast the LN model. Fourth, price homogeneity is not assumed in the wage equation as in the LN model. Since the coefficient on prices is below unity in most cases, shown in the empirical section, inflation has a positive impact on employment.

2 The Model

Labour supply. Labour force participation is assumed to be a positive function of real take home pay, population of working age (15-64 years of age), POP, labour demand, L^d , and mismatch, MM,

where w^{dir} is direct wage payments, t_t the average direct tax rate on income and PE^{CPI} the expected consumer prices. Labour demand is measured as employment which is assumed to affect labour supply via discouraged worker effects. Mismatch is intended to account for changes in the composition of jobs and the persistence effect in labour supply as discussed in chapter 6.

Labour demand is given by

$$L_t^d = L^d(w_t/p_t^{\text{VA}}, \theta_t), \quad (2)$$

- +

where W is compensation to employees and p^{VA} the value-added price-deflator.

Wage equation. With lowercase letters representing logs the wage equation is given by

$$w_t = w_t(x_t, p_t^{\text{VA}}, pe_t^{\text{CPI}}, \theta_t, t_t, \zeta_t), \quad (3)$$

+ + + + + +

where ζ_t is pay-roll taxes to account for the wedge between w^{dir} and W .

3 Empirical Estimates

3.1 Specification

Stochastic specification. The equations (1) to (3) are stochastically specified as

$$l^s_t = \beta_0 + \beta_1 \text{pop}_t + \beta_2 l^d_t + \beta_3 \text{mm}_t + \beta_4 w^{\text{disp}}_t + \beta_4 w^{\text{disp}}_{t-1} + e_{1t} \quad (4)$$

$$l^d_t = \alpha_0 + \alpha_1 l^d_{t-1} + \alpha_2 (w-p)_t + \alpha_3 y_t + e_{2t} \quad (5)$$

$$w_t = \gamma_0 + \gamma_1 w_{t-1} + \gamma_2 u_t + \gamma_3 \theta_t + \gamma_4 p^{\text{VA}}_t + \gamma_5 \zeta_t + \gamma_6 t_t + \gamma_7 \tau_t + \gamma_8 \text{mm}_t + \gamma_9 \text{pop}_t + e_{3t}, \quad (6)$$

where w^{disp} is the real after tax wage, l^d is the labour demand for the whole economy whereas l^d only covers most of the private sector as discussed in the data section below, τ is the wedge between p^{VA} and consumer prices, p^{CPI} , that is the composite of terms-of-trade and indirect taxes, u the rate of unemployment as a proxy of excess demand for labour, y is GDP and e a zero-mean finite-variance disturbance term.

A time trend, or a split time trend to account for the productivity slow-down after 1973, as a proxy for labour augmenting technological progress are omitted from the

estimates of labour demand since it was positive in many instances. Since the elasticity of substitution, indicated by the negative of the long-run coefficient on the real product wage in the estimates below, is lower than one in almost all cases, a positive coefficient on the time trend indicates technological regress.¹

The dynamics of the wage and labour demand equations are restricted to the dependent variable lagged one period. The dynamics allowed for in the labour supply are limited to real disposable income since labour supply may be assumed to adjust instantaneously to the remaining explanatory variables.

1. The factor augmenting production function is given by

$$Y = Q[A(t)L, B(t)K],$$

where A and B are input efficiency parameters. Under CES technology and constant returns to scale, the factor augmenting production function becomes

$$Y = [\delta(A \exp(\lambda_L t)L)^{-\rho} + (1-\delta)(B \exp(\lambda_K t)K)^{-\rho}]^{-1/\rho},$$

where $\rho = (1 - \sigma)/\sigma$, σ the elasticity of substitution and δ a distributional parameter. Optimazation under profit maximization yields

$$p\zeta A_Y^{\rho+1} \delta (A \exp(\lambda_L t))^{-\rho} L^{-\rho-1} - W = 0, \text{ then}$$

$$L = \delta^{\sigma} (W/P^{VA})^{-\sigma} (A \exp(\lambda_L t))^{\sigma-1} Y.$$

If $\sigma < 1$, then $A \exp(\lambda_L t)$ and L are negatively related. Note, that Hicks-neutral technological progress in the Cobb-Douglas derived labour demand function, where the labour demand is a function of real wages and capital stock, may be expected to affect labour demand positively since it influences income, and hence the marginal productivity of labour, positively.

Estimation method. The instrument variable method is employed with each instrument entered contemporaneously and lagged one period. The instrumented variable is lagged one period. In the labour demand equation the arguments in the wage equation are used as instruments for real wages, and the following instruments are employed for GDP: Population of working age, cyclical and inflation adjusted fiscal balance as a per cent of potential GDP, real capital stock, M1 divided by consumer prices and world trade volume. In the labour supply equation the arguments in the labour demand equation are used as instruments for employment and the instruments used for GDP in the labour demand equation are used as instruments for real disposable income. In the wage equation the instruments for the GDP in the labour demand equation are used as instruments for the unemployment rate and M1, consumer prices and labour costs as instruments for the value-added price-deflator.

The general to specific method is employed to gain efficiency with 5 per cent significance as the bench-mark critical level. Coefficients with signs opposite to the expected sign were deleted. This occurred only for τ and is discussed in the previous chapter. The maximum likelihood estimator that takes first order serial correlation into account is employed in the estimates with first order serial correlation.

Data. Labour costs, employment in the labour demand equation and the value-added price-deflator cover private service and manufacturing. Trend productivity is estimated as a steady exponential growth between the bench-mark years 1960, 1973, 1979 and 1989. Labour demand is measured in person hours. Mismatch is measured as the accumulated value of the change in the manufacturing employment in the years that it is falling. The disadvantage of this procedure is that it does not account for the fact that some of the laid-off workers will drop out of the labour force after some years of unemployment while others find employment elsewhere. The tax rates used in this chapter are the same as the previous chapter. Data sources are detailed in chapters 3 and 7.

3.2 Empirical Estimates

Labour demand. The results of estimating equation (5), presented in table 1, are encouraging. The coefficients are significant in all the cases, except for real wages for Greece and Italy. Moreover, the magnitude of the long-run coefficients are quite similar across countries, conceivably reflecting not too dissimilar technologies. Whilst the diagnostic tests do not indicate misspecification, the tests may be invalid in the few cases where first order serial correlation is corrected for.

Table 1. Parameter estimates of labour demand. $l_t^d = \alpha_0 + \alpha_1 l_{t-1}^d + \alpha_2 (w-p)_t + \alpha_3 y_t + e_1 t$

	α_0	α_1	α_2	α_3	AC(1)	DF	R ²
Canada	2.33 (2.50)	0.24 (1.85)	-0.27 (3.01)	0.56 (6.52)	1.38	4.16*	0.994
USA#	4.65 (4.97)	0.25 (2.88)	-0.74 (4.67)	0.84 (10.79)	0.72	5.89*	0.997
Japan	1.38 (0.97)	0.76 (4.21)	-0.12 (1.70)	0.17 (1.56)	1.59	3.73*	0.983
Australia	0.38 (0.69)	0.63 (7.66)	-0.29 (7.11)	0.35 (6.63)	0.35	4.88*	0.991
Austria#	-0.82 (0.52)	0.81 (8.83)	-0.06 (1.38)	0.22 (2.16)	0.36	5.46*	0.788
Belgium#	-0.29 (0.54)	0.72 (22.15)	-0.23 (7.84)	0.24 (5.96)	0.13	5.27*	0.985
Denmark	0.08 (0.11)	0.23 (2.38)	-0.68 (8.93)	0.70 (8.56)	0.13	3.90*	0.955
Finland#	1.37 (0.93)	0.41 (3.36)	-0.37 (4.01)	0.42 (4.59)	0.38	4.74*	0.856
France	-0.10 (0.21)	0.75 (15.15)	-0.22 (5.15)	0.24 (4.56)	0.71	4.62*	0.971
Germany#	0.02 (1.04)	0.26 (4.98)	-0.68 (4.23)	0.73 (3.68)	0.56	5.74*	0.894
Greece	1.93 (4.34)	0.45 (3.28)		0.32 (3.65)	0.84	3.87*	0.987
Ireland	1.14 (0.91)	0.79 (6.64)	-0.12 (1.43)	0.11 (1.51)	1.41	3.87*	0.812
Italy	3.38 (2.63)	0.63 (4.49)		0.06 (2.63)	1.41	4.14*	0.918
Netherlands	2.90 (2.01)	0.43 (2.31)	-0.16 (3.62)	0.32 (2.75)	0.89	4.74*	0.973
Norway	2.43 (2.00)	0.45 (2.34)	-0.18 (1.79)	0.27 (2.02)	1.54	3.48*	0.712
Portugal	1.96 (1.89)	0.45 (2.94)	-0.22 (3.86)	0.32 (4.20)	0.33	5.37*	0.908
Spain	1.87 (3.04)	0.62 (11.34)	-0.74 (6.97)	0.73 (6.50)	0.48	5.60*	0.967
Sweden	1.76 (1.11)	0.65 (5.57)	-0.15 (3.03)	0.18 (2.34)	0.72	5.82*	0.784
Switzerland	3.35 (5.06)	0.33 (4.18)	-0.25 (6.09)	0.40 (6.60)	0.89	4.33*	0.929
UK	0.72 (0.44)	0.57 (5.01)	-0.54 (6.07)	0.46 (5.77)	0.93	6.12*	0.940

Notes: t-statistics in parentheses. AC(1) = Lagrange multiplier test for first order serial correlation, $t(n-1)$ -distributed under the null of no serial correlation, where n is the number of observations. DF = Dickey-Fuller test for co-integration, $t(n-k)$ -distributed (not conventional student t -distribution) under null of no co-integration, where k is the number of explanatory variables incl. the constant term. R² = the adjusted multiple correlation coefficient. Estimation period 1961-89 except for Denmark (1967-89) and Greece (1966-89).

*: Significant at the 5 per cent level (coefficients in equations excluded).

#: Corrected for first order autocorrelation by maximum likelihood.

Labour supply. The results of estimating the labour supply function are presented in table 2. The real disposable income is insignificant in all instances, as it is with most other macroeconomic studies. Labour supply is very responsive to labour demand and population of working age. The tendency for labour supply to mimic employment in Japan, Austria, Italy, Norway, Portugal and Switzerland is noteworthy and implies that changes in the level of employment have a muted impact on unemployment. The low coefficient on population of working age for most of the same set of countries is remarkable too. Mismatch is significant for seven countries, all of which have experienced a stronger decline in the manufacturing employment than the OECD average, with the exception of Japan.

Unemployment benefits have often been suggested as a contributing factor to the rise in the unemployment via higher wage claims and higher incentives to join the labour force (Bean et al. (1986); Layard and Nickell (1986); Layard et al. (1991); Dolado et al. (1986); Minford (1983)). Since replacement ratios are not readily available for all countries and span a shorter time period than considered, as discussed in the previous chapter, the residuals of the wage and labour supply equations are regressed on the replacement ratios for the years for which data are available. Replacement ratios do not explain the residuals significantly in any case suggesting that

Table 2. Parameter estimates of labour supply. $1^S_t = \beta_0 + \beta_1 \text{pop} + \beta_2 \text{lt}^d + \beta_3 \text{mm} + e_{2t}$.

	β_0	β_1	β_2	β_3	AC(1)	DF	R ²	F(Ben)
Canada #	-2.55(4.76)	0.79(5.09)	0.46(4.18)		-0.33	5.92*	0.999	0.01
USA	-0.92(1.47)	0.63(5.45)	0.43(5.29)	0.25(4.74)	1.65	4.39*	0.998	-0.04
Japan	0.11(0.46)		0.99(44.84)	0.15(3.58)	1.26	6.44*	0.997	0.04
Australia	-0.52(1.72)	0.42(4.53)	0.63(9.32)	0.13(2.99)	0.22	4.91*	0.999	-0.81
Austria #	-1.98(3.90)	0.17(2.82)	1.07(17.04)		0.84	4.28*	0.942	-
Belgium #	-0.32(0.69)	0.98(18.68)			0.24	5.57*	0.978	0.51
Denmark #	-10.01(11.37)	2.20(20.28)			0.39	4.21*	0.989	-0.08
Finland #	-0.17(0.14)	0.52(2.64)	0.48(3.09)		0.17	5.29*	0.977	-
France #	-1.03(1.54)	0.72(11.23)	0.35(3.00)		0.48	5.67*	0.993	-1.57
Germany #	-0.99(1.15)	0.54(7.02)	0.53(8.19)		1.35	3.60*	0.985	-0.94
Greece #	-1.18(0.75)	1.07(6.02)			0.23	5.54*	0.967	-
Ireland	0.01(0.01)	0.22(4.80)	0.77(7.84)	0.32(7.80)	1.28	3.45*	0.985	-
Italy	-3.15(3.88)	0.18(3.63)	1.14(16.14)	0.12(4.33)	0.43	6.07*	0.982	-0.02
Netherl.	1.38(2.08)		0.84(10.56)	0.43(8.65)	0.88	4.28*	0.973	0.01
Norway	-0.40(3.09)		1.06(60.63)		0.83	4.29*	0.992	0.44
Portugal	-1.89(5.32)		1.24(28.55)		0.03	5.02*	0.967	-
Spain #	-1.26(1.10)	0.74(9.92)	0.36(4.11)		0.93	4.35*	0.973	-0.07
Sweden	-1.76(2.35)		0.80(9.56)	0.12(2.87)	0.04	5.07*	0.991	0.29
Switz.	-0.25(0.57)		1.03(19.17)		1.15	4.10*	0.929	0.07
UK #	-6.88(7.22)	1.32(15.86)	0.32(5.14)		0.28	5.00*	0.985	-1.99

Notes: See notes to table 1. F(Ben) is a F-test for heteroscedasticity where the residuals are regressed on the replacement ratios explaining the, $F(1,n-k)$ -distributed under the null of no correlation. A minus in the front of the F-test indicates a negative relationship. A "-" indicates that replacement ratios not are available. The estimation period for the F(Ben) tests are from 1962 to 1984 except for Australia (1977-84), Belgium (1964-82), Netherlands (1967-84), Spain (1973-84) and Switzerland (1975-84).

unemployment benefits are not likely to affect labour force participation and there is unlikely to be an omitted variable bias in the parameter estimates.

Wage equation. The results of estimating equation (6) are presented in table 3. The need to correct for the presence of first order serial correlation in most of the estimates suggests specification problems. The wage explosion from the mid 1960s to the mid 1970s may be the cause of the problem. The problem is not dealt with here, in order to keep the analysis as simple as possible, and because the strong wage aspirations over this period are difficult to model. In contrast to other studies that account for the unemployment path, price homogeneity has not been assumed since biased parameter estimates result if this assumption is violated.² As appears from table 3, the hypothesis of

2. The bias of restricting the long-run coefficient on value added prices to unity can be computed as the following. Let the wage equation be given by

$$w_t = \alpha_1 X_t + \alpha_2 p_t^{VA} + e_t,$$

where X is a vector of all other variables. Rearranging yields

$$(w/p^{VA})_t = a_1 X_t + (a_2 - 1)p_t^{VA} + e_t.$$

If the term $(a_2 - 1)$ is omitted, the least-squares estimator of a_1 is

$$\begin{aligned} \text{est}(a_1) &= \Sigma(w/p^{VA})_t X_t / \Sigma X_t^2 \\ &= \Sigma(a_1 X_t + (a_2 - 1)p_t^{VA} + e_t)_t X_t / \Sigma X_t^2 \\ &= a_1 + (a_2 - 1) \Sigma p_t^{VA} X_t / \Sigma X_t^2 + \Sigma e_t X_t, \end{aligned}$$

then the expected value of the estimate of a_1 is

$$E(\text{est}(a_1)) = a_1 + (a_2 - 1)b_{12},$$

price homogeneity is rejected for half of the countries. Since the long-run coefficients on the value-added price-deflator in most instances are below one, long-run nominal price rigidity exists, and higher prices have a positive impact on labour demand.

Except for France, the trend productivity and the value-added price-deflator are significantly different from zero and the long-run coefficients on trend productivity is close to unity. Pay-roll taxes are not fully passed on into wage costs. Direct taxes influence labour costs marginally and the combined impact of terms-of-trade and indirect taxes on labour costs are negligible or non-existent. Finally, for Belgium and Germany only do replacement ratios explain the residuals, suggesting that wages are not likely to be much affected by unemployment benefits. This result concur with the results in the previous section.

4 Accounting for the Unemployment Path

Two simulation experiments are performed to shed light on factors that may have contributed to the changes in the rate of unemployment over time and across countries. In the first experiment an unemployment path after 1973 is simulated with most of the "exogenous" variables assumed to

where b_{12} is the regression coefficient in the regression where p_t^{VA} is regressed on X_t . If $a_2 < 1$, the estimate of a_1 is downward biased since X_t and p_t^{VA} are likely to be positively correlated.

Table 3. Parameter estimates of the wage equation.

$$w_t = \gamma_0 + \gamma_1 w_{t-1} + \gamma_2 u_t + \gamma_3 \theta_t + \gamma_4 p_t^{VA} + \gamma_5 \zeta_t + \gamma_6 t_t + \gamma_7 \tau_t + e_{3t}.$$

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	$\chi^2(p=1)$	AC(1)	DF	R^2	F(Ben)
Canada#	-8.85 (4.35)	0.16 (2.17)		0.62 (2.25)	0.84 (8.22)	0.37 (2.61)	0.24 (3.13)		0.00	1.48	3.87*	1.000	-0.52
USA#	-8.38 (6.25)	0.17 (1.67)		1.03 (3.53)	0.75 (6.87)	0.58 (5.71)	0.17 (3.33)		2.80	1.20	4.86*	0.955	-0.10
Japan#	-9.85 (11.42)			0.86 (11.09)	1.34 (16.19)	0.60 (4.07)			16.92*	1.70	3.75*	1.000	-0.26
Austral#	-7.94 (6.44)	0.44 (3.36)		0.58 (2.10)	0.46 (3.23)	0.79 (4.32)	0.18 (2.46)		14.31*	0.50	4.52*	1.000	0.99
Austria	-11.04 (8.56)	0.26 (2.26)		1.19 (8.96)	0.36 (1.58)	0.94 (7.85)	0.26 (1.33)		4.24*	0.73	4.48*	1.000	-
Belgium#	-9.10 (5.06)			0.79 (3.51)	0.94 (4.74)	0.28 (1.54)	0.51 (3.20)	0.60 (1.42)	0.09	1.69	3.69*	0.999	5.77
Denmark#	-8.31 (9.78)			0.99 (8.81)	1.05 (23.44)	0.56 (3.69)			1.27	2.31*	2.69	0.999	0.42
Finland#	-8.24 (10.51)			0.92 (5.88)	0.99 (14.34)	0.53 (4.10)			0.02	0.71	4.10*	1.000	-
France#	-1.53 (3.11)	0.52 (4.01)			0.67 (3.18)	0.23 (1.42)			8.58*	1.54	4.25*	1.000	-0.63
Germany#	-7.06 (7.69)			1.00 (6.18)	1.01 (6.71)	0.34 (2.01)			0.01	2.54*	3.07	1.000	17.45*

Table 3 Cont.

	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	γ_7	$\chi^2(p=1)$	AC(1)	DF	R ²	F(Ben)
Greece#	-3.60 (4.31)	0.41 (3.04)		0.77 (4.26)	0.65 (4.24)				11.97*	0.47	4.14*	1.000	-
Ireland#	-5.63 (3.63)			0.42 (1.99)	1.13 (15.89)	0.41 (2.18)			3.34	0.74	4.55*	0.985	-
Italy#	-6.04 (17.91)		-0.09 (1.67)	1.29 (14.02)	0.92 (25.98)				3.91*	1.03	4.22*	0.999	1.87
Netherl#	-8.87 (7.07)	0.51 (4.87)		0.90 (3.66)	0.34 (3.30)	0.86 (5.06)			6.30*	0.88	4.21*	0.999	0.34
Norway#	-2.58 (3.38)	0.62 (5.45)	-0.09 (3.86)	0.52 (3.55)	0.39 (3.24)				0.80	0.04	5.07*	0.999	0.35
Portugal#	-7.19 (11.02)			1.40 (8.66)	0.86 (19.27)		0.39 (2.80)		9.97*	1.49	3.87*	0.999	-
Spain#	-7.53 (2.68)			1.70 (11.82)	0.73 (8.92)		0.17 (1.99)		15.11*	0.42	3.99*	1.000	-0.14
Sweden	-9.95 (6.27)	0.34 (3.41)	-0.06 (3.62)	1.12 (7.09)	0.45 (5.53)	0.84 (4.36)			83.04*	1.62	3.67*	1.000	0.61
Switz#	-4.66 (8.11)	0.25 (3.30)		0.88 (5.96)	0.84 (7.82)				2.98	0.21	4.93*	1.000	0.91
UK	-5.38 (14.20)	0.15 (2.58)		0.75 (12.24)	0.84 (13.48)	0.26 (4.87)			0.63	0.44	5.51*	1.000	-1.28

Notes: See notes to table 1. $\chi^2(p=1)$ = Wald test for $\gamma_4/(1-\gamma_1)$ equal to one, $\chi^2(1)$ -distributed under the null of unity.

grow at the yearly average growth rate from 1961 to 1989 for the individual countries and compared with the actual unemployment path. In the second experiment the "exogenous" variables for the individual countries are assumed to follow the average value of other OECD countries.

The developments in productivity and income are independently treated in the simulation experiments; that is labour demand is simulated with an "exogenous" income path and wages are simulated with an "exogenous" productivity path. However, income and productivity are merged in the presentation below under the heading GDP because of difficulties in separating the net impact of productivity and factor usage on labour demand. In fact, income and productivity are highly correlated. To separate the effects of factor use and productivity on income, and hence labour demand, is a complex task and hence disregarded.³

3. Higher productivity affects labour demand via two channels. First, higher real product wages, caused by the productivity term in the wage equation, lower labour demand. This, in turn, increases labour productivity, due to substitution towards capital, which further increases the real wages via the wage equation. This process continues until convergence. The second effect of productivity works via factor biased technological progress. The effect can be seen by considering the labour demand function with factor augmenting technological progress repeated from footnote 1:

$$L = \delta \sigma (W/P^{VA})^{-\sigma} (A \exp(\lambda_L t))^{\sigma-1} Y,$$

where $A \exp(\lambda_L t)$ is labour augmenting progress which affects labour demand negatively for $\sigma < 1$. So if $\sigma < 1$ the substitution effect from capital to labour as a result of higher labour productivity (labour augmenting progress) is not strong enough to outweigh the displacement of labour.

Employment in the residual sector, $l_t^d - l^d$, composing of the General Government, agriculture and mining, is ignored as a potential factor which has contributed to the changes in the rate of unemployment. A change in the government employment has an impact on the unemployment path via the balanced budget multiplier. However, its impact is time variant, depending on the way in which the fiscal stimuli is financed and the strength of crowding out, which is likely to differ over time and across countries. The impact of both these effects are too difficult to identify in a simple model. Finally, the coefficient on the value-added price-deflator of 1.34 for Japan is set equal to unity and the coefficient on the population in labour supply of 2.20 for Denmark is omitted because these coefficient estimates do not make much sense.

Experiment 1. This experiment simulates the equations (4) to (6) with the hypothetical drifts in the "exogenous" variables for each country since 1973. The "exogenous" variables are divided into a group of upward trended variables and a fraction of variables that cannot increase indefinitely. The former group comprises of GDP, productivity, mismatch, population of working age and the value-added price-deflator. The paths' of these variables

Whereas the first effect can be computed, the second cannot because labour augmenting technological progress is excluded in the labour demand function and is hence likely to be captured by the income term.

after 1973 in the experiment are estimated using the average growth rates over the period 1961 to 1989. The latter group composes of pay-roll taxes, direct taxes, indirect taxes and terms-of-trade. The simulations are performed from the base value of the variables in 1973.⁴

The results of simulating model 1 are presented in table 4. The numbers in the table indicate the percentage points the unemployment would have changed from 1973 to 1989 had the "exogenous" variables followed the "artificial" paths' rather than the actual paths'. Estimation errors do not influence the results as the contributions are computed as the difference between the unemployment path simulated with the actual and the "artificial" changes in the "exogenous" variables. The results suggest that the combined effect of productivity and GDP growth slow-downs after 1973, denoted GDP in table 4, has been the main factor contributing to the unemployment rise in most of the countries. Denmark and the UK are exceptions. The results for the UK reflect the fact that the productivity and the GDP growth rate did not change much after 1973.⁵ A stronger slow-down in

4. The procedure employed here differs from other studies in the sense that the "exogenous" variables are decomposed into growing and shift variables. Other studies, for instance the studies in the special issue of *Economica* (1986), treat all "exogenous" variables as shift variables. Since income is treated cyclically in most of the studies, following the model suggested by Layard and Nickell (1986), the distinction becomes less important.

5. This finding is not at variance with the finding of chapter 5 where the GDP slow-down was found to have had severe consequences for the UK unemployment. The simulations in chapter 5 terminated in 1983 when the UK recession was at its deepest.

Table 4. Break-down of the *contributions* to the actual changes in unemployment with hypothetical changes in "exogenous" variables, 1973 to 1989.

	p ^{VA}	Taxes ¹	gdp	mm	pop	Total	Actual
----- Per cent -----							
Canada	0.18	-1.26	-3.63	-	5.09	0.38	1.99
USA	0.84	-3.56	-3.13	-1.10	2.18	-4.77	0.39
Japan	0.01	0.00	-0.08	-0.61	-	-0.68	0.99
Australia	0.77	-0.99	-3.75	-0.74	1.89	-2.82	3.93
Austria	-0.06	0.42	0.59	-	-0.63	0.32	2.04
Belgium	0.18	-3.64	-9.27	-	-0.77	-13.50	7.04
Denmark	-0.01	1.24	4.87	-	1.02	7.12	7.35
Finland	0.02	-0.86	-2.14	-	2.18	-0.80	1.18
France	-3.37	-2.05	-10.53	-	1.20	-14.75	6.83
Germany	0.04	-0.10	-1.14	-	-0.75	-1.95	5.94
Greece	0.10	-	-6.02	-	-4.64	-10.56	5.49
Ireland	-0.28	-0.02	-0.37	-3.74	-0.77	-5.18	10.08
Italy	0.00	-	0.22	-1.39	-0.03	-1.14	5.67
Netherl.	-0.10	0.32	-0.13	-2.36	-	-2.27	6.14
Norway	-0.07	-	0.01	-	-	-0.06	3.44
Portugal	-0.59	0.17	0.35	-	-	-0.07	2.38
Spain	5.23	-1.34	-22.55	-	-1.33	-19.97	16.03
Sweden	0.29	-0.28	0.23	-0.43	-	-0.19	-1.12
Switzerl.	-0.03	-	0.29	-	-	0.26	0.45
UK	0.29	1.06	2.61	-	-1.70	-2.26	3.97

1. Composite of terms-of-trade, direct and indirect taxes and payroll taxes.

productivity growth than GDP growth in Denmark after 1973 has prevented a employment growth slow-down. Spain, in contrast, did not experience a productivity slow-down after 1973 but a slow-down in factor usage.

In this experiment the "Wage push" factors have not been responsible for much of the rise in unemployment, which to a small extent reflects the inability of the wage equation to account for the real wage explosion from the mid 1960s to the mid 1970s. Terms-of-trade and taxes, composing of indirect and direct taxes and pay-roll taxes, have pushed the unemployment rate up by 0.54 per cent for all countries on average. Whereas the inflation slow-down in France has added 3.4 percentage to the rate of unemployment, the increased inflation in Spain after 1973 has generated a 5.2 percentage lower unemployment rate due to lower real wages.

Concerning labour supply factors, the slow-down in the population growth has reduced the rise in the rate of unemployment in countries which traditionally have had a high inflow of labour such as Canada, the US and Australia. The opposite has been experienced in Greece, Spain and the UK. Finally, mismatch, has contributed significantly to the rise in unemployment in Ireland, Italy and the Netherlands.

Experiment 2. This experiment simulates the unemployment paths' after 1973 assuming the "exogenous" variables follow the average paths' of all countries. For the countries

where the coefficient on employment in the labour supply equation is close to, or even above, unity the average coefficient on employment in the labour supply function for all countries is employed, that is for Japan, Austria, Italy, Norway, Portugal and Switzerland.

The results of simulating the model are presented in table 5. The countries that in particular would have gained from the hypothetical path in the "exogenous" variables, in terms of lower rates of unemployment are Spain, Ireland and Canada. Spain has been trapped by its composition of the GDP growth as discussed above. Ireland has been trapped by a decline in manufacturing employment while the rate of unemployment in Canada has been boosted by high population growth. The countries that would have lost from the hypothetical path of the "exogenous" variables are Japan, Denmark, Finland and the UK. Japan would experience higher unemployment due to lower factor using GDP growth and Denmark due to higher taxes. Finland and the UK would experience higher unemployment due to higher population growth.

The results indicate that the paths in the "exogenous" variables can explain some of the different rates of unemployment among countries. The countries that have experienced the strongest rise in the rate of unemployment have seen a relative slow GDP growth relative to the productivity growth and the strongest decline in

Table 5. Break-down of the contributions to the unemployment changes from 1973 to 1989 with the OECD average changes in the "exogenous" variables.

	p ^{VA}	Taxes	gdp	mm	pop	Total	Actual
Canada	-0.27	0.75	3.72	-	-7.57	-3.37	1.99
USA	-1.43	4.45	5.79	-1.76	-3.62	3.43	0.39
Japan	2.96	1.87	2.46	0.34	-	7.63	0.99
Australia	0.29	6.67	2.58	-1.73	-5.71	2.10	3.93
Austria	-2.00	-2.66	1.27	-	0.78	-2.61	2.04
Belgium	-0.50	-2.46	-3.80	-	6.19	-0.58	7.04
Denmark	0.33	3.86	0.72	-	-	4.91	7.35
Finland	0.00	1.73	0.78	-	3.92	6.43	1.18
France	3.86	-0.50	0.25	-	0.90	4.46	6.83
Germany	0.27	2.15	-2.65	-	2.05	1.82	5.94
Greece	0.02	-	0.01	-	-1.72	-1.69	5.49
Ireland	-0.25	0.63	0.26	-4.00	-0.96	-4.32	10.08
Italy	-0.01	-	0.24	-2.07	0.61	-1.23	5.67
Netherl.	-1.98	4.53	0.82	-4.66	-	-1.29	6.14
Norway	-0.07	-	0.60	-	-	0.53	3.44
Portugal	1.34	-1.12	1.92	-	-	2.14	2.38
Spain	3.85	1.52	-12.51	-	-2.21	-12.39	16.03
Sweden	-1.40	1.86	0.43	-1.00	-	-0.14	-1.12
Switzerl.	1.05	-	-2.15	-	-	1.10	0.45
UK	0.08	3.19	-0.99	-	9.81	12.09	3.97

manufacturing employment. Price movements, taxes and population growth, in contrast, are not much correlated with the different unemployment experiences. Comparing the last two columns of table 5 indicates only a weak correlation between the change in the rate of unemployment and the simulated changes. If the high unemployment performers, encompassing Spain and Ireland, are ignored the correlation becomes almost nonexistent. This suggests changes in the "exogenous" variables considered here have not been responsible for the differences in the rate of unemployment across countries, although they contribute to the explanation of the cross country differences.

4.1 Comparison With Results of Other Studies

The results obtained in the previous section are encouraging since they concur with some of the findings of other authors and, more importantly, are able to explain some of the conflicting results obtained in the single country and the cross-country studies. The finding that excess real wages do not account for much of the rise in the rate of unemployment concurs with the estimates of Gordon (1987), the chapters 3 and 4 of this thesis and Artus (1987) suggesting that the real wage gap has declined since the mid 1970s and has become small in the 1980s. This result is additionally in line with the findings of Glyn and Rowthorn (1988) that changes in real wages over the period 1973 to 1985 are not correlated with changes in the

rate of unemployment over the same period across countries. The importance of the manufacturing employment decline as a factor explaining some of the changes in the rate of unemployment over time and across countries concur with the results of Glyn and Rowthorn (1988).

The finding that the changes in GDP growth have been a major factor contributing to the changes in unemployment over time is not easily compared with the results of other time series studies since the data period terminates in 1983 in these studies (most of the studies in the special issue of *Economica* in 1986). That this factor additionally explains some of the different changes in the rates of unemployment across countries concur, to some extent, with the findings of Glyn and Rowthorn (1988) (their data period terminates in 1985). Glyn and Rowthorn find GDP changes barely significant at explaining unemployment changes across countries. Since the effect of GDP on labour demand is the composite of factor usage and the direct and secondary influences of productivity in the present study some discrepancy of the results are not surprising. Extreme observations presented by Spain and the US, for instance, can explain the point. Spain, on the one hand, has had a high growth in both GDP and labour productivity and hence a slow growth in employment. The US, on the other hand, has experienced a modest increase in the rate of unemployment, even though GDP growth has been low. This has occurred

because the low growth in GDP has outpaced productivity growth and as a result employment has increased.

Finally, the finding that changes in population of working age has not contributed to cross country differences in the rate of unemployment is at variance with Glyn and Rowthorn (1988). Extreme observations again may help to explain the disagreement. Ireland has seen a strong growth in the population of working age and unemployment since 1973. Switzerland and Japan, on the other hand, have seen a modest rise in the rate of unemployment and a decline in the population of working age. Since labour supply is insensitive to population of working age in all the three countries, reflected in the estimates of labour supply, changes in population do not have much effect on unemployment in the simulations in the previous section.

5 Conclusions

The chapter has established a model to simulate unemployment changes under different assumptions of the paths of the "exogenous" variables. Although the simulations suggest the rise in the unemployment and especially the cross country differences in unemployment experiences to be complex, some patterns can be traced out. First, wage push factors can explain only a modest proportion of the rise in the rate of unemployment since 1973 concurring with the fact that the disequilibrium wage

has not changed much over the same period. Second, the slow-down in the growth of GDP relative to productivity since 1973 has contributed much to the increased rate of unemployment and explains some of the different changes in the unemployment rates across countries that has occurred since 1973. Third, the decline in the manufacturing employment has been an important contributing factor behind the rise in the rate of unemployment in Ireland, Italy and the Netherlands. Fourth, different changes in the population of working age growth have not contributed to the different unemployment changes across countries. Fifth, the strong rise in the value-added price-deflator for Spain after 1973 has alleviated its unemployment problem since wages have not changed proportionally.

The policy implications of the findings are as follows. First, since wages in general do not follow prices proportionally, an expansive monetary policy may not only boost labour demand via the traditional IS/LM multiplier but also via lower real wages. Second, although declining manufacturing employment over the medium or long term may be difficult to prevent and, even if a desirable outcome, a sudden and large decline may generate higher unemployment, even though employment is growing in other sectors, and may be avoided to some extent by an appropriate mix of fiscal and monetary policy. Third, an economic policy directed towards increased productivity may have negative employment

consequences. If directed towards factor usage, it will unambiguously increase employment.

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