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Employment creation in the US and UK: an econometric comparison

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EMPLOYMENT CREATION IN THE US AND UK: AN ECONOMETRIC COMPARISON

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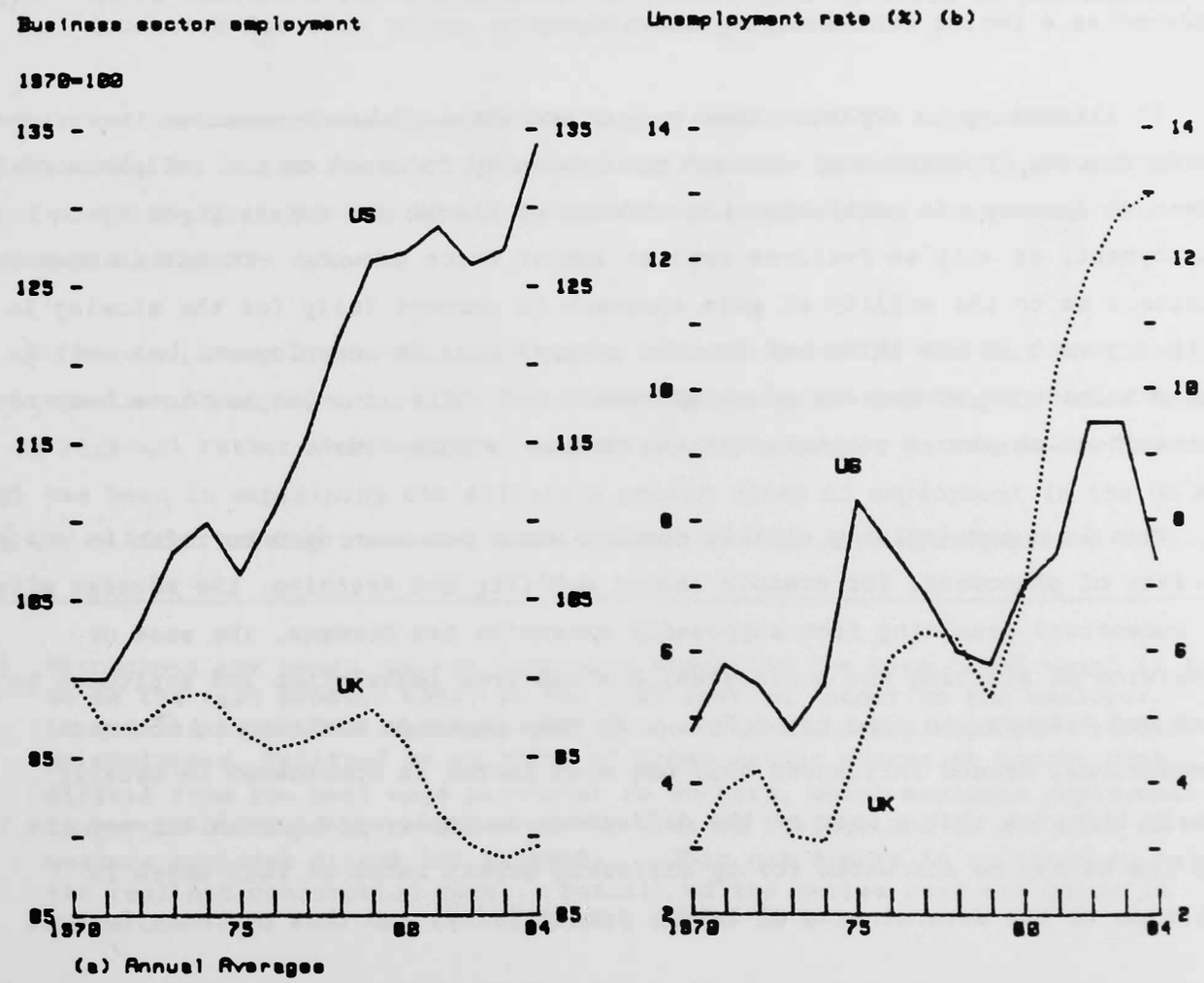
I INTRODUCTION

1 This paper considers those factors which may underlie the very different business sector employment creation performances seen in the US and the UK since the start of the 1970s. Unemployment in the US, which had averaged between 5% and 6% in the 1960s, rose very sharply during the 1974 downturn in economic activity, but fell back by much the same magnitude during the subsequent recovery. While the two recessions experienced in the early 1980s pushed the unemployment rate to a post-War record high of over 10% by the fourth quarter of 1982, it fell back by over 3% points during the next two years. Business sector employment rose by 27% between 1970 and 1979 and a further 6% in the five years to 1984.

Chart 1

Employment and unemployment in the US and UK (a)



(a) Annual Averages

(b) Unemployment rate data in chart are on OECD standardised definition; those in text are on the national definitions given in Annex C

2 Similar figures for the UK (and indeed for some other European countries) show a rather different outturn. In the UK, business sector employment fell by over 2% between 1970 and 1979, and from the cyclical peak of the latter year had fallen a further 10% by 1984. This performance was associated with a rise in the unemployment rate from a 2% average in the 1960s to 4% in the 1970s, and from 5% in 1979 to over 12% five years later. Between 1970 and 1984, business sector output in the US increased by just over 50%, while in the UK it rose by 13% over the same period.

3 One reason for the superior US job creation record is perhaps the faster growth of the labour force in that country. Chiefly for demographic and social reasons, and also because of immigration, the US has seen one of the most rapid increases in available labour amongst all the OECD countries over the past fifteen years or so, while the UK has had one of the lowest. Nevertheless, the reasons why the rapid growth of the US labour force has been absorbed into employment are of considerable interest, in view of both the UK's inability to accommodate a much smaller increase, and the fact that the pace of labour force growth is sometimes adduced as a factor behind rising unemployment.

4 In attempting to explain these very different employment creation performances, 'conventional wisdom' has typically focussed on the influence of 'demand' factors, in particular the effects of fiscal and monetary policy on employment, as well as features such as labour force growth. Doubts in some quarters as to the ability of this approach to account fully for the slowing in output growth in the 1970s and for the general rise in unemployment, as well as the simultaneous occurrence of unemployment and inflation, has led to a body of research which places greater emphasis on the 'supply-side'.

5 This is a particularly elastic concept which has been used to refer to a wide variety of phenomena, for example labour mobility and training, the adverse effect on incentives resulting from supposedly excessive tax burdens, the ease or otherwise of starting new businesses, minimum wage legislation and attitudes to work and leisure, to name but a few. In this paper in addition to the more conventional demand influences only one such factor is considered in detail, namely the view that a part of the difference in employment growth between the US and the UK may be accounted for by different growth rates of real wages in relation to the determinants of labour productivity, and thus by those factors

which determine the real wage.[1] This is not to deny that the other 'supply-side' influences may have been important. However, a comparison of labour market developments in the US and the UK is of special interest because, as is shown later, the behaviour of real wages has differed between the two countries during the period 1970-84, and particularly since around the middle of the 1970s.

6 The issue of real wages is one which encourages extreme positions to be taken. Some believe high real wage growth to be of decisive importance in reducing employment growth, while others assert that it is of no significance or even that, by raising personal income and consumption, its effect on employment is if anything beneficial. Such a complete dichotomy is not, however, necessary. The 'demand' and 'supply' side explanations can, in some respects, be seen to complement rather than contradict each other, for two separate conditions can be regarded as necessary for the existence of full-employment:

(i) there must be a sufficient level of demand for goods and services to buy the output of the fully-employed labour force;

(ii) there must be a sufficient level of profit made by firms to provide the incentive for this volume of goods to be produced.

Unemployment associated solely with the latter case could be regarded as 'classical', as it results from inappropriate relative prices of output and factor inputs, and might be contrasted with 'Keynesian' unemployment due purely to inadequate effective demand.

7 In view of these arguments, this paper takes an eclectic position on the determination of employment. It considers both 'demand' and 'supply' side factors to be relevant rather than mutually exclusive, and attempts to assess how important each has been in explaining the different growth rates of employment in the US and the UK. After briefly reviewing earlier work in this area (paragraphs 8 to 13), it

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[1] Throughout the paper, unless otherwise specified the term 'real wage' is taken to be the real product wage, ie the real cost of labour to the employer. This is defined as nominal earnings plus labour taxes and any employee benefits paid by employers, deflated by an index of gross output prices at factor cost. It differs from the real wage pertinent to workers, which excludes employment taxes, is deflated by an index of the cost of living, and in the case of a net measure excludes direct tax payments. This net figure is referred to below as the real net consumption wage. Details of the series used are given in Annex C.

describes a framework which can be used to analyse the two approaches together (paragraphs 14 to 40), and then applies this in order to quantify their respective influences on employment growth in the US and UK over the 1974-84 period (paragraphs 41 to 68). While disentangling the two effects cannot be done with any great degree of accuracy, not least because of the interdependence of the demand and supply-side factors - their interaction means, in particular, that real wages cannot be analysed independently of the strength of demand - it is suggested that it may be possible to infer the broad orders of magnitudes involved. The factors behind the changes in US and UK employment are calculated by first quantifying the influence of various proximate determinants of employment, including the real wage (see, in particular, paragraph 61). In addition, to the extent that real wages are held to affect employment growth it is important to seek to understand how the real wage was determined (paragraph 62). The results of estimating the factors behind the changes in both employment and real wages in each country are then combined to provide a more complete analysis of the two countries' employment records (paragraphs 63 to 68).

II THE HISTORICAL CONTEXT

8 For a good part of the post-War period, many economists have been rather agnostic over any connection between aggregate real wages and employment. In the General Theory [Keynes (1936)], Keynes asserted that an inverse relationship would exist between the two as an increase in effective demand would raise employment and also, in the presence of diminishing returns and perfect competition, the price of output. Given relatively inflexible nominal wages the rise in the price level would bring about a decline in real earnings.[2] However, Keynes stressed that this association did not imply that the direction of causality ran from real earnings to employment. Rather both were determined by the strength of effective demand. Subsequent research challenged the empirical validity of this position, although it did not undermine the essential arguments in the General Theory. Both Dunlop (1938) and Tarshis (1939) found no evidence of the systematic inverse cyclical relationship between money and real wages which Keynes had in mind, and the insignificance of the relationship between real wages and employment appeared to be substantiated for later periods by, inter alia, Bodkin (1969) and Geary and Kennan (1982).

9 The notion that real wages may nevertheless be a relevant factor associated with employment behaviour gained some ground in the analysis of the impacts of the 1973 and 1979 oil price shocks, initially through the construction of real wage 'gaps'. In this approach the increase in real wages 'warranted' by productivity growth (typically a normalised measure to adjust for the effect of the business cycle) and perhaps also changes in the terms of trade, is set against the actual rise in real wages over a particular period. If the latter exceeds the warranted increase, this is held to be prima facie evidence that excessive real earnings growth is eroding the profit incentive facing producers, thereby acting as a constraint on employment.

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[2] "But in the case of changes in the general level of wages, it will be found, I think, that the change in real wages associated with a change in money-wages, so far from being usually in the same direction, is almost always in the opposite direction. This is because, in the short period, falling money-wages and rising real wages are each, for independent reasons, likely to accompany decreasing employment; labour being readier to accept wage-cuts when employment is falling off, yet real wages inevitably rising in the same circumstances on account of the increasing marginal return to a given capital equipment when output is diminished". Keynes (1936), Chapter 2 II.

10 Probably the first results using such a methodology were presented by Flemming (1976), who suggested that the real net consumption wage in the UK had not adjusted sufficiently to the fall in its warranted level brought about by the terms of trade deterioration associated with the 1973 oil price shock, and similar calculations have appeared in a number of OECD publications [see, for example, OECD (1982) Table 21]. More recent work includes that of Sachs (1983) and Bruno and Sachs (1985), in which it is suggested that a higher real wage gap was of some importance in explaining inflation and unemployment in the UK and some other European countries from the 1970s, but less so in the US. A rather more sophisticated derivative of this approach was provided by Artus (1984), who attempted to estimate production functions for the manufacturing sectors of each of the seven largest industrial countries in order to investigate the role of real wages in influencing employment. In this work, the 'warranted' level of real wages is defined to be equal to the marginal product of labour at 'high employment', obtained by partially differentiating the estimated production function taking the capital stock and state of technique as given. Artus found that real wage growth in the UK over the past twenty years was well in excess of the level warranted on his definition, but this appeared not to be the case for the US. He suggested that the former development may well be responsible for the increase in unemployment in the UK since the early 1970s.

11 There are, however, a number of drawbacks associated with both the crude real wage gap, and Artus' work. Regarding the former, some forms of production function suggest that an increasing real wage gap can be consistent with continued employment growth [see, for example, Sachs (1983) and Dornbusch et. al. (1983)], and the measure provides no information about the dynamic relationship between the two variables. Moreover, it can be misleading in instances where faster growth in labour productivity is itself the result of real wage pressure which may have induced firms to substitute away from labour in the production process, and in instances where changes in demand induce changes in the real wage gap, although purely cyclical changes in aggregate demand and labour productivity ought to be abstracted from by the normalisation process, if one is used. Furthermore, real wage gap analysis is cast purely in terms of changes from some initial position which has to be assumed to approximate to one of equilibrium. Artus' work has the merit of making the nature of the production technology explicit, but it assumes that labour market equilibrium requires equality of the real wage with the marginal product of labour whereas in imperfect competition firms' perceptions of the

elasticity of demand for their output, which may change as a result of demand shocks, will also be relevant. It is perhaps not surprising that some of the empirical work in this area has produced what appear to be curious results. In Artus (op. cit.), for example, it is calculated that an increasingly large gap arose between actual and warranted earnings in Japan after the late 1960s without this seemingly having a large adverse impact on unemployment, and Gordon (1985) reported that the decline in employment in the UK since 1979 has been associated with a fall in the real wage gap.

12 A more formal approach to this issue has been to model simultaneously all of those factors which it is believed may determine employment. This type of econometric work has been to date chiefly concerned with the UK, and has produced some evidence suggestive of an inverse relationship between real wages and employment, for both the whole-economy and within the manufacturing sector alone.[3] These findings, which challenge previous perceptions of the relationship, may have arisen for a number of reasons, such as the use of more appropriate data definitions (for example the use of employees' compensation, which includes employers' social security contributions and non-wage benefits, rather than merely basic earnings, and a price series for gross or net output which is more appropriate for producers than other indices such as the CPI); a more thorough investigation of the most appropriate dynamic specification; and finally the inclusion of other variables in the labour demand function, most notably the real 'raw materials' price and the capital stock as well as on occasion, but less commonly, measures of the strength of demand, which allow the real wage term to become better determined.

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[3] See, inter alia, Lipschitz and Schadler (1984), Symons (1985), Symons and Layard (1984), and Wadhwani (1985) in which estimates of labour demand equations for the manufacturing sectors of the US and/or UK (and in some instances other industrial countries) are presented; Sargent (1978) in which the relationship between whole-economy employment and real earnings in the US is examined; Beenstock and Warburton (1982), Layard and Nickell (1985 [1]), Minford (1983) and Nickell and Andrews (1983) which report estimates of equations designed to explain employment and the real wage at the whole-economy level in the UK; Layard and Nickell (1985 [2]) and Newell and Symons (1985) which provide similar analyses for a number of OECD countries; and Dimsdale (1984) which reports labour demand equations for the UK in the inter-war period.

A summary of some of these papers is provided in H M Treasury (1985), which also reports simulations on the Treasury model designed to explore the relationship between real wages and employment in the UK. Andrews et. al. (1985) summarise simulations on a number of econometric models of the UK which illustrate labour market responses to a number of shocks.

13 In view of the fact that the determinants of the very different labour market experiences of the US and the UK have been considered by many commentators, it is clearly of interest to investigate whether this apparent rediscovery of a price elastic aggregate labour demand curve can help to explain employment trends in the two countries. This type of analysis may be worthy of further examination in particular because empirical work has typically been more successful in detecting a significant role for real wages and the wage gap in the case of the UK than for the US.[4] While the wage bargaining institutions in each country are dissimilar it may be implausible to believe that the economic forces governing employment growth are really so substantially different for two advanced industrial countries. The rest of the paper explores the matter in more detail.

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[4] See, for example, Bruno and Sachs (1985) p 172: 'In fact, the United States does stand out in the evidence given here as having relatively little direct link between real wage levels and employment or unemployment'.

III THE DETERMINANTS OF EMPLOYMENT AND REAL WAGES

(a) Employment determination

14 This section outlines the framework within which the effects of demand and 'supply-side' factors on employment are analysed. It is argued that employment would be expected to respond positively to a variety of factors affecting demand, such as a relaxation of fiscal stance or monetary policy, greater world activity or improved international competitiveness, but to fall, reflecting the effect on the level of supply desired by firms, if real wage growth exceeds that warranted by the rise in labour productivity induced by capital accumulation and technical progress. In order to consider in more detail how these influences might work it is necessary to make some assumptions about the nature of the markets within which firms operate, about the supply of labour, and concerning how firms typically behave and their production processes.

15 The typical product market facing a firm is assumed to be imperfectly competitive. That is, while product markets are competitive in the sense that most types of output are produced and sold by a reasonably large number of firms, this competition is imperfect in that the outputs of a given type of product of each of the various producers are not exactly the same, but differ in various respects, albeit in some cases very minor ones. One important implication of an imperfectly competitive market structure is that firms do not take the price at which they can sell their output as given, but instead set their own prices in the light of demand conditions and perceive that they can only sell additional output, ceteris paribus, by lowering their prices.

16 The determination of employment is analysed below by examining influences on firms' demand for labour. However, the latter will only fix the level of employment if the real wage is always such that the labour supply offered is at least equal to what firms would like to employ. In what follows it is assumed that this condition has generally held in the period considered. This may not be unreasonable given that the real wage would have been likely to respond asymmetrically to excess supply and demand in the labour market, in particular reacting more rapidly and powerfully to the latter. If at a given real wage firms'

demand for labour exceeded the supply which was forthcoming, the upward pressure on nominal and real wages arising from the workers' side of the wage bargaining process would be accentuated by firms bidding up wages. Under these circumstances, the real wage would very probably increase. This would tend to restore balance to the labour market by both raising labour supply and, as is argued below, reducing the demand for labour.

17 It is assumed that firms attempt to maximise their profits over a period of time. It is also presumed that the technology used by firms to generate gross output can be characterised by a 'putty-putty', strictly convex production function containing labour, imported inputs, the capital stock and the state of technique, where advances in the latter are disembodied. In the short-term capital and technology are regarded as predetermined. Thus, in the light of the ruling state of technique, firms are envisaged as being able to adjust continuously the amount of labour and imported goods which are combined with the extant capital stock so as to maximise their profits. The assumption of strict convexity implies that output is produced subject to diminishing returns to each factor. In these circumstances, the optimal supply which a firm would like to produce is found by equating the marginal cost of each factor with the marginal revenue which it generates. Therefore, profit maximising behaviour implies that, ceteris paribus, firms' demand for labour is negatively related to the real wage.

18 Of the other arguments of the production function, if the capital stock were to rise, the marginal (and average) productivity of labour would be increased thereby making it worthwhile to employ workers whose contribution to the firm would hitherto have been too small to warrant their employment at the ruling real wage. This suggests that the capital stock would be expected to have an independent positive effect on labour demand.

19 The overall influence of technical progress on employment also needs to be considered in this context. Technical advance embodied in new capital goods is assumed to be reflected in the measures of the capital stock used. However, disembodied technical progress can have an independent influence. It is assumed here that the latter results in equal savings in the use of labour and existing capital (ie is Hicks neutral); its effect on employment therefore depends on the net impact of three different mechanisms. First it will increase the effective size of the capital stock and so the demand for labour, but this will tend to be

offset by a rise in the effective amount of labour input associated with a given level of employment. The third effect is that by raising the efficiency of labour technical progress reduces its effective price and therefore has an impact on employment similar to a fall in the real wage. A more detailed discussion of the possible influence of technical progress is provided in Annex A.

20 The final argument of the production function is the real price of imported inputs, the effect of which on employment is ambiguous. On the one hand, a higher real price of inputs diminishes the profitability of producing output, and this effect would depress employment. On the other hand, for a given real wage such an increase implies a reduction in the price of labour relative to imported inputs. This effect would tend to raise employment.

21 It is worth noting some other mechanisms which might lead to an inverse relationship between real wages and employment at the individual firm level. First, a reduction in the real wage implies, other things being equal, an improvement in unit profitability and, especially if it results in higher output and sales, in improvements in total profits and corporate cash flow. This could impinge on employment if supply depends not just on whether the profitability of offering it is positive but also on its absolute level, and could apply especially insofar as absolute profitability affects multinational companies' decisions concerning the allocation of production between plants in different countries. Second, in the longer-run higher profitability might lead to greater corporate fixed investment, which in turn would boost the growth rate of the capital stock. The analysis above suggests that this would be beneficial to employment. Third, upward pressure on profitability may diminish attempts to reduce X-inefficiency [see Leibenstein (1966)], in particular over-manning, thus possibly boosting employment, at least in the short-run.

22 As noted above, the formal model used suggests that an increase in the capital stock would boost the demand for labour. However, it might be that some capital investment is undertaken with the intention of economising on labour input, for example because the price of labour has risen in relation to the cost of capital, and so might not induce an increase in employment. Whilst the latter possibility is ruled out of the formal model considered here by the 'putty-putty' assumption, it nevertheless represents a further mechanism which may generate an inverse relationship between real wages and employment. This would arise if an increase in

the real wage was also associated with a rise relative to the real cost of capital which in turn induced labour-saving investment that depressed the demand for labour.[5]

23 More generally, a fall in the whole-economy real wage will generally imply a reduction in the price of labour relative to that of physical goods. This suggests two final mechanisms by which an inverse relationship between real wages and employment may be produced. First, a change in the pattern of consumer demand towards more labour intensive products (especially services) may occur. Second, the attractiveness of employing workers whose functions amount to slowing the rate of depreciation of the capital stock (eg maintaining infrastructure) is increased.[6]

24 To summarise, in this framework changes in employment following a fall in the real wage may occur through two mechanisms: substitution towards labour may arise at given levels of output, and in addition the real wage fall may induce firms to expand the volume of production itself.

25 The marginal revenue curve facing a firm will depend on the shape and location of the demand curve for its output. These characteristics may be expected to be significant because the expected effect on a firm's profits of raising employment depends in part on its perception of how far its output price would have to fall to sell any additional output. The shape and location of a firm's demand curve are affected by the strength of aggregate demand, which necessitates the inclusion in the aggregate employment equation of a number of factors which may shift the level of aggregate demand, such as measures of fiscal stance, monetary policy, world activity and international competitiveness. In what follows, these demand factors are referred to collectively as 'autonomous demand'. An autonomous demand

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[5] There is a possible inconsistency between this mechanism and the employment equation derived in this paper. Labour-saving investment could raise the measured capital stock, since the latter might not accurately reflect the possible associated scrapping of obsolete, more labour-intensive techniques. This type of increase in the capital stock would not produce the rise in employment which the formal model used in this paper would predict.

[6] Although not the subject of this work, in the non-trading public sector real wages and employment would again be expected to be negatively related to some extent, because a higher level of public sector employment can be afforded from a given real tax base and given tax rates if public sector real wages fall, or rise less quickly.

stimulus which shifted the product demand curves facing firms outwards (ie such that they perceive a greater quantity of output to be demanded at the price originally ruling) might lead firms to revise upwards their perceptions of their price elasticity of product demand; this would increase the attraction of producing extra output, and hence might cause employment to be raised.[7]

26 Although the general assumption is one of imperfect competition, some product markets are oligopolistic in nature. Since, for a variety of reasons, participants in these markets will often eschew price changes in response to short-run developments, they will instead respond to demand shocks by altering employment and output. This is another reason for including autonomous demand in the aggregate demand for labour equation.

27 The above arguments suggest that, assuming a log-linear functional form, the static aggregate demand for labour equation can be written as:[8]

$$(1) \quad \ln N = CNST(1) + b \ln (W/P) + c \ln (PM/P) + d \ln K + e \ln TQ + f\, DWT + g\, FST + h\, M + i\, COMP$$

where
- N: employment
- W: nominal earnings
- P: price of gross output
- PM: nominal price of imported inputs
- K: capital stock
- TQ: state of technique
- DWT: world activity
- FST: fiscal policy
- M: monetary policy
- COMP: international relative price competitiveness

Lower FST and M imply a policy relaxation; higher DWT implies higher world output; higher COMP implies enhanced competitiveness. Expected parameter signs are $b < 0$; $d > 0$; $c, e \gtrless 0$; $f, i > 0$; $g, h < 0$.

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[7] Other factors, notably changes in industrial concentration over time, will also have affected the elasticities of demand for output facing firms. No attempt is made here to assess the importance of these effects.

[8] Equation (1) can also be derived within a perfectly competitive framework [see, for example, Symons and Layard (1984)]. This implies that firms' notional demand for labour will proximately depend only upon the real wage, the real price of imported inputs, the capital stock and the state of technique. However, Barro and Grossman (1971) and Malinvaud (1977) have suggested that firms may be prevented from selling their desired quantity of output by inadequate aggregate demand in product markets. This 'rationing' would allow factors influencing aggregate demand to affect employment directly.

(b) Real wage determination

28 Given the possible importance of the real wage (the difference between nominal wages and some measure of the level of prices) in determining employment, and the fact that it is itself endogenous to the economy, it is clearly of interest to extend the analysis in order to investigate how the real wage might be determined.

29 It is assumed that the real wage emerges as the outcome of a bargaining process between profit-maximising firms and utility-maximising unions rather than in a perfectly competitive fashion. Unions are presumed to maximise a utility function in which real net consumption wages (as defined in footnote [1]) and employment have positive effects. The assumption that the real wage is determined purely by the interaction of firms and unions is debateable, particularly for the US which has had quite a low rate of unionisation over the post-War period. The role of unions in determining US wages should not, however, be underestimated. As union earnings are typically higher than those elsewhere, the proportion of the aggregate wage bill which they account for is greater than union density measures would suggest, while union wages may also act as a yardstick for settlements in the rest of the economy (especially as some employers in the non-union sector may raise wages in order to prevent unionisation).

30 Moreover, the theoretical literature suggests that unions need not be the sole source of real wage rigidity, and that the outcome of a wage determination process from which they are absent need not be qualitatively different. For example, in efficiency wage models firms may not lower wages in the event of unemployment because of the possible adverse impact on their employees' productivity, while in implicit contract theories, risk-neutral firms insure risk-averse workers against fluctuations in employees' marginal productivity by maintaining relatively stable wages over time. Thus, the specifications of real wage equations which are derived from models in which a non-union sector is given some weight can include the same sets of variables as those described below, despite the different theoretical bases. In practice, therefore, empirical specifications tend to be similar, with four groups of variables being of relevance.[9]

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[9] See Layard and Nickell (1985 [1]), Minford (1983), Nickell (1984) and Nickell and Andrews (1983) for further discussion of the specification of real wage equations.

31 The first includes those factors which appear in the labour demand specification. For example, an increase in the capital stock for a given supply of labour would be expected to strengthen the unions' position (and so put upward pressure on the real wage) as it raises the level of the real wage consistent with unchanged unemployment. A change in the state of technique or the real price of imported inputs which raised labour demand would (ceteris paribus) similarly be expected to lead to a higher real wage. The signs of the autonomous demand variables depend on the net impact of two effects. When the firm-union bargain is struck, the nominal wage is set given some expectation of the output price which will rule over the contract period. However, because autonomous demand is, by definition, not under the control of domestic private sector agents, and the components influencing it are untrended, movements in it are not likely to be fully anticipated. If an unanticipated boost to autonomous demand occurs which induces higher than expected output prices and nominal wages are relatively sticky, then the real wage will decline. On the other hand, an increase in autonomous demand may also raise the demand for labour directly, and the tighter labour market which ensues could increase the strength of the union position, leading to a higher real wage.

32 The second group of influences on the real wage comprises those factors which affect the supply of labour available for work. In this paper, the supply of labour is measured as total non-general government employment plus the registered unemployed. If this rises, for example as a result of demographic developments, then ceteris paribus unemployment will increase. This would be expected to weaken the union position, and put downward pressure on the real wage. It is also necessary to take account of the possibility that not all of the registered unemployed may be available for work and constitute an effective potential supply of labour. This could be the case for at least two reasons. First, some of the registered unemployed might be in this state voluntarily. Changes in the replacement ratio may affect the proportion of the registered unemployed for whom this is true. Second, at any time there is some mismatch both by skill and geographical location between the unemployed and the vacancies available. The extent of this may be related to the pace of structural change in the economy, suggesting that a proxy for this might appear in an equation for the real wage. These last two variables were not included in the US wage equations, reflecting both data problems and the fact that the increase in the measured labour supply has largely been absorbed into the employed workforce, which suggests that the measured labour supply is a good indicator of the effective supply of labour.

33 The third group contains those variables, in particular taxes and the real price of imports, increases in which reduce the real net consumption wage, and if successfully resisted will increase the real product wage and reduce the demand for labour. A rise in the rate of personal direct or indirect taxes is the source of one such wedge between real product and real net consumption wages. An increase in the payroll tax rate directly boosts the real product wage; however, firms may attempt to pass at least some of this on in the form of higher gross output prices. If employees successfully resist the resulting fall in the real net consumption wage through higher nominal wage settlements, again the result will be a real product wage higher, and employment lower, than would otherwise have been the case. In the empirical work reported below the effective rates of personal direct, indirect and payroll tax are entered into the real wage equation as a single variable in which they are added together to form a measure of the overall 'tax wedge'.

34 The impact of changes in the real price of imports on the real wage depends on the balance of two influences. First, a movement in the real price of imported inputs which reduces labour demand is likely to put downward pressure on the real wage. Second, in general consumers purchase both domestically produced and imported goods. Thus, a rise in the real price of imported consumer goods reduces the real net consumption wage associated with a given real product wage. If a fall in the former is successfully resisted, this will tend to boost the latter. In this work, the real price of imported inputs to domestic production and of imported consumer goods are both proxied by the total imports deflator and hence the same 'real price of imported inputs' appears in the employment and real wage equations.

35 The fourth group includes institutional factors such as trade unions and incomes policies. Greater trade union pressure on nominal wages may amount to an increase in the weight attached to net consumption wages at the expense of that of employment, and therefore result in a higher real wage. It is also possible that some incomes policies have had at least a transitory effect on real wages.

36 The real wage equation to be estimated therefore takes the static form:

$$(2)\quad \ln(W/P) = CNST(2) + k \ln(PM/P) + m \ln K + n \ln TQ + o\,DWT + p\,FST + q\,M + r \ln LS + s\,TX + t\,TUWP + u\,RR + v\,SC + w\,COMP + y\,IPDM$$

where LS: labour supply
TX: tax wedge
TUWP: trade union wage pressure
RR: replacement ratio
SC: proxy for structural change
IPDM: incomes policy dummy

and expected parameter signs are $m, s, t, u, v > 0$; $r, y < 0$; $k, n, o, p, q, w \gtrless 0$.

(c) The effect of a change in the real wage on aggregate demand

37 It has been suggested above that a reduction in the real wage might be expected to raise employment, provided that such reduction takes place from a level where labour supply exceeds firms' demand for labour so that firms are able to expand their workforces. However, if in those circumstances a fall in the real wage induced firms to expand their employment and output, would aggregate demand be sufficient to absorb this increased supply? It is possible that a lower real wage would drive a wedge between aggregate desired supply, which would be increased, and aggregate demand, which could fall because of lower personal income and expenditure.

38 However, other factors may act to counteract this downward pressure on the level of aggregate demand. First, the direct effect of lower real wages on consumers' real incomes and spending may be offset, at least in part, by higher employment. Although the benefit to employment from lower real wages might come through fairly slowly, the same could be true of the adverse direct effect on consumer spending. Second, as noted above, lower real wages imply, other things being equal, increased unit profitability and, especially if output is higher, improvements in total profits, rates of return and cash flow. This should boost corporate fixed investment and stockbuilding. Third, if a fall in the real wage is induced by a lower nominal wage, this may lead to downward pressure on the price level. As a result, an improvement in international relative output price competitiveness may occur, which would be expected to boost the demand for domestic output.[10] A lower price level would also raise the real value of private sector holdings of both money and financial claims on the public and overseas sectors denominated in nominal terms, thereby boosting private expenditure and hence demand. In addition, it might stimulate demand through inducing lower nominal interest rates, and could cause a de facto relaxation of fiscal stance if fiscal plans are expressed in nominal terms. Equally, a lower price level might depress desired supply somewhat, as the real wage could be raised. The position eventually reached might nonetheless leave real wages lower than before the initial reduction, and both desired supply and actual demand higher.

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[10] Although this mechanism would not provide a linkage from lower real wages to increased demand for the world as a whole.

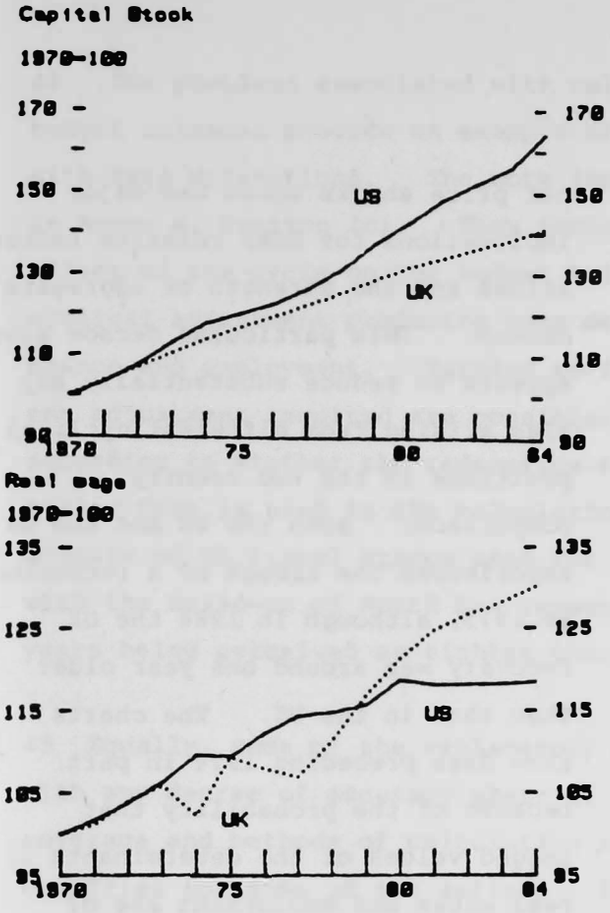
(d) The overall effect of autonomous demand on employment

39 An important issue is the implications of the theoretical model described above for the overall impact of autonomous demand on employment. In particular, if, as in the econometric estimates reported below, the coefficients in the employment and real wage equations are such that the direct effect of fiscal stimulus on employment is not fully offset by a higher real wage, it might be supposed that this implies that a permanent loosening of fiscal policy would permanently raise the level of employment. However, such an inference would not be warranted. This is because the model estimated is designed to explain the past in terms of the actual values of various autonomous demand components, without investigating the interrelationships of these components. For example, although the long-run effect in the two-equation system estimated of fiscal expansion on employment is positive other things being equal for both the US and the UK, its direct impact may have been at least partly, and possibly completely, undone if it resulted in higher interest rates.

40 Equally, the theoretical model advanced does not determine the nominal price level, and consequently does not facilitate an assessment of the implications of fiscal expansion for inflation. If the unemployment rate falls below that at which the real wage determined in the wage-bargaining process is compatible with the mark-up of prices on wages desired by firms, it is likely that the rate of inflation will rise. This means that fiscal expansion when unemployment is already at or below the so-called non-accelerating inflation rate of unemployment (NAIRU) could have a deleterious effect on inflation unless it accompanies a simultaneous fall in the upward pressure on wages being exerted by other forces, such as trade union activity. This is one reason why an attempt to shift permanently the stance of fiscal policy in an expansionary direction might be unsustainable; therefore it may be misleading to think of such a policy as being capable of permanently reducing the unemployment rate. Clearly, an assessment of this possibility, as well as derivation of estimates of the level of the NAIRU at various points in history, would require additional equations to be added to the structure outlined here.

Chart 2

Evolution of selected direct influences on employment in the US and UK



IV ESTIMATION AND RESULTS

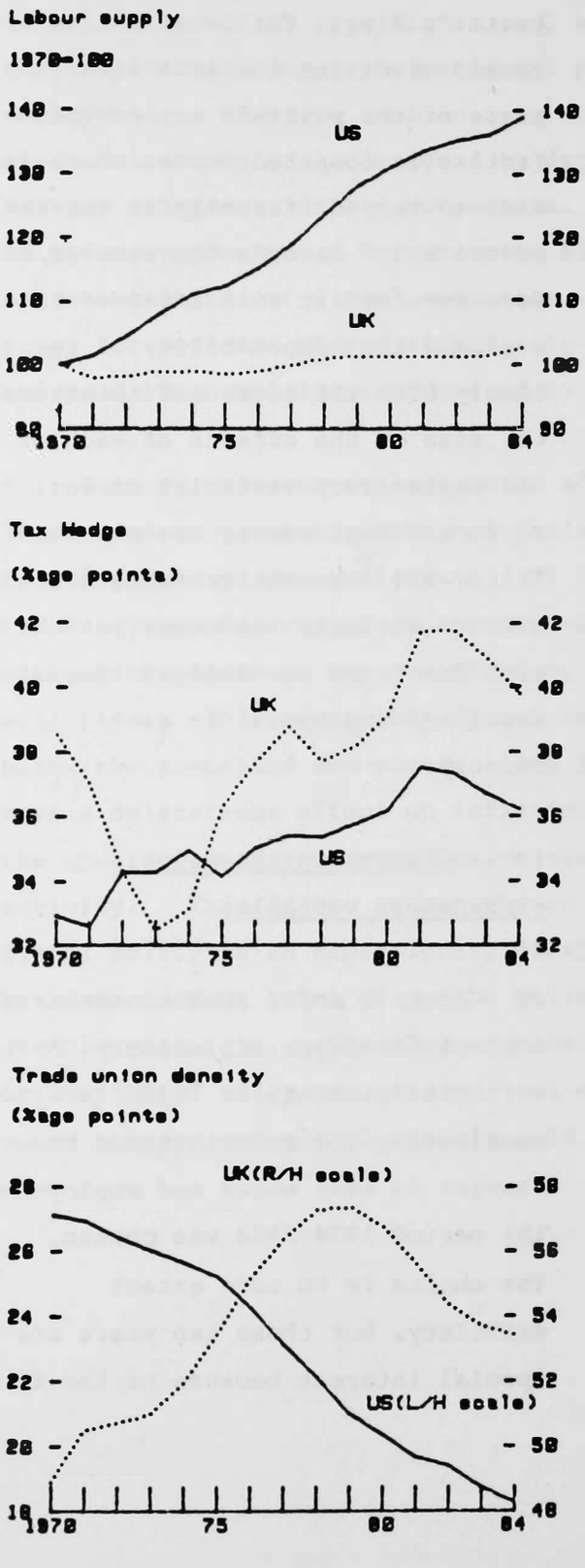
41 This section reports the use of the theory outlined above in attempting to account for the different behaviour of US and UK employment. It falls into three parts. First, the behaviour in the US and UK during the last fifteen years of the possible explanatory factors is compared to see which have evolved very differently in the two countries. Second, the results of some econometric work intended to evaluate the compatibility of the theory with the data, and to estimate the size of the effects of each of the explanatory variables on real wages and employment, are reported. Third, the econometric results are used to estimate the contributions of each factor to the changes in real wages and employment in each country.

(a) Changes in the major explanatory variables

42 Charts 2 and 3 show movements in some of the major explanatory variables since 1970. In considering the contributions to changes in real wages and employment, the period 1974-1984 was chosen. The choice is to some extent arbitrary, but those ten years are of special interest because of the two

Chart 3

Evolution of selected determinants of real wages in the US and UK



oil price shocks which had major implications for both relative factor prices and the strength of aggregate demand. This particular decade also appears to reduce substantially any bias arising from different cyclical positions in the two country comparison. Both the US and the UK experienced the trough of a recession in 1975, although in 1984 the UK recovery was around one year older than that in the US. The charts show data preceding 1974 in part because of the probability that lagged values of the determinants of real wages and employment are of importance for the current period outturn.

43 There are a number of qualifications which relate to the interpretation of the charts. Each of the explanatory factors can be measured using a variety of detailed conceptual and practical data definitions. The definitions used in the charts are the ones employed in the econometric work discussed below, which are described in detail in Annex C. These are considered to be the most appropriate of those available to us. Nevertheless, it should be emphasised that the results obtained could be sensitive to the data definitions chosen.

44 The problems associated with calculation of cyclically and inflation adjusted budget balances provide an example of the conceptual difficulties which can arise with data definitions. The more important of these problems are discussed briefly in Annex A, Section (c). They include the various difficulties of identifying the effect of the cycle on the budget balance, and the possibility of inaccurate cyclical adjustment producing some degree of spurious association between fiscal stance and employment. Turning to inflation adjustment, a variety of measures of the adjustment required are possible. Each can have a very different time profile according to whether the redemption or market value of marketable fixed coupon public debt is used in the calculation. Moreover, no adjustment is made in the measure of UK fiscal stance used for the reduction in the budget deficit associated with the build-up of North Sea revenues. This may lead to fiscal policy in recent years being perceived as tighter than it was in reality.[11]

45 Equally, some of the explanatory concepts are difficult to measure in practice with any degree of accuracy whatever the precise definitions employed, and the coverage and methods of calculation are also likely to differ between the two countries for some of the series. For instance, it is particularly difficult to measure the capital stock: the Central Statistical Office judge that the margin of error attaching to their estimates of the total UK capital stock is $\pm$ 10-20% [see CSO (1985), Table 12c].

46 These qualifications notwithstanding, the charts suggest particularly noticeable differences in the behaviour of some of the factors. It is apparent that real wage growth has been considerably lower in the US than in the UK over the period as a whole. As argued in the previous section, however, real wage growth should not be analysed in isolation but in the context of those factors which may warrant a higher level of real wages by independently raising labour productivity. Of these, the impact of the real price of imported inputs and technical progress are theoretically indeterminate, but it is noteworthy that the growth in the US capital stock has

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[11] Like the other data employed in this study, the fiscal measures used have no prescriptive content: in particular, an inflationary shock will often cause a tightening of policy as measured by a cyclically and inflation adjusted budget balance (because nominal interest rates will often not fully adjust to the rise in inflation). However, such an automatic tightening of policy may well be appropriate in the face of a shock of this nature. More generally, policy makers need to pay attention also to the level of the unadjusted budget balance, since it is this which needs to be financed.

significantly exceeded that in the UK. By itself, this should have validated a higher rate of real wage growth in the US compared with that in the UK.

47 Of the components of autonomous demand, the econometric evidence reported below suggested a role for post-tax real interest rates in explaining US real wages, but UK employment and real wages were estimated to respond to nominal interest rates. The interest rate figures are therefore not directly comparable. The measures of fiscal stance employed suggest that the level of the cyclically and inflation adjusted budget balance has exhibited a more substantial move towards contraction in the UK than in the US over the period in question. Turning to factors which may account for the slower growth of real wages in the US than in the UK, both absolutely and a fortiori relative to the growth in the capital stock, the very much faster growth in the supply of labour in the US compared with that in the UK is particularly notable. The large magnitude of the increase in US labour supply reflected in particular the impact of the post-War baby-boom generation on the US labour market, an increase in the female participation rate and immigration. There has also been a sharp decline in the measure of trade union wage pressure in the US used in this study (namely 'union density', the proportion of non-agricultural sector employees who are members of trade unions).

(b) Econometric results

48 The results of estimating the equations for US and UK employment and real wages are set out in Table 1. Details of the estimation methodology and further properties of the equations are described in the annexes. In brief, the two equations for each country were estimated using the non-linear three stage least squares technique which allowed a series of cross-equation restrictions to be implemented. The results should be interpreted with a more than usual degree of caution. In addition to the problems associated with the data mentioned above, the equations were estimated using annual data for 1952-1983/4, and this sample size does not offer a large number of degrees of freedom. Finally, in interpreting the results it should be borne in mind that some of the variables treated as exogenous to the labour market are themselves interrelated. For example, although the long-run direct effect of fiscal expansion on employment in the two-equation system considered is estimated to have been positive for both the US and the UK, as noted

in the earlier theoretical discussion its impact may have been at least partly, and possibly completely, undone if it resulted in higher interest rates. Moreover, the results do not allow the effect of a future change in fiscal policy to be adequately assessed since the overall impact which it would have is dependent on factors such as interest rates and inflation which are not explained within the model considered.

49 The results contained in the employment equations for the two countries exhibit a number of similarities. In both cases, the real wage terms are statistically significant, with the long-run elasticity of employment with respect to the real wage being -1.2 in the US and -0.8 in the UK, although the lag lengths suggest that three to four years elapsed before the total impact was felt. Of the other arguments in the production function, as expected the capital stock entered with a positive coefficient in both equations, as did the proxy for the state of technique. Capital accumulation and improvements in technology are clearly intertwined, and quantifying their separate influences is particularly hazardous. Nevertheless, the evidence that the net direct effect of the improvements in technology in both the US and UK over the past thirty five years has been to raise employment is noteworthy. This is at variance with the notion that technical innovation inevitably reduces employment.

50 In general, it was found that those variables comprising autonomous demand had a significant direct effect on employment. In the UK, more expansionary monetary and fiscal stances as well as positive shocks to world trade were all found to have had positive direct effects on employment (in the equations, higher FST implies a tighter fiscal policy). The US results indicated that the same was true of fiscal policy in that country. However, de-trended world activity appears to have affected US employment only in a transitory fashion. Despite testing a variety of different definitions, it did not prove possible to enter an interest rate term into the US employment equation.

51 The role of the real price of imported inputs and international competitiveness in the employment equations deserves comment. The price of imports relative to that of domestic gross output can be viewed as a measure of international relative output price competitiveness, and therefore in order to conserve degrees of freedom estimation started using the real price of imported inputs to capture three separate elements: the size of the income and substitution effects in the production process

Table 1: Econometric results

US Employment Equation

$$\ln N = \underset{(1.4)}{1.00} + \underset{(6.6)}{0.57}\ln N_{-1} - \underset{(2.4)}{0.17}\ln N_{-2} - \underset{(6.0)}{0.24}\ln RW - \underset{(6.0)}{0.24}\ln RW_{-1}$$

$$- \underset{(6.0)}{0.24}\ln RW_{-2} + \underset{(2.5)}{0.08}\,\Delta_1 \ln RM + \underset{(6.5)}{0.13}\ln RM_{-2} + \underset{(7.5)}{0.43}\ln K$$

$$+ \underset{(4.7)}{0.54}\ln TQ + \underset{(7.7)}{0.62}\,\Delta_1 DWT - \underset{(2.9)}{0.28}\,FST_{-2}$$

SE = 0.008 DW* = 1.936

US Real Wage Equation

$$\ln RW = \underset{(0.9)}{0.45} + \underset{(7.0)}{0.54}\ln RW_{-1} + \underset{(6.6)}{0.12}\ln RM + \underset{(5.1)}{0.28}\ln K$$

$$+ \underset{(5.3)}{0.35}\ln TQ - \underset{(2.2)}{0.20}\,DWT_{-1} + \underset{(2.6)}{0.20}\,FST_{-1} + \underset{(6.0)}{0.76}\,RI$$

$$- \underset{(4.9)}{0.39}\ln LS + \underset{(3.4)}{0.42}\,TX + \underset{(3.4)}{0.39}\,TUWP$$

SE = 0.005 DW* = 2.073

UK Employment Equation

$$\ln N = \underset{(4.2)}{1.30} + \underset{(10.2)}{0.99}\ln N_{-1} - \underset{(3.8)}{0.39}\ln N_{-2} - \underset{(5.5)}{0.32}\ln RW_{-1} - \underset{(6.5)}{0.19}\ln RM_{-1}$$

$$+ \underset{(9.5)}{0.23}\ln K + \underset{(2.0)}{0.16}\ln TQ + \underset{(2.4)}{0.12}\,DWT - \underset{(4.1)}{0.25}\,FST_{-1} - \underset{(5.7)}{0.22}\,I$$

$$- \underset{(5.7)}{0.22}\,I_{-1}$$

SE = 0.006 DW* = 1.923

UK Real Wage Equation

$$\ln RW = \underset{(2.2)}{1.56} + \underset{(4.6)}{0.63}\ln RW_{-1} - \underset{(5.9)}{0.42}\ln RM + \underset{(1.8)}{0.16}\ln RM_{-1} + \underset{(2.6)}{0.27}\ln K$$

$$+ \underset{(1.8)}{0.18}\ln TQ + \underset{(2.8)}{0.38}\,DWT - \underset{(1.7)}{0.16}\,DWT_{-1} - \underset{(2.3)}{0.40}\,\Delta_1 FST$$

$$- \underset{(1.9)}{0.29}\,I - \underset{(2.5)}{0.46}\ln LS + \underset{(4.0)}{1.33}\,\Delta_1 TX$$

SE = 0.013 DW* = 1.824

where: RW = (W/P)
RM = (PM/P)
RI = post-tax real interest rate
I = nominal interest rate

't' ratios in parentheses.

* Further and more appropriate tests for residual autocorrelation are presented in Annex B.

and also relative price competitiveness.[12] For the US it was found that higher real import prices had raised employment, implying that the effects of substitution towards labour and improved international competitiveness together outweighed the reduction in firms' incentive to produce due to the fall in the marginal profitability of production associated with higher real imported input costs. By contrast, preliminary results for the UK suggested that the effect of an increase in the real price of imported inputs was to reduce employment, implying that the depressing effect on firms' desired output outweighed the combined effects of the substitution of labour for imported inputs and enhanced competitiveness.

52 This feature of the preliminary UK results might be considered surprising, and since it could have arisen because the real price of imports did not adequately capture the impact of competitiveness, it was decided to recommence the nested sequence of tests applied to the UK employment equation with an additional variable included which explicitly measures international relative price competitiveness. The one selected was relative manufactured wholesale prices. Although UK trade is far from exclusively in manufactures, this measure was chosen both because of the greater ease of measuring competing prices for manufactured goods and because it is less highly correlated with the real price of imported inputs than some other measures which were considered. However, despite the retention of the relative manufactured wholesale price terms until near the end of the testing sequence, they never became at all significant statistically and were therefore finally excluded. As is explained in more detail in Annex B, the failure to identify a statistically well-determined effect of international competitiveness could have been a reflection of high correlations of this with other variables in the equation; however, this did not appear to be the case. A number of reasons which suggest that international relative price competitiveness may be less important than some previous econometric work on the UK has suggested are put forward in Annex B, but in view of the large movements in UK competitiveness which have occurred since 1970 it does seem likely that it has had some impact on the change in employment between 1974 and 1984. This should be borne in mind when considering the estimated contributions of various factors to the change in employment over this period which are reported below.

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[12] Thus, in terms of equation (1) the effects of COMP were initially assumed to be subsumed in (PM/P), so that the former was not entered explicity into the equations estimated. Despite the statistical testing described in paragraph 52, no explicit terms in COMP appear in the preferred US and UK econometric equations shown in Table 1. The autonomous demand rows of Tables 2-4 which follow therefore include only the estimated effects of world activity, fiscal policy and monetary policy.

53 The real wage equations should be interpreted in the context of those for employment. As explained in more detail in Annexes A and B, a number of long-run static neutrality restrictions appeared to be plausible a priori, and when tested were not rejected by the data. They were therefore imposed. This involved estimating the employment and real wage equations simultaneously subject to certain cross-equation parameter restrictions which relate to the coefficients on the capital stock, state of technique and labour supply in the real wage specifications. Thus, the coefficients on both capital and technology in the real wage equations were restricted so that the direct positive effect which the levels of both of these variables had on employment was in the long-run wholly offset by an increase in the real wage, leaving employment unchanged. In addition, the coefficient on labour supply was restricted so that an offsetting decline in the real wage ensured that the level of the labour supply did not have any effect on the unemployment rate in the long-run.

54 Reflecting these neutrality restrictions, capital accumulation and technical progress both have positive signs in the UK and US specifications, whilst in each case labour supply has a negative impact on the real wage. Of the other explanatory variables, innovations in autonomous demand were found to have had different effects on the real wage in the two countries. The results indicate that in the US a demand expansion appears to have permitted an increase in output prices relative to labour costs, thereby reducing the real wage. This is consistent with the widely held view that over much of the post-War period nominal earnings in the US have been relatively sticky. Such an inelastic response of wages with respect to price changes appears to have been one channel through which an increase in autonomous demand affected employment in that country. On the other hand, rises in autonomous demand in the UK appear to have increased the real wage, suggesting that nominal earnings were quite sensitive to a tightening of the labour market.

55 The equations also suggest that an increase in import prices relative to the price of final output was associated with a decline in the real wage in the UK but an increase in the US. These results should be interpreted in the light of the labour demand equations. In both instances, shocks to the terms of trade which are estimated to decrease employment directly also induce declines in the real wage which bolster employment. There is, therefore, some evidence in this case of flexibility in both countries' labour markets. Nevertheless, in the US as well as the UK increases in the tax wedge (as defined in paragraph 33) are estimated not to

have been absorbed solely by a decline in the real net consumption wage but also to have resulted in a rise in the real product wage. In the US, the results suggest that this latter increase was durable.

56 The different impact on real wages of the variables explicitly proxying trade union wage pressure is noteworthy. Despite the use of two possible measures, it turned out not to be possible to identify such an effect for the UK. However, it proved to be an important factor for the US, with a change in union density apparently having had a considerable impact in the same direction on US real wages. This finding is perhaps surprising given the relative size of the UK unionised sector compared to that in the US. It might be thought that the US result is at least partly spurious, since an association between union density and real wages does not prove that causality runs uniquely from the former to the latter. Rather it may be generated, at least in part, by increases in real wages inducing a rise in membership for those unions which obtain them. However, similar results were obtained when a separate measure of wage pressure, strike activity (which has a very high correlation with the union density measure), was used in the specification.

57 It should also be noted that the proxy for union wage pressure by no means captures the full economic impact of trade unions. Certainly its absence from the final UK real wage equation does not imply that they are irrelevant to the wage bargaining process. The whole structure of both the US and UK economies would be different in their absence, and so very probably would the estimates of the extent to which real wages change in the face of shocks to, inter alia, autonomous demand and movements in the terms of trade. The trade union variable is therefore best interpreted as a measure of the marginal effect of trade unions' activity rather than as a complete representation.

(c) Contributions to the changes in US and UK employment

58 Tables 2 to 4 below set out respectively the estimated contributions of each of the explanatory factors to the changes in US and UK employment between 1974 and 1984 derived from the two employment equations alone (Table 2); the determinants of the real wage contributions to the changes in employment, which are themselves generated from the results of the real wage equations (Table 3); and finally the substitution

of the results of Table 3 into Table 2 in order to calculate the overall impact on US and UK employment of those explanatory variables which are treated in this work as being determined outside the labour market (Table 4).

59 These contributions are calculated by expanding the rational lag structures of the equations estimated so that the dependent variable is expressed as a function of the contemporaneous and nine lagged terms in each of the independent variables only. The contribution of an explanatory factor to a change in the dependent variable in question can then be obtained from the change over the same period in the value of a weighted sum of lags (from zero to nine years previous) of the explanatory variable, where the weights are taken from the lag structure of the relevant equation. An important property of the equations estimated, which is relevant to interpreting the tables which follow, is that it takes a considerable time for a change in one of the explanatory factors to have its full effect on the level of employment. This is especially true of those which impinge only indirectly, by altering the real wage. For example, not only is trade union wage pressure estimated to take a number of years to affect fully the US real wage, but the real wage changes themselves then feed through to US employment with a lag. In all, the results suggest that it takes six years for 95% of the long-run impact of a permanent change in US trade union wage pressure to impinge on the level of US employment.

60 A degree of caution must be exercised in interpreting the figures in the tables, not least because they are dependent upon econometric results which, as discussed earlier, should not be regarded as precise. The numbers are best seen not as point estimates but as central values of a likely range. Reflecting the interrelationship between fiscal stance and interest rates referred to earlier, the most appropriate way to present the results obtained in all of the tables which follow is to show the estimated impact on employment and the real wage of the components of autonomous demand taken together, rather than individually.[13]

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[13] The residual rows in tables 2 to 4 reflect the fact that the employment and real wage equations do not fully account for the changes in these variables over the 1974-84 period.

Table 2: Proximate contributions to the changes in US and UK employment between 1974 and 1984

(Percentage points)

	Contribution to percentage change in employment	
	USA	UK
Capital stock	23.2	12.9
Technical progress	4.7	2.2
Real wage	-13.5	-15.3
Sub-total	14.4	-0.2
Autonomous demand	1.0	-8.3
Real price of imported inputs	4.8	-2.1
Residual	1.7	0.7
CHANGE IN EMPLOYMENT	21.9	-9.9
Memorandum item:		
Change in labour supply	25.2	3.6

61 Turning to Table 2, in the US the positive effects on employment of growth in the capital stock and technical progress are calculated to have outweighed substantially the impact of higher real labour costs. This gap appears to have been an important source of the rise in US employment, although by itself it would not have been sufficient to have caused all of the increase in US labour supply to be absorbed into employment between 1974 and 1984. No such gap was found for the UK, where the upward impetus to employment provided by capital investment and improvements in the quality of technology was wholly eroded by increases in real wages. The autonomous demand factors taken together are estimated to have had only a moderate direct impact on the growth in US employment over the period 1974-84 as a whole. By contrast, the direct effects associated with contractionary movements in the autonomous demand components in aggregate are estimated to have been of similar magnitude to the reduction in UK employment over this period, though a more complete representation of the impact of the components of autonomous demand is given in Table 4 in which their effect on the real wage is also taken into account.

62 The numbers in Table 3 suggest that capital accumulation and technical progress boosted the real wage in both countries, although the capital stock grew considerably more quickly in the US over this period. The growth in labour supply is estimated to have depressed the real wage in both the US and the UK, although this was far more marked in the former country reflecting the much faster increase there in available labour. Of the other figures in the table, a similarity between the two countries is that in both higher tax wedges are estimated to have induced a higher real wage. A notable difference, however, is that the movement in aggregate autonomous demand in the US brought about a higher real wage over the period,[14]

Table 3: Proximate determinants of the real wage contribution to the changes in US and UK employment between 1974 and 1984

(Percentage points)

	Effect on real wage contribution	
	USA	UK
Capital stock	24.5	15.1
Technical progress	6.6	4.0
Labour supply	-25.6	-2.1
Tax wedge	3.5	4.3
Trade union wage pressure	-6.9	-
Autonomous demand	2.3	-5.3
Real price of imported inputs	9.8	-2.4
Residual	-0.7	1.7
REAL WAGE CONTRIBUTION	13.5	15.3

[14] This may appear to contradict the results of the US real wage and employment equations in which higher autonomous demand was found to raise employment and reduce the real wage. However, the numbers in Tables 2 and 3 reflect the different lag structures in the two equations, as well as the absence of a direct effect of interest rates on employment in the equation estimated.

the opposite outturn to that in the UK, where an autonomous demand contraction restrained the real wage. The fall in union density in the US appears to have been associated with a weakening in the power of the trade union movement, which is estimated to have induced a lower level of real wages than would otherwise have been the case, though no impact of trade union wage pressure on UK real wages could be detected.

63 As mentioned above, the restriction that, ceteris paribus, increases in the level of labour supply in both the US and the UK are fully absorbed into employment in the long-run through the mechanism of real wage adjustments was tested, and could legitimately be imposed. Hence, as shown in Table 3, the greater increase in US labour supply relative to that in the UK is estimated to have depressed real wage growth in the former country compared with that in the UK, and indeed to have been the single most important factor behind the greater buoyancy of US employment. However, since the rapid growth of US labour supply was essentially the result of demographic and social factors, a more informative way of interpreting the results is to use them to attempt to explain why the increase in US labour supply has been absorbed into the employed workforce so much more successfully, though not completely, than has been the case for the UK. This is analysed in Table 4. The numbers are obtained by substituting the results in Table 3 into Table 2 in place of the real wage effect (and taking the difference between the change in labour supply and its impact on employment into the row 'Effect of rate of growth of labour supply' - see also paragraph 67).

64 It should be borne in mind that the results in Table 4 are conditional on the pattern of behaviour actually observed. For example, given the wage bargaining institutions which existed over the period, an increased tax wedge was calculated to have brought about higher real wages and lower employment in the US and UK (see below). However, this does not necessarily imply that higher taxes were the 'cause' of the fall in employment. Rather it could be argued that the more fundamental problem was the structure of wage bargaining in the two countries.

65 The factors underlying the gaps between growth in employment and labour supply in the US and UK were firstly the tax wedge, which is calculated to have reduced employment growth by some 4¾ points in both countries between 1974 and 1984. The results also suggest that the autonomous demand factors reduced the level of employment in both countries. In the US, this was the consequence of the effect of

Table 4: Overall (system) contributions of the identified explanatory factors to the changes in US and UK employment between 1974 and 1984

(Percentage points)

	Contribution to percentage change in employment	
	USA	UK
CHANGE IN EMPLOYMENT	21.9	-9.9
Change in labour supply	25.2	3.6
DIFFERENCE	-3.3	-13.5
OF WHICH:		
Tax wedge	-3.5	-4.3
Trade union wage pressure	6.9	-
Autonomous demand	-1.3	-3.0
Real price of imported inputs	-5.0	0.3
Effect of rates of growth of:		
(Labour supply	0.4	-1.5
(Capital stock	-1.3	-2.2
(Technical progress	-1.9	-1.8
Sub-total	-2.8	-5.5
Total explained	-5.7	-12.5
Residual	2.4	-1.0
TOTAL	-3.3	-13.5
Memorandum item:		
Change in unemployment rate (OECD standardised definition)	1.9	7.7

an induced higher real wage offsetting more favourable direct results (see footnote [14]). For the UK, the direct impact of a fall in autonomous demand was to a considerable extent counteracted by the depressing influence which this had on real wages.

66 The real price of imported inputs is estimated to have had a significant detrimental impact on US employment. The former rose very sharply at the time of the 1973 oil price shock and further in 1979 before falling in recent years. While its direct effect was to raise employment in the US, this was more than offset by the higher real wage which it brought about. For the UK, the increase in the real imported inputs price during the 1970s was less and the impact it had on employment was of a much smaller magnitude.

67 As noted above, the two-equation systems estimated for both countries were restricted to have the property that the levels of the capital stock, state of technique and labour supply had no impact on the gaps between employment and labour supply changes in the US and UK in the long-run. However, this is compatible with capital, technology and labour supply having an effect on these gaps over a particular period of time if the rates of growth of these variables are not constant [see Annex A, Section (g) for a fuller discussion of this]. The numbers in Table 4 suggest that over the 1974-84 period in both countries the changes in the capital stock and state of technique boosted employment directly by less than they depressed it indirectly through inducing a higher real wage. They also suggest that in the US the growth in labour supply directly caused a slightly greater than equiproportionate increase in employment whilst, by contrast, in the UK the rise in labour supply did not depress the real wage sufficiently to boost employment directly by an equiproportionate amount.

68 Perhaps the most notable difference between the countries indicated in Table 4 is the employment growth in the US attributed to the fall in union density, which declined by almost 10% points over the period in question to some 18% at the end. This contrasts significantly with the UK results, but as discussed earlier this variable by no means captures the full impact of trade union activity. A formal and detailed analysis of the mechanism by which the fall in union density has affected US real wages and employment is beyond the scope of this paper. It may nevertheless be useful to consider some of the factors which could underlie the decrease in density. Amongst the most commonly cited are changes in the

composition of the labour force, on an occupational basis away from blue-collar to white-collar employment, on a regional basis away from the older industrial areas, and on a demographic basis towards women and younger workers who may be less amenable to unionisation. Deregulation has also contributed to the decline in union density in industries such as trucking, airlines and communications. More generally, some commentators have viewed forces such as a diminished appeal of unionism to individual workers and the increased difficulty of union organising to have been of some importance. These factors taken together appear to have weakened the bargaining position of the trade union movement in the United States.[15]

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[15] See, for example, Bloom and Bloom (1985), Cullen (1985), Doyle (1985), Flanagan (1984) and Freeman (1980).

V CONCLUSIONS

69 The results in this paper were derived from a highly aggregated and in many respects simple model. This is one reason why the estimated contributions to the changes in employment in the US and UK over the decade starting in 1974 of the explanatory factors considered are subject to a margin of error which could be large. Moreover, the model may not indicate accurately the overall effects on employment, especially over the longer-term, of future changes in the determinants of employment. A more complex framework would doubtless allow a more thorough empirical analysis of important elements such as the treatment of expectations and the link between factor prices (notably the real wage) and aggregate demand. However, the overall properties of a larger model which might deal with these elements more thoroughly are harder to test against the data directly and yet can be very sensitive to the precise specification of a number of key equations [see, for example, Dunn et. al. (1984)]. Despite the relative simplicity of the approach, a large number of parameters had to be estimated using only a limited number of observations, which will have added a further degree of imprecision to the statistical findings.

70 These important caveats notwithstanding, it is noteworthy that some evidence was found supportive of the notion that in both the US and the UK relative factor prices, as well as the strength of autonomous demand, have been significant determinants of employment growth, and that analyses which concentrate on monocausal explanations of unemployment may be neglecting other relevant features. The results also suggest that changes in the strength of autonomous demand have themselves had some impact on relative factor prices, as well as a direct effect on activity and employment.

71 As regards the <u>direct</u> contributions to employment growth over the 1974-84 period shown in Table 2 which are derived from the econometric results, it was found that the low growth in the real wage, relative to the increase in labour productivity induced by capital accumulation and technical progress, was a significant source of the rise in employment in the US. In the UK, increases in the real wage offset all of the upward impetus to employment derived from the growth in the capital stock and technical progress. Movements in the components of autonomous demand were

calculated to have had a substantial proximate depressing effect on UK employment, although their impact was to a considerable extent offset by the downward pressure on the real wage which these movements brought about. Of the other factors determining the real wage listed in Table 3, the increase in the labour supply in the US was of considerably greater magnitude than in the UK; labour supply growth was estimated therefore to have exerted much greater downward pressure on the real wage in the US. Thus, a lower rate of growth of the real wage appears to have been a mechanism through which the rise in the supply of labour fed through to higher US employment. The results suggest that real wage growth in the US was also depressed by a decline in trade union wage pressure. Indeed, when the results of the employment and real wages equations were combined so as to obtain a more complete explanation of employment changes (Table 4) the latter phenomenon, which has been related to a variety of economic and social developments, proved to be the single most important factor behind the difference in the ability of the two countries to draw labour supply increases into employment, though by no means to the exclusion of other influences. For example, the US was adversely affected relative to the UK by a rise in the real price of imported inputs.

72 The results also indicate that there are certain features in common between the two countries concerning the determination of employment over the chosen period. In both, the rise in the tax wedge induced a higher real wage and lowered employment; in neither was the gap between real wage growth and the improvement in labour productivity brought about by increases in the capital stock and technical advance sufficiently large to cause by itself all of the increase in the labour supply to be absorbed into employment; and in both the overall impact of the autonomous demand factors was such as to reduce employment.

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ANNEX A SOME MORE DETAILED THEORETICAL ISSUES

A1 The purpose of this annex is to discuss several more detailed issues concerning the specification of the equations derived in the main paper. The equations to be estimated may be written in static form as:

Employment

(A1) $\ln N = CNST(1) + b \ln (W/P) + c \ln (PM/P) + d \ln K + e \ln TQ + f\ DWT + g\ FST + h\ M + i\ COMP$

Real wage

(A2) $\ln (W/P) = CNST(2) + k \ln (PM/P) + m \ln K + n \ln TQ + o\ DWT + p\ FST + q\ M + r \ln LS + s\ TX + t\ TUWP + u\ RR + v\ SC + w\ COMP + y\ IPDM$

(a) Measurement and expected effect of technical progress

A2 It is assumed that the effect of embodied technical advance on employment is captured by the measures of the capital stock used. However, an attempt has been made to isolate the separate influence of disembodied technical progress. The latter seems a reasonable characterisation of many of the possible causes of trend improvements in total factor productivity, such as changes in labour quality due to better education and improvements in resource allocation reflecting reduced barriers to trade.

A3 The measures of disembodied technical progress used are very imperfect. It is proxied in this work by changes in five year backward-looking moving averages of total factor productivity constructed using standard growth accounting methodology. The latter involves calculating movements in total factor productivity by comparing changes in output with measured changes in inputs of labour and capital (the exact formulae used are set out in Annex C). However, there are two notable problems with these measures of technical progress connected with the data on the capital stock. First, although in principle the capital stock data published by national statistical authorities are in constant efficiency

units[16], it is likely that the deflators for investment flows used to construct the capital stock data do not adequately separate genuine inflationary price rises from those associated with quality improvements. Thus, the capital stock figures may understate the extent of embodied technical progress. Even to make a rough adjustment for this imposes heavy information requirements, as Artus has shown in his work on the disequilibrium real wage hypothesis in manufacturing in the major seven Western industrialised countries [see Artus (1984)][17], so official published capital stock data have been used in this study. As a result, the measures of disembodied technical progress constructed will also reflect elements of technical advance which are actually embodied in the capital stock. Second, the published capital stock data are intended to measure the amount of capital extant, but at any time not all of this is being used to produce output. If the proportion of the measured capital stock which is not being used has increased through time, the extent of disembodied technical progress will tend to be underestimated because the input of capital services will be exaggerated. These two problems may tend to offset each other, but the net bias imparted to the measures of disembodied technical progress used is unknown.

A4 The expected effect of disembodied technical progress within the core of the theory of employment determination represented by equation (A1) above depends upon whether it is assumed to be neutral (ie 'Hicks neutral') or labour-saving (ie 'Harrod neutral'). If it is neutral, then for given levels of the autonomous demand factors the firm's problem is:

$$(A3)\quad \underset{N^*,\,M}{\text{Max}} \quad P.F\,(N^*, M, K^*) - (W/TQ).N^* - PM.MT$$

where: MT: volume of imported inputs; $N^* = N.TQ$; $K^* = K.TQ$

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[16] Leaving aside the possibility of the technical efficiency of capital goods once installed deteriorating with age, something which is not taken into account in gross capital stock data, and probably not adequately captured in calculations of the net capital stock extant.

[17] The adjustment involves knowing the mean age of the capital stock, which is a function of the time profile of investment and retirements, and taking a view on the annual rate of embodied technical progress which is not captured in constant price fixed investment data.

The first-order conditions for a solution to this problem yield (after adopting a log-linear functional form) a labour demand function of the form:

(A4a) $\ln (N.TQ) = b.\ln(W/P.TQ)+c.\ln(PM/P)+d.\ln(K.TQ)$

ie (A4b) $\ln N = b.\ln(W/P)+c.\ln(PM/P)+d.\ln K+(-b+d-1).\ln TQ$,

$b < o$, $d > o$

By a similar argument, labour-saving technical progress yields:

(A5) $\ln N = b.\ln(W/P)+c.\ln(PM/P)+d.\ln K+(-b-1).\ln TQ$

A5 The intuitive rationale behind these parameter restrictions is best illustrated by the neutral technical progress case. Neutral disembodied technical progress has three effects. First, it boosts the size of the capital stock measured in efficiency units, thus raising the demand for labour similarly measured (with elasticity d). However, by definition this is counterbalanced by a rise, with unit elasticity, in the supply of efficiency units of labour associated with a given level of employment. Under constant returns (which implies d=1) these two effects cancel out[18]. Third, it reduces the real price of labour per efficiency unit, thus raising the demand for labour in accordance with the elasticity of this with respect to the real wage (b).

A6 Thus, the net effect of technical progress on the profit-maximising level of employment is theoretically indeterminate. However, it can be seen from equations (A4b) and (A5) that the effects on employment of both neutral and even 'labour-saving' technical progress can be positive, although for this to be so in the latter case requires that the absolute elasticity of employment with respect to the real wage exceeds unity.

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[18] The restriction d=1 actually implies a rather strong form of constant returns, namely that this holds not only at a given point in time, but also through time. In Artus (1984), Constant Elasticity of Substitution production functions are estimated which exhibit constant returns within a given time period, but in which the 'capital intensity of production' parameter is made a linear function of the passage of time. In the cases of the US and UK (and, indeed, Japan and France) Artus estimated that the capital intensity of production in manufacturing has risen to an appreciable extent since the mid-1950s.

A7 The impact of technical progress on the real wage is discussed in the section on system neutrality below.

(b) Treatment of hours of work

A8 No account has been taken of changes in the inputs of labour and capital services arising from variations in the average number of hours worked by employees or in the utilisation of the capital stock. This is because there are serious deficiencies in the data available on average hours worked in the UK, and little information on the intensity of utilisation of the capital stock in the US and UK is available.

(c) Specification of fiscal stance variable

A9 The basic fiscal stance variable used was the budget balance both cyclically and inflation adjusted as a proportion of 'high-employment' GDP at current prices. However, it was felt that in the context of equations for employment and the real wage the budget balance might more appropriately be scaled by (current price) high employment GDP per man. The data were transformed to achieve this by multiplying the original data by indices of whole-economy labour supply.

A10 A detailed discussion of the problems involved in measuring fiscal stance, in particular using a cyclically and inflation adjusted budget balance, is outside the scope of this paper.[19] But it is nevertheless worth briefly considering the more important of these. The cyclical adjustments made in the measures of fiscal stance employed in this paper involve attempting to calculate what the budget balance relative to output would have been had the unemployment rate always been at a constant, 'high-employment' level. In practice, somewhat arbitrary assumptions are made about what constitutes the 'high-employment' level of unemployment; in particular, if this is put at a figure below that which could realistically have been achieved, the fiscal stance will be measured as more restrictive than was actually the case. A second difficulty is that the impact on the budget balance of

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[19] Many of the problems associated with cyclical adjustment of fiscal balances are noted in Ward and Nield (1978) and Hartley and Bean (1978), and those involved in inflation adjustment are discussed in Taylor and Threadgold (1979). An overview of these difficulties and some discussion of the implications of the advent of North Sea oil and gas for the measurement and formulation of fiscal policy is provided in Odling-Smee and Riley (1985).

a deviation of unemployment from the 'high-employment' level depends, in part, on why this deviation has occurred. The calculation of cyclically adjusted measures of fiscal stance generally involves making rather crude assumptions about how a 'high-employment' level of activity is hypothetically attained, and also about key relationships within the economy such as that between employment and output. Moreover, these measures make no allowance for the probability that inflation and interest rates, in particular, would have differed from their outturn levels had 'high-employment' actually been experienced. A final problem of note in this context is that if the cyclical response of taxation to nominal income is overestimated, this will result in the cyclically adjusted budget balance being shown as more contractionary than it really was during recessions, and more expansionary in cyclical upswings. This could lead to a relationship between fiscal stance and activity and employment being detected econometrically which is, in fact, at least partly spurious.

All Turning to inflation adjustment, there is once again no unique measure of the size of adjustments required. The profile through time of these can be significantly affected by whether the inflation adjustment is calculated by simply multiplying the redemption value of marketable, fixed coupon public debt by an indicator of the inflation rate, or by taking into account the shifting market value of public debt. For a given real rate of interest, the market value of a marketable fixed coupon public instrument will fall in response to a step increase in the inflation rate, and subsequently, if it was initially trading below par, appreciate more rapidly in nominal value until redemption day (if the instrument initially had a market value above par, it will subsequently depreciate less rapidly). Thus, inflation adjustment done as described using market values tends to concentrate the required adjustments into years in which the inflation rate changes significantly and hence produces a more volatile series of adjustments than that arising from focussing purely on the inflation rate and redemption values. Which method of adjustment is more appropriate depends on what is thought to determine private sector behaviour [for a fuller discussion of these different possible methods of adjustment, see Taylor and Threadgold (1979), especially paragraphs 44-52]. Another source of differences in adjustments calculated are issues related to data definitions, for example the choice of inflation index and whether or not this is averaged over a run of years before use to generate the inflation adjustments (as it should be if private sector agents react to this rather than purely the current inflation rate). Finally, if agents are thought to be less than fully rational and not immune from money illusion, it may be desirable to make

allowance for the fact that the impact on demand of changes in the inflation tax may be different from the effect of fluctuations in the adjusted budget balance arising from other sources; but the precise weight to be given to the inflation tax is clearly open to debate.

A12 A final problem with the measures of fiscal stance used is that they are not adjusted in any way for the effect on the public accounts of natural resource discoveries and their subsequent exploitation. In particular, the advent of substantial revenues from taxation of North Sea oil and gas extraction has helped to reduce the measured UK fiscal deficit, but it is not clear that this represents a tightening of fiscal policy. This is because it can be argued that the exploitation of North Sea oil and gas increased national wealth, and the appropriation of much of this by the public sector to reduce its deficit neither harmed non-North Sea output nor, given the large economic rent inherent in the pre-tax production price of North Sea oil and gas in the period considered (ie before the oil price fall at the end of 1985), North Sea output.

A13 Some concern has been expressed about the estimation of single-equations in which aggregate activity is explained partly in terms of fiscal stance, on the grounds that if the authorities operated a perfect counter-cyclical policy these equations would suggest that fiscal policy had no effect on output and employment [see Blinder and Solow (1974), especially pp 63-71]. However, this concern is misplaced provided that the other sources of cyclical variation in employment are included within the employment function (and many of these are indeed included, for example, interest rates, world activity, and the level of the real wage relative to the capital stock and state of technique). If between two periods employment is unchanged as a result of a fiscal stimulus offsetting contractionary influences then, assuming the estimation procedure is assigning sensible coefficients to the other determinants of employment, this will be 'explained' by the equation through a coefficient which implies that fiscal expansion raises employment.

(d) Measurement of monetary policy

A14 Monetary policy is regarded as having a qualitatively similar effect to fiscal policy, and therefore a variable which in some sense measures the 'stance' of monetary policy should be specified as a determinant of employment. However, measuring this 'stance' is extremely difficult. Perhaps the best that can be done

is to use the real interest rate as a proxy for the ex post stance of monetary policy, and indeed this is implemented in the US estimation. Whilst no direct effect of either real or nominal interest rates on US employment could be identified, real interest rates were estimated to affect US real wages, and hence to have an effect on employment indirectly. By contrast, although it did not prove possible to identify an effect of real interest rates on UK employment, the latter does appear to be quite powerfully directly influenced by the level of nominal interest rates, and for consistency the latter was used in the UK real wage equation as well. Whilst it is acknowledged that the nominal interest rate is not a precise indicator of the stance of monetary policy, there are a number of effects of interest rates on demand and employment which depend on their nominal level, for example:

(i) their influence on corporate fixed investment and stockbuilding through the size of companies' undistributed income. In addition, employment may be depressed directly as a result of firms' risk aversion and the increased probability of bankruptcy to which higher nominal interest rates lead;

(ii) given the existence of widespread rationing of members of the household sector in credit markets, nominal interest rates may be more relevant to spending on consumption goods and new house purchase;

(iii) revaluations of private sector holdings of outside debt, which may affect private spending, depend on nominal rather than real interest rates;

(iv) nominal rates play a key role in the phenomenon, for which there is some UK and US evidence, of shares becoming undervalued during times of high inflation, which may put downward pressure on employment through reducing the borrowing capacity of firms. This undervaluation appears to reflect the discounting of real returns using nominal interest rates and a failure to add back the gains from inflation-erosion of corporate debt into profits struck net of nominal interest payments.

Another reason why it did not prove possible to identify an effect of real interest rates on US and UK employment may be the difficulty in adequately modelling the inflationary expectations relevant to 'real' interest rates, especially when these expectations relate to long horizons, as might be the case with the decision to

purchase fixed investment goods. In particular, it is unclear to what extent the low ex post real interest rates of the 1970s were those relevant at the time to longer-term decision making.

A15 Nominal interest rates would be expected to affect UK real wages both because of their effect on the pressure of demand in the labour market and more directly through their influence on corporate cash flow and the financial position of industry generally.

A16 The use of a nominal interest rate as a factor affecting autonomous demand might be objected to on the grounds that it is, in fact, endogenous to the economy. However, in the UK case, nominal interest rates, especially short-term, are heavily influenced both by the operations of the authorities and by interest rates abroad. Both of these factors endow movements in nominal interest rates with a fair degree of exogeneity.

(e) Measurement and specification of world activity effects

A17 In order to minimise problems of endogeneity, world activity has to be measured differently for the US and UK. Reflecting the importance of the US economy, it is conceptually difficult to devise a measure of world activity or trade which is not influenced by the level of activity in the US itself; this is problematic because it is the latter which the US employment equations estimated are effectively seeking to explain. The measure used is an average, weighted by share of US exports, of domestic demand in the other majors plus that in selected Less Developed Countries which take a significant proportion of US exports. For the UK, world activity has been measured by the volume of exports of industrial countries other than itself.

A18 It was decided to explain employment using not the level of world activity but rather its deviation from trend. This reflects a presumption that changes in firms' perceptions of the price elasticity of demand for their output are more likely be brought about by unexpected shocks to world demand than by the trend expansion of world activity. The deviations from trend of the measures of world activity have been calculated as the residuals on (OLS) equations 'explaining' the logs of these in terms of quintic polynomials in time.

(f) Measurement of labour supply

A19 The measurement of the supply of labour potentially available for employment in the business sector presents a number of conceptual difficulties. The approach used here is to calculate it as the sum of business employment plus all of the registered unemployed. This implies that employment in government (and, in the US, agriculture as well) is predetermined, and in particular independent of the level of business demand for labour. In addition no account is taken of the self-employed as potential employees.

A20 A further difficulty is that this approach assumes that, on balance, the published data on registered unemployment reflect reasonably accurately the numbers not in work but genuinely seeking and available for it. In the case of the US the measure of labour supply is dominated by movements in employment rather than in the numbers unemployed. However, as noted in the main paper, this is not the case in the UK, for which it seemed desirable to add the replacement ratio and a measure of structural change, both of which may induce fluctuations in the effective availability for work of a given number of registered unemployed, as modifiers to the effect of labour supply on the real wage. The degree of structural change in the economy (which in turn would be expected to affect the extent of mismatch between the unemployed and available vacancies) has been proxied here by the sum of absolute changes in the percentage share of employment in each of eight broad industrial groupings. Of course, ideally one would like to observe the degree of mismatch between the unemployed and available vacancies directly, using a fairly fine breakdown of both of these by occupation and geographical region. However, such a calculation was outside the scope of the present study.

(g) System neutrality

A21 As noted in the main paper, it was decided to test a number of long-run static neutrality restrictions which would if accepted and imposed limit the effects of capital accumulation, technical progress and changes in labour supply on the unemployment rate [following Layard and Nickell (1985 [1])]. The restrictions tested are whether the long-run static system elasticities of employment with respect to the capital stock and state of technique were zero, and that with respect to labour supply was unity.

A22 These restrictions mean that a step change in the level of the capital stock or technology has no long-run effect on employment, whilst such a change in labour supply induces an equiproportionate change in employment in the long-run. In turn, this implies that if capital, technology or labour supply grow at constant proportional rates, then even in the short-run the first two would have no effect on employment, and the elasticity of employment with respect to labour supply would be unity. However, because the rates of growth of capital, technology and labour supply are not constant, in practice the restrictions imposed do not produce full neutrality in the sense just mentioned. For example, in the model estimated, in which the long-run static neutrality restrictions referred to above are imposed, a step increase in the steady-state growth rate of labour supply would permanently lower the ratio of employment to labour supply ie permanently raise the unemployment rate.

A23 The reason for seeking to impose the static neutrality restrictions described is that if they did not hold changes in the level of the capital stock, the state of technique and labour supply could generate ever higher, or ever lower, levels of the unemployment rate, a feature which does not seem to be borne out by historical experience over long periods of time. Admittedly, as noted above, changes in the rates of growth of capital, technology and labour supply can affect the unemployment rate even in the presence of these neutrality restrictions (because they refer to static, rather than dynamic, long-run responses), but this is less worrying from an empirical point of view since, for example, continual rises in the unemployment rate could be generated as a result of dynamic non-neutrality only by continual increases in the rate of growth of labour supply - something which is unlikely to occur.

A24 Nevertheless, the fact that only long-run static neutrality restrictions were imposed does mean that movements in capital, technology and labour supply can affect the gap between labour supply and employment growth over the period considered (see Table 4). Since the capital stock and the state of technique are treated as predetermined, and no explanation for their evolution is offered, it is perhaps fortunate that their impact on the gap between labour supply and employment growth during the period 1974-84 was similar in the US and UK. However, it does appear that the profiles of labour supply growth in these two countries over the last two decades has been such as to render the absorption of this into employment during the 1974-84 period easier in the US than in the UK.

A25 The contributions of the 'rates of growth' of capital, technology and labour supply to explaining the gaps between labour supply and employment growth in the US and UK could be reduced by imposing stronger restrictions designed to achieve long-run neutrality with respect at least to changes in the steady-state growth paths of capital, technology and labour supply (ie first-order long-run dynamic neutrality). However, this was not explored for two reasons. First, the discussion above suggests that the justification for imposing dynamic neutrality is less clear-cut than for the static analogue. Second, it appears that, even in the context of single-equation models, imposition of constraints on long-run dynamic effects can severely distort other properties of the equation [see Patterson and Ryding (1984)].

A26 The long-run static neutrality restrictions were implemented as follows. If we define x_n to be the value of parameter x at lag n, and the parameters on the lagged dependent variables in the employment and real wage equations are denoted a and j respectively, then the required cross-equation restrictions are:

1 Capital stock

(A6a) $$m_0 = [d_0/(b_0 + b_1 + b_2)] \cdot (1 - j_1)$$

2 State of technique

(A6b) $$n_0 = [e_0/(b_0 + b_1 + b_2)] \cdot (1 - j_1)$$

3 Labour supply

(A6c) $$r_0 = [(1 - a_1 - a_2)/(b_0 + b_1 + b_2)] \cdot (1 - j_1)$$

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ANNEX B ESTIMATION

(a) Some general estimation issues

B1 The data definitions and sources employed are listed in Annex C. Annual data were used because quarterly figures were not available for some of the variables considered in this study. Except where otherwise stated, the estimation period of the equations was 1952-1984 for the US and 1952-1983 for the UK.

B2 Estimation proceeded by specifying a general dynamic form, and then sequentially restricting this in the manner described in, for example, Davidson et. al. (1978) and Hendry (1979). The lags thus introduced are intended to represent a partial adjustment process, arising from the costs faced by firms in adjusting the size of their workforces. It may also be that firms determine employment in part with reference to expected future values of the various explanatory variables and that these expectations depend on a distributed lag of their past values. If the lags included in the equations do not fully capture the process by which expectations are generated, this failure may be a source of parameter instability.

B3 The imposition of long-run static system neutrality of employment with respect to the capital stock and the state of technique and a unit long-run system elasticity with respect to the supply of labour complicates the nested testing procedure because this involves non-linear cross-equation restrictions on certain parameters of the employment and real wage equations. In order to avoid repeated simultaneous estimation of the two equations subject to these restrictions, the following method was adopted. First, the employment equation was estimated using instrumental variables, treating the contemporaneous nominal wage and output price as current endogenous. Second, the real wage equation was tested down, with the parameters of the employment equation relevant to the long-run system properties referred to above treated as fixed numbers when restrictions on the latter came to be imposed. Explicit terms in price shocks were excluded from the real wage equations because it was felt that it might be at least partly through these that fluctuations in autonomous demand affected employment; hence, price shock terms could mask the effect of the latter. Nevertheless, since price shocks can occur for other reasons, part of the effect of these may appear in the equation

disturbance, which could therefore be correlated with any current dated variable capable of inducing a shock [this is emphasised in Nickell and Andrews (1983)]. As a result, the only current dated variables used as instruments in estimating the real wage equations are the capital stock and state of technique, both of which are treated throughout as predetermined. Finally, the preferred employment and real wage equations were re-estimated simultaneously using non-linear three stage least squares (NL3SLS) with all relevant cross-equation restrictions imposed. In the NL3SLS estimation again the only current dated variables used as instruments were those regarded as predetermined ie the capital stock and stock of technique.[20]

B4 A final issue concerns the order of dynamics used as a starting point in the estimation. Despite using estimation periods starting in 1952 the number of potential explanatory variables means that the order of dynamics should be kept as low as possible so as to conserve degrees of freedom. However, some initial experiments with the data suggested that whereas a maximum of one lag of the independent variables would suffice for the UK estimation, two lags of some of the explanatory variables would need to appear in the most general equations considered for the US.

(b) US results

(i) Employment

B5 The first issue addressed was whether (disembodied) technical progress in both the US and UK is better modelled as neutral or as purely labour-saving. These alternative assumptions imply different formulae for measuring technical progress and, at least within the core of the theoretical framework used, different parameter

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[20] The instruments used to obtain single-equation estimates of the employment equations were all of the variables in the most general employment function considered other than the contemporaneous nominal wage and output price, together with lagged labour supply, the current and lagged tax wedges, lags of the proxy for trade union wage pressure and, for the UK, contemporaneous values of the replacement ratio and the proxy for structural change. In estimating the real wage equations the instrument set was as for the employment equation except that all current dated variables other than the capital stock and state of technique were treated as current endogenous. In the UK case, additional lags of some of the instruments used to estimate the employment equation were specified as instruments in place of the current dated variables which could not be employed as instruments for the real wage equation. The non-linear three stage least squares estimation utilised the set of instruments employed for obtaining single-equation estimates of the real wage equations.

restrictions (see paragraph A4 on the latter). Since the assumption of neutrality seems more appealing a priori, no formal testing of the non-nested alternatives was undertaken. Instead, the most general employment equations considered were estimated using both assumptions to see if either appeared to be clearly more compatible with the data. Since this turned out not to be the case for either the US or UK, the assumption of neutrality was adopted for both countries.

B6 The most general US employment specification estimated is shown as (A) in Table B1. The use of two lags of many of the explanatory variables means that there are rather few degrees of freedom in this equation. This no doubt accounts for the imprecision with which many of the parameters are estimated, something to which the zero long-run static response of employment with respect to fiscal stance, and positive response to real interest rates, may be due. Similar remarks apply to the most general forms considered of the other equations estimated in this study.

B7 Starting with equation (A), world activity at lags zero and one were entered as a first difference, interest rates in the current year and fiscal stance in the current and previous year were sequentially excluded because they had the wrong signs, and the current and first lags of the real imported inputs price were entered as a first difference. These restrictions were highly compatible with the data: the highest 't' ratio for a single step was 1.1, except for the removal of the current level of interest rates (t=1.7). Next, without violation of the data, each of the real wage terms was constrained to have the same coefficient [CHISQ (2) = 0.2]. Testing down continued by removing the remaining interest rate terms, which were economically and statistically insignificant, and the second lag of world activity. The highest 't' ratio for one of these latter steps was 0.9.

B8 Finally, the parameter restrictions implied by the hypotheses of neutral technical progress and constant returns to scale were tested. The restriction implied by the former [equation (A4b)] was not rejected (t=0.9). However, the hypothesis of constant returns, defined here as a unit long-run elasticity of employment with respect to the capital stock, was rejected whether or not it was tested using an equation embodying the restriction associated with neutral technical progress as the maintained form [CHISQ (1) = 28.5 and 20.0 respectively]. The latter maintained form was used because of the difficulties inherent in separating the effects of technical progress and capital accumulation [see Annex A, Section (a)]. The rejection of the constant returns hypothesis might have arisen because the capital stock data do not accurately measure inputs of capital services into production. Reflecting the testing undertaken, the preferred employment

Table B1: US employment equations

Equation	(A) IV		(B) IV		(C) NL3SLS	
lnN_{-1}	0.57	(2.3)	0.62	(6.3)	0.57	(6.6)
lnN_{-2}	-0.29	(2.0)	-0.24	(2.7)	-0.17	(2.4)
lnRW	-0.59	(1.2)	-0.20	(4.1)	-0.24	(6.0)
$lnRW_{-1}$	0.44	(0.8)	-0.20	(4.1)	-0.24	(6.0)
$lnRW_{-2}$	-0.63	(1.2)	-0.20	(4.1)	-0.24	(6.0)
lnRM	0.05	(1.0)	0.05	(1.6)	0.08	(2.5)
$lnRM_{-1}$	-0.01	(0.1)	-0.05	(1.6)	-0.08	(2.5)
$lnRM_{-2}$	0.10	(1.9)	0.12	(5.2)	0.13	(6.5)
lnK	0.52	(2.0)	0.43	(6.4)	0.43	(7.5)
lnTQ	0.57	(2.2)	0.41	(2.9)	0.54	(4.7)
DWT	0.71	(2.4)	0.62	(6.8)	0.62	(7.7)
DWT_{-1}	-0.70	(3.3)	-0.62	(6.8)	-0.62	(7.7)
DWT_{-2}	0.25	(0.9)				
FST	0.20	(1.2)				
FST_{-1}	0.30	(1.2)				
FST_{-2}	-0.49	(2.3)	-0.32	(2.9)	-0.28	(2.9)
RI	0.58	(1.7)				
RI_{-1}	-0.22	(0.9)				
RI_{-2}	-0.09	(0.4)				
CNST	1.58	(1.1)	1.78	(1.9)	1.00	(1.4)
Test statistics						
-2 R	0.998		0.998			
SE	0.010		0.009		0.008	
DW	2.179		2.138		1.936	
AR (1)*	5.8		0.9			
Long-run static solution coefficients						
lnRW	-1.08		-0.97		-1.18	
lnRM	0.19		0.20		0.22	
lnK	0.71		0.70		0.71	
lnTQ	0.79		0.67		0.90	
DWT	0.34		0		0	
FST	0.01		-0.52		-0.46	
RI	0.36		0		0	

where:
- RW: own-product real wage
- RM: own-product real price of imported inputs
- K: capital stock
- TQ: state of technique
- DWT: deviation from trend of world activity
- FST: cyclically and inflation adjusted budget balance relative to output per man at current prices (positive effect of fiscal expansion on employment implies negative sign)
- RI: post-tax real interest rate

* This is the test for serial independence of the equation residuals against the alternative that they are generated by a first-order autoregressive process which is suggested in Godfrey (1976) for use with dynamic simultaneous equation models. Under the null hypothesis, the statistic is asymptotically distributed as a CHISQ (1) variate.

equation is that incorporating the restriction associated with neutral technical progress, but not that implied by constant returns. The preferred equation estimated by single-equation methods appears as (B) in Table B1. The result of re-estimating this simultaneously with the preferred real wage equation is shown in column (C).

B9 The preferred equation contains no term which might capture the stance of monetary policy. The nested testing reported above was undertaken using a real post-tax interest rate, but it was thought worthwhile to explore whether any effect of either pre-tax real rates or nominal rates could be identified. However, this turned out not to be the case.

(ii) Real wage

B10 The most general US real wage equation considered appears as (D) in Table B2.[21] This was restricted by first removing the second lagged dependent variable (t=0.5), and then imposing the long-run system properties discussed in paragraphs A21-A26, to yield equation (E). The latter restrictions were in accord with the data: CHISQ (3) = 4.6, against CHISQ (3), 5% = 7.8. Subsequent testing down involved a sequence of exclusion restrictions, in which the first lag of the tax wedge, current fiscal stance, the first lag of the real price of imported inputs, contemporaneous de-trended world activity, fiscal stance two years previously and the first lag of real interest rates were removed in turn. The highest 't' ratio for a single one of these latter steps was 1.3. The preferred US real wage equation estimated by single-equation methods which resulted is shown as (F) in Table B2; the same equation estimated simultaneously with the preferred employment function is set out as (G).

(c) UK results

(i) Employment

B11 The most general equation considered appears as (H) in Table B3. Two features of this equation are notable. First, monetary influences on autonomous demand are captured by nominal interest rate terms. As mentioned in Annex A, this

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[21] This is not rejected as a valid reparameterisation of an even more general form in which the nominal wage is the dependent variable and all other terms in nominal wages and the output price enter freely: CHISQ (3) = 1.7.

Table B2: US real wage equations

Equation	(D) IV		(E) IV		(F) IV		(G) NL3SLS	
$lnRW_{-1}$	0.27	(0.5)	0.56	(3.7)	0.58	(7.0)	0.54	(7.0)
$lnRW_{-2}$	0.26	(0.5)						
lnRM	0.13	(2.5)	0.10	(2.9)	0.13	(5.6)	0.12	(6.6)
$lnRM_{-1}$	-0.02	(0.2)	0.03	(0.7)				
lnK	-0.20	(0.3)	0.32		0.31		0.28	(5.1)
lnTQ	0.69	(2.5)	0.30		0.29		0.35	(5.3)
DWT	0.08	(0.4)	0.07	(0.6)				
DWT_{-1}	-0.13	(0.5)	-0.14	(1.1)	-0.21	(2.0)	-0.20	(2.2)
FST	-0.38	(0.7)	0.05	(0.3)				
FST_{-1}	0.11	(0.4)	0.21	(1.8)	0.21	(2.2)	0.20	(2.6)
FST_{-2}	0.14	(0.7)	-0.13	(1.3)				
RI	0.60	(1.3)	0.81	(4.1)	0.73	(5.1)	0.76	(6.0)
RI_{-1}	0.36	(1.0)	-0.03	(0.2)				
lnLS	0.14	(0.2)	-0.45		-0.44		-0.39	(4.9)
TX	1.19	(1.6)	0.38	(1.2)	0.40	(2.8)	0.42	(3.4)
TX_{-1}	-0.06	(0.1)	0.05	(0.2)				
TUWP	0.57	(1.3)	0.37	(2.1)	0.36	(2.8)	0.39	(3.4)
CNST	-4.02	(1.1)	1.12	(2.6)	1.07	(4.0)	0.45	(0.9)
Test statistics								
R^2	0.999		0.999		0.999			
SE	0.009		0.007		0.007		0.005	
DW	2.146		2.034		1.873		2.073	
AR (1)	0.1		0.9		0.3			
Long-run static solution coefficients								
lnRM	0.24		0.29		0.30		0.27	
lnK	-0.44		0.72		0.72		0.60	
lnTQ	1.49		0.69		0.69		0.76	
DWT	-0.09		-0.14		-0.49		-0.44	
FST	-0.28		0.31		0.49		0.44	
RI	2.06		1.77		1.74		1.64	
lnLS	0.30		-1.04		-1.04		-0.84	
TX	2.43		0.98		0.94		0.91	
TUWP	1.22		0.84		0.87		0.84	

where: LS: labour supply
TX: tax wedge
TUWP: trade union wage pressure

reflects a lack of success in identifying any effect of real interest rates on UK employment. Second, an explicit term in international relative output price competitiveness is included in the specification.[22] The reason for this is discussed in Section (e) of this Annex.

B12 Equation (H) was sequentially restricted by (in turn) excluding the contemporaneous fiscal balance term, which had an implausible sign, constraining the nominal interest rate terms to have the same coefficients, excluding the contemporaneous real price of imported inputs and real wage and finally removing the lagged deviation from trend of world activity. The highest 't' ratio testing the validity of these restrictions was, for an individual step, 0.6. Next, the contemporaneous competitiveness term was excluded because it had the wrong sign (t=0.8), and since the lag of competitiveness, although correctly signed, was statistically ill-defined this too was eliminated (t=0.9).

B13 At this stage, the restriction implied by neutral technical progress [Equation (A4b)] was imposed, and found to be easily accepted by the data (t=0.6). Finally, the issue of constant returns was investigated. Taking the equation incorporating the neutral technical progress restriction as the maintained form, the hypothesis of CRS was rejected [CHISQ (1) = 7.0]. Despite this, as with the US work, it was decided to test the CRS hypothesis further using an equation without the restriction implied by neutral technical progress imposed as the maintained form. Using this test, CRS was marginally not rejected: CHISQ (1) = 3.2.

B14 It was nevertheless decided to regard the equation with the restriction implied by neutral technical progress, but not CRS, imposed [Equation (I)] as the preferred specification. This reflected the facts that in the unconstrained estimation the long-run capital stock elasticity fell well short of unity; that, partly as a result, imposing CRS led to major changes in some of the other parameters; and that the restriction associated with neutral technical progress was highly compatible with the data. Another factor influencing this decision was that the CRS restriction might not hold in the data being used even if production is actually subject to constant returns. The result of estimating an equation with the form of (I) simultaneously with the preferred real wage specification appears as (J) in Table B3.

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[22] The contemporaneous price of UK manufactured exports was treated as current endogenous.

Table B3: UK employment equations

Equation	(H) IV		(I) IV		(J) NL3SLS	
lnN_{-1}	0.99	(4.6)	0.99	(8.5)	0.99	(10.2)
lnN_{-2}	-0.36	(1.8)	-0.36	(2.8)	-0.39	(3.8)
lnRW	-0.04	(0.3)				
$lnRW_{-1}$	-0.25	(1.5)	-0.34	(4.3)	-0.32	(5.5)
$lnRW_{-2}$						
lnRM	0.02	(0.1)				
$lnRM_{-1}$	-0.18	(2.5)	-0.18	(5.0)	-0.19	(6.5)
$lnRM_{-2}$						
lnK	0.17	(0.7)	0.24	(8.1)	0.23	(9.5)
lnTQ	0.24	(0.5)	0.21	(1.8)	0.16	(2.0)
DWT	0.12	(1.1)	0.15	(2.6)	0.12	(2.4)
DWT_{-1}	-0.03	(0.5)				
DWT_{-2}						
FST	0.05	(0.3)				
FST_{-1}	-0.24	(1.5)	-0.22	(2.8)	-0.25	(4.1)
FST_{-2}						
I	-0.20	(1.4)	-0.24	(4.6)	-0.22	(5.7)
I_{-1}	-0.31	(1.5)	-0.24	(4.6)	-0.22	(5.7)
I_{-2}						
COMP	-0.04	(0.5)				
$COMP_{-1}$	0.04	(0.4)				
CNST	1.78	(0.6)	1.04	(2.5)	1.30	(4.2)
Test statistics						
-2 R	0.964		0.974			
SE	0.009		0.007		0.006	
DW	2.115		1.961		1.923	
AR (1)	1.6		0.1			
Long-run static solution coefficients						
lnRW	-0.80		-0.94		-0.80	
lnRM	-0.44		-0.48		-0.47	
lnK	0.47		0.64		0.59	
lnTQ	0.67		0.58		0.40	
DWT	0.23		0.40		0.32	
FST	-0.53		-0.61		-0.63	
I	-1.39		-1.34		-1.14	
COMP	0		-		-	

where: I: nominal interest rate
COMP: relative manufactured wholesale prices

B15 In the cases of both the US and UK employment equations the roots of the polynomial in the lag operator which defines the coefficients on the lagged dependent variables are such as to imply some degree of overshooting in the reaction of employment to changes in the independent variables. However, the empirical magnitude of this overshooting is sufficiently small to be of little concern even to those who feel that cumulative response functions should be monotonic.

(ii) Real wage

B16 As noted in the main paper and Annex A, the most general UK real wage equation considered includes a number of variables not entered into the US specification. In addition to an explicit term in relative price competitiveness (used for consistency with the UK employment equation), these are a measure of the replacement ratio, a proxy for the degree of structural change and a dummy for the possible effects of various incomes policies on the level of real wages. The entry of these additional variables implies that there are rather few degrees of freedom in the most general equation, and its rather poor residual autocorrelation properties may well reflect overfitting. Again for consistency with the employment equation, monetary conditions were captured by terms in nominal interest rates. Two measures of trade union wage pressure were considered for the UK, namely union density defined analogously to the US case and the measure of union mark-up employed in Layard and Nickell (1985 [1]). These yielded similar results; those obtained using the latter are reported here.

B17 The most general equation, used as a starting point for testing, is shown as (K) in table B4.[23] The first reparameterisation employed was to impose the restrictions on the long-run system properties of the real wage and employment equations taken together referred to in paragraphs A21-A26, to yield equation (L). These restrictions were highly compatible with the data: CHISQ (3) = 2.9. Next, it was noted that the replacement ratio terms were entering with incorrect sign and were both very insignificant. Without violence to the data, these were both excluded [CHISQ (2) = 0.1]. The coefficients in the resulting equation suggested that fiscal stance should enter as a first-difference, and this was imposed next (t=1.0). There then followed a number of exclusion restrictions, in which the current and lagged values of relative price competitiveness, and the incomes policy

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[23] As in the US case, this is not rejected as a valid simplification of a nominal wage equation with output prices and lags of nominal wages entered freely: CHISQ (2) = 0.4.

Table B4: UK real wage equations

Equation	(K) IV		(L) IV		(M) IV		(N) NL3SLS	
$lnRW_{-1}$	0.17	(0.3)	0.63	(1.8)	0.68	(4.1)	0.63	(4.6)
lnRM	-0.59	(2.4)	-0.30	(1.8)	-0.41	(4.9)	-0.42	(5.9)
$lnRM_{-1}$	-0.26	(0.7)	0.09	(0.3)	0.20	(1.9)	0.16	(1.8)
lnK	1.38	(1.7)	0.26		0.22		0.27	(2.6)
lnTQ	-1.65	(1.1)	0.23		0.20		0.18	(1.8)
DWT	0.56	(1.7)	0.24	(0.9)	0.36	(2.5)	0.38	(2.8)
DWT_{-1}	-0.13	(0.5)	-0.12	(0.6)	-0.16	(1.5)	-0.16	(1.7)
FST	-1.13	(1.2)	-0.23	(0.4)	-0.39	(2.0)	-0.40	(2.3)
FST_{-1}	0.62	(1.4)	0.56	(1.3)	0.39	(2.0)	0.40	(2.3)
I	-0.66	(0.8)	0.10	(0.1)	-0.29	(2.0)	-0.29	(1.9)
I_{-1}	-0.09	(0.1)	-0.53	(1.2)				
lnLS	-0.55	(0.8)	-0.40		-0.34		-0.46	(2.5)
TX	2.77	(2.2)	1.62	(1.7)	1.23	(3.5)	1.33	(4.0)
TX_{-1}	-1.48	(0.9)	-1.57	(1.8)	-1.23	(3.5)	-1.33	(4.0)
TUWP	0.04	(0.7)	-0.02	(0.7)				
RR	-0.21	(0.5)	0.05	(0.1)				
RR_{-1}	-0.42	(0.8)	-0.06	(0.1)				
SC	0.37	(0.3)	0.36	(0.5)				
COMP	0.21	(1.1)	0.02	(0.1)				
$COMP_{-1}$	0.40	(1.4)	-0.01	(0.1)				
IPDM	0.01	(0.4)	-0.01	(0.3)				
CNST	-7.87	(1.3)	1.13	(0.9)	1.00	(2.0)	1.56	(2.2)
Test statistics								
-2 R	0.999		0.999		0.999			
SE	0.016		0.017		0.016		0.013	
DW	2.543		2.406		1.788		1.824	
AR(1)	11.1		5.9		0.6			
Long-run static solution coefficients								
lnRM	-1.03		-0.58		-0.66		-0.69	
lnK	1.66		0.69		0.69		0.74	
lnTQ	-1.99		0.62		0.62		0.49	
DWT	0.52		0.34		0.64		0.58	
FST	-0.62		0.89		0		0	
I	-0.90		-1.16		-0.91		-0.79	
lnLS	-0.66		-1.07		-1.07		-1.25	
TX	1.56		0.12		0		0	
TUWP	0.04		-0.07					
RR	-0.77		-0.01					
SC	0.45		0.96					
COMP	0.74		0.01					

where: RR: replacement ratio
SC: proxy for degree of structural change
IPDM: incomes policy dummy

dummy were excluded, because they had incorrect signs and/or were insignificant (the highest 't' ratio relating to a single one of these steps was 0.9). Next, it was decided to remove the measure of trade union wage pressure because it had an implausible sign; this was notwithstanding the fact that it was almost significant at the 95% level (t=1.9).

B18 The next stage of the testing procedure concerned the effect of nominal interest rates. The contemporaneous term was rather more statistically insignificant than that lagged one year, but reflecting intercorrelations of interest rates and the lagged dependent variable it appeared that a more plausible speed of adjustment could be obtained if the lagged term was deleted. Since the other properties of the equation (including the long-run response to interest rates) were very similar whichever of the two interest rate terms was deleted, it was decided to remove the first lag of interest rates ('t' test of this restriction = 1.5). Subsequently, the proxy for structural change was removed because its effect was poorly determined (t=0.8).

B19 Throughout most of the nested testing sequence the pattern of coefficients on the current and lagged terms in the tax wedge suggested that it should enter as a first difference, and this was imposed at this stage (t=0.5), to yield the preferred specification, the single-equation estimate of which is shown as (M) in Table B4. The possibility of restricting the equation further by excluding the first lag of de-trended world activity was explored, but this led to some deterioration in the autocorrelation properties of the equation residuals. It was therefore decided that the effect of world activity should not be more parsimoniously parameterised than in (M). The preferred specification was re-estimated simultaneously with the chosen UK employment function; the resulting UK real wage equation appears in column (N) of Table B4.

B20 The UK is sufficiently open for it to be worthwhile to explore the robustness of the results obtained to the order of the polynomial in time used to generate deviations in world activity from trend. The preferred UK equations were re-estimated using deviations from a cubic, as opposed to quintic, trend, but this made little difference to the results.

(d) Parameter stability

B21 The issue of parameter stability is of importance because coefficients estimated using data for the period 1952 to 1983/4 are used to explain developments since 1974, a procedure which would be inappropriate in the presence of marked

Table B5: Parameter stability

(a) Employment

	1952-74	1952-79	1952-84	1952-73	1952-78	1952-83
	US			UK		
Long-run static elasticities						
ln RW	-0.96	-0.76	-0.97	-0.85	-1.26	-0.94
ln RM	0.13	0.17	0.20	-0.59	-0.55	-0.48
ln K	0.67	0.68	0.70	0.59	0.75	0.64
ln TQ	0.63	0.44	0.67	0.44	1.02	0.58
DWT*	0.48	0.83	1.00	0.62	0.63	0.40
FST	-0.50	-0.58	-0.52	-0.67	-0.86	-0.61
I				-1.49	-1.56	-1.34
Structural stability tests	CHISQ (9) = 19.2 , against			CHISQ (9) = 10.3, against		
	CHISQ (9), 5% = 16.9			CHISQ (9), 5% = 16.9		

(b) Real wages

	US			UK		
Long-run static elasticities						
ln RM	0.23	0.33	0.30	-0.52	-0.49	-0.66
DWT	-0.26	-0.59	-0.49	0.15	0.53	0.64
FST$^{\prime}$	0.21	0.41	0.49	-0.30	-0.71	-1.22
RI	1.17	1.94	1.74			
I				-0.35	-1.21	-0.91
TX$^{\prime}$	0.86	0.86	0.94	3.64	2.72	3.86
TUWP	0.72	0.72	0.87			
ln K	0.70	0.90	0.72	0.69	0.60	0.69
ln TQ	0.66	0.58	0.69	0.52	0.80	0.62
ln LS	-1.04	-1.32	-1.04	-1.17	-0.79	-1.07
Structural stability tests	CHISQ (8) = 6.9, against			CHISQ (9) = 9.4, against		
	CHISQ (8), 5% = 15.5			CHISQ (9), 5% = 16.9		

* For the US, this is the impact coefficient on Δ DWT divided by $(1-a_1-a_2)$, not the long-run static solution coefficient.

$\prime$ For the UK, these are the impact coefficients on Δ FST and Δ TX respectively, divided by $(1-j_1)$, not long-run static solution coefficients.

parameter instability. There are a large number of factors which could cause the relationships estimated to be unstable over time. For example, the effects of fiscal and monetary policy on employment could have been influenced by the switch from fixed to floating exchange rates made in the early 1970s. Equally, the processes by which expectations are formed may have altered significantly through time.

B22 The extent of any problem posed by this was examined in two ways:

(i) formal tests of structural stability were undertaken by estimating 'general' equations (by single-equation IV) in which the parameters of the preferred equations were allowed to vary between the first and second halves of the sample period, and testing the hypothesis that the preferred equations in which the parameters are fixed over the whole sample are a valid simplification of the 'general' specifications;

(ii) the analysis of contributions to changes in employment in the main paper is predecated upon point estimates of parameters. Thus, if these are unstable to an appreciable extent this would be a matter of concern even if such parameter drift were not statistically significant. It was therefore decided to examine how the parameters of the preferred equations move if these equations are re-estimated over sub-samples of the original estimation period. In view of the limited degrees of freedom offered even by the full sample, it is not sensible to examine the coefficients of equations estimated over the first and second halves of the full sample. Thus, the preferred equations were instead re-estimated over the periods 1952-73/4 and 1952-78/9. Since the analyses of contributions to the change in employment deal with a full decade, they are especially sensitive to the long-run (static) elasticities of employment and the real wage with respect to their determinants, and it is these which are reported here.

B23 The evidence assembled on parameter stability is set out in Table B5. For three of the four equations, the hypothesis of parameter constancy was not rejected. It was rejected in the case of the US employment equation, although it should be borne in mind that if a small-sample correction were made, the latter test statistic would be placed well down into the region of non-rejection. Turning to the point estimates of long-run elasticities, the US employment equation appears to be quite stable. Many of the long-run responses in the US

real wage equation also seem to be rather stable.[24] However, extending the estimation period forwards from 1974 leads to increases in the elasticities of the real wage with respect to the components of autonomous demand. This might suggest that the response of the US real wage to demand shifts during the period 1974-84 was greater than is suggested by the preferred US real wage equation estimated over the whole of the period from 1952 to 1984.

B24 The long-run elasticities embodied in the UK employment equation again appear to be rather stable in the main. Perhaps the least stable of the four equations is that for UK real wages. The equations estimated suggest that fiscal tightening and higher nominal interest rates may have induced greater declines in the level of real wages since 1973 than in the twenty years before then, and that therefore the responses in the preferred equation, although quite large, may not be as high as those experienced during the 1974-84 period.

(e) International competitiveness and UK employment

B25 It is reported above that it did not prove possible to identify an explicit effect of international competitiveness on UK employment, despite the large changes in this which have been experienced since 1970. This might be thought surprising, and it therefore seemed desirable to explore a number of possible explanations for this finding. One possible reason for this result is that competitiveness is not exogenous to the economy, and its effect may be captured by other terms in the employment equation estimated. For example, the major changes in UK competitiveness since 1970 were associated with movements in the sterling effective exchange rate which in turn may have been affected by the stance of monetary and fiscal policy. This might suggest that two of the components of autonomous demand in the employment equation could be picking up competitiveness effects. If true, this might not bias the estimated influence of the elements of autonomous demand and competitiveness taken together. Another possibility is

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[24] In the cases of long-run responses with respect to the capital stock, the state of technique and labour supply this follows from stability of the employment equation, since these parameters of the real wage equation are functions purely of parameters in the employment equation.

that competitiveness influences might be captured in the employment equation by either the real wage term alone, or by the real wage, capital stock and state of technique taken together.[25]

Table B6: Correlations of relative manufactured wholesale prices* and other terms in the preferred UK employment equation

$\ln N_{-1}$	$\ln N_{-2}$	$\ln RW_{-1}$	$\ln RM_{-1}$	$\ln K$	$\ln TQ$
-0.27	-0.28	0.41	0.14	0.43	0.50

DWT	FST_{-1}	$(I + I_{-1})$	$(-0.32 \ln RW_{-1} + 0.23 \ln K + 0.16 \ln TQ)$
-0.08	-0.12	0.42	0.44

$(-0.25 FST_{-1} - 0.22 [I + I_{-1}])$
-0.23

* Average of value in current and previous year; measured so that a rise indicates an improvement in competitiveness

B26 Both of the above possibilities were investigated by examining the correlations of the average of the current value and first lag of international competitiveness in the data with each of the other variables in the employment equation, and also with the (log-linear) combinations of the real wage, capital stock and state of technique, and fiscal stance and interest rates, in the preferred UK employment equation. As Table B6 shows, none of these correlations are particularly strong. Moreover, the correlation between the real wage on its own

[25] The latter possibility was formally derived by I D Saville as follows. Define a measure of unit labour costs, ULC, as (W/PROD), where PROD is output per man. Then if domestic prices are set using the simple rule:

$$\ln P = a.\ln ULC + (1-a).\ln PF$$

where PF is an index of competitors' gross output prices in domestic currency, it follows that:

$$\ln(ULC/P) = (1-a).\ln(ULC/PF)$$
$$\ln(P/PF) = a.\ln(ULC/PF)$$

Hence, $\ln(ULC/P) = [(1-a)/a].\ln(P/PF)$, where $\ln(ULC/P) = \ln(W/P) - \ln PROD$

If ln PROD is well proxied by ln K and ln TQ taken together, then the real wage, capital stock and state of technique terms may proxy the effect of international relative price competitiveness.

and competitiveness is positive, which suggests that if the effect of the latter is reflected in the real wage coefficient, then an underestimate will have been obtained of the impact of the real wage per se on employment.

B27 The second test undertaken of whether the real wage, capital and technology combination is obscuring the effects of international competitiveness was to re-estimate the preferred employment equation with the former terms deleted, but with contemporaneous and two lags of relative manufactured wholesale prices entered. The real wage, capital stock and state of technique terms deleted were highly statistically significant taken together: a test of the relevant restrictions (using a maintained form not embodying the restriction associated with neutral technical progress) yielded CHISQ (3) = 20.7, against CHISQ (3), 5% = 7.8. By contrast, an equivalent test of the joint significance of the competitiveness terms gave CHISQ (3) = 6.2. The contemporaneous competitiveness term had the wrong sign, and was removed (t=1.4). Although the remaining competitiveness terms had the correct sign, they remained individually insignificant (with 't' ratios of 0.5 and 0.9 respectively) and the hypothesis that their coefficients were both zero was not rejected: CHISQ (2) = 4.1, against CHISQ (2), 5% = 5.99 (this was despite the fact that the real price of imported inputs continued to exhibit a negative sign throughout the testing described in this paragraph).

B28 It thus appears that the failure to identify an explicit statistically well-determined effect of competitiveness on UK employment does not reflect high correlations of the former with other variables in the equation. In turn, this evidence suggests that the effect of international competitiveness per se on UK non-general government employment may be fairly weak. This might seem surprising to those familiar with econometric evidence on UK trade flows, especially in manufactures. However, it should be borne in mind that total trade flows (exports plus imports) in those categories of transaction for which there is an appreciable body of evidence suggestive of the importance of competitiveness effects, namely manufactures and services, only amounted to 35% of private non-North Sea gross output even at the end of the equation's estimation period (1983), when the share of trade in total output was higher than over the post-War period as a whole (of this, manufactured trade accounted for some 25% points). Hotson and Gardiner (1983) report an average long-run elasticity of manufactured trade flow with respect to relative manufactured prices of 0.5. Applying the share of manufactured and services trade in private output of 0.35 to this would suggest an elasticity of

private employment with respect to manufactured competitiveness of only around 0.2 (although diminishing returns to single factors and multiplier effects might mean that this is an underestimate).

B29 Moreover, most of the econometric studies of trade flows do not embody a mechanism whereby some of the beneficial effects on trade of improvements in competitiveness which result from exchange rate depreciation can be attenuated by the impact on firms' willingness to supply of a higher real price of imported inputs. It is also possible that improvements in manufacturing or services competitiveness to some extent tend to induce an increase in these industries' output through a switch of resources from other sectors, so that whole-economy output and employment is less affected. Furthermore, the absence of an explicit competitiveness term in the UK employment equation does not automatically imply that the latter cannot be adversely affected by exchange rate appreciation. On the contrary, in the system estimated exchange rate appreciation which has lowered the real price of imports is calculated to have induced a rise in the real wage, with detrimental effects on employment.

B30 Nevertheless, in view of the large changes in UK competitiveness which have occurred since 1970, further work on the impact of competitiveness on UK employment would be warranted. For example, if the (statistically very ill-defined) long-run elasticity of employment with respect to competitiveness of 0.15 exhibited in the last equation in the main sequence of nested tests [described in Section (c) (i)] which included a competitiveness term were accepted[26], together with that equation's dynamic structure, this would imply that the latter proximately induced a decline in UK employment of some 2% between 1974 and 1984.

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[26] The same long-run elasticity of employment with respect to competitiveness emerged when the preferred equation was re-estimated with the terms in the real wage, capital stock and state of technique removed, and the first and second lags of relative manufactured wholesale prices entered.

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ANNEX C DATA DEFINITIONS AND SOURCES

United States

The sectoral coverage of the data definitions for the US is, as far as possible, that of the private sector excluding, as is conventional, agricultural activities. Unless otherwise stated, data are taken from the Business Conditions Digest, the Economic Report of the President and the Survey of Current Business (various issues).

1 Employment (N)

Total wage and salary workers in private sector non-agricultural establishments.

2 Nominal wage (W)

Hourly compensation in the non-farm business sector. Compensation comprises employees' wages and salaries plus employers' contributions for social insurance and to private benefit (especially pension) funds.

3 Price of imported inputs (PM)

Deflator for total imports.

4 Price of gross output at factor cost (P)

Deflator for total final expenditure at factor cost.

5 Capital stock (K)

Corporate sector net non-residential capital stock at 1972 replacement cost.

6 State of technique (TQ)

This may be calculated for year T using the following growth accounting formulae:

Assuming neutral technical progress

$$TQ = EXP\left[\sum_{T=1}^{T}(\Delta \ln Y - sh.\,\Delta \ln N - (1-sh).\,\Delta \ln K)\right]$$

Assuming labour-saving technical progress

$$TQ = EXP\left[\sum_{T=1}^{T}(1/sh.\,\Delta \ln Y - \Delta \ln N - ((1-sh)/sh).\,\Delta \ln K\right]$$

where Y: total net output at factor cost
sh: share of labour income in the total

The raw data used was the index of 'multifactor productivity' in the private business sector calculated by the Bureau of Labor Statistics using a formula analagous to that given above for the neutral technical progress case. An index of labour-saving technical progress was formed by multiplying this by (1/sh). The value of sh was calculated as SIE/GDP$,

where SIE: total employee compensation
GDP$: gross domestic product at current factor cost

In the empirical work reported, five-year backward looking moving averages of TQ have been employed.

7 Deviation of world activity from trend (DWT)

A proxy for the volume of world activity most relevant to US exports was calculated as a weighted average of real domestic demand in the nine most important trading partners of the US, with the weights given by shares of US exports. Deviations from trend of world activity were measured as the residuals from an (OLS) regression explaining the log of this in terms of a quintic polynomial in time.

8 Cyclically and inflation adjusted budget balance as a percentage of high employment GDP per man (FST)

Data on the cyclically and inflation adjusted budget balance as a percentage of high-employment GDP for 1955-81 were taken from Eisner and Pieper (1984), table 6. The series was extended backwards to 1950 and forwards to 1984 using Bank estimates of the cyclical and inflation adjustment required. The latter were calculated using a similar methodology to that employed by the IMF (see, for example, IMF World Economic Outlook, May 1983, Appendix A, Supplementary Note 2).

Since it is desired to have the cyclically and inflation adjusted budget balance expressed as a percentage of high-employment GDP per man, the data were multiplied by an index of high-employment civilian labour supply, defined as a five-year centred moving average of the sum of total civilian employees, the self-employed and the registered unemployed, scaled to 1952 = 1.0.

9 Real and nominal interest rates

Nominal interest rate (I): high grade corporate bond rate
Real pre-tax interest rate (PRI): $I - [(P/P_{-1})-1].100$
Real post-tax interest rate (RI): $I.(1-t)-[(P/P_{-1})-1].100$

where t: average corporate tax rate (Source: Peckman, J A, 'Federal Tax Policy', The Brookings Institution, 1983, p 144.)

10 Labour supply to private non-agricultural sector (LS)

Defined as N plus total number unemployed.

11 Tax wedge (TX)

Three tax rates were constructed:

(i) effective personal direct tax rate (TXDR). This was measured as (TAXJ+SSCJ)/(SYJ-SYJG)

where TAXJ: personal sector direct tax payments
SSCJ: personal sector social security contributions
SYJ : personal sector income, before employee social security contributions
SYJG: current grants to personal sector by general government

(ii) effective indirect tax rate (TXID). This is (TBUS/EF$)

where TBUS: 'indirect business tax'
EF$: total final expenditure at current prices

(iii) effective rate of payroll tax (TXEM). This was formed as (SSCT-SSCJ)/SIE

where SSCT: total social security contributions
SSCJ: employees social security contributions

The tax wedge is TXDR + TXID + TXEM.

12 Trade union wage pressure (TUWP)

Two measures of this were explored:

(i) trade union density. This was defined as a three-year centred moving average of the percentage of non-agricultural employees unionised, as calculated by the Bureau of Labor Statistics.

(ii) number of stoppages involving 1,000 or more workers and lasting a full shift or longer. Source: Bureau of Labor Statistics, Monthly Labor Review, September 1985.

13 Unemployment rate: national definition used

Unemployment rate of civilian workers.

United Kingdom

The sectoral coverage of the data definitions used for the UK is, as far as possible, the whole-economy less the general government and North Sea sectors. Although not made explicit in what follows, where relevant the data have been adjusted to avoid them being distorted by the transfer of the Post Office from the general government to the public corporations sector in April 1961. Unless otherwise stated, data are taken from National Income and Expenditure (the 'Blue Book') and Economic Trends Annual Supplement (ETAS), various issues.

1 Employment (N)

'Employees in employment' less general government employment other than in HM Forces.

2 Nominal wage (W)

[IE + TSET + YECS - (GGIE.((IE + TSET + YECS)/IE))]/N

where IE: income from employment
TSET: payments of Selective Employment Tax
YECS: payments of National Insurance Surcharge
GGIE: general government income from employment

3 Price of imported inputs (PM)

(KM£ + DSO£)/(KM + DSO)

where KM£, KM: total imports, current and constant prices
DSO£, DSO: domestic sales of North Sea oil and gas, current and constant prices [Bank short-term model (STM) databank]

This expression for PM treats both foreign and North Sea oil and gas consumed in the UK as imported into the non-North Sea, non-general government sector.

4 Price of gross output at factor cost (P)

(EF£ - FCA£ - GOO£ - GGIE)/(EF - FCA - GOO - GN . 5.76)

where EF£, EF: total final expenditure, current and constant prices
FCA£, FCA: factor cost adjustment, current and constant prices
GOO£, GOO: gross output of North Sea oil and gas, current and constant prices (Bank STM databank)
GN: general government employment

The scalar 5.76 reflects the value of income from employment per employee in the general government of £5,760 in 1980.

5 Capital stock (K)

Whole economy gross capital stock at 1980 replacement cost less that in the industries: 'extraction of mineral oil and natural gas', 'dwellings' and 'other services' (the latter incorporates most of the capital stock of the general government).

6 State of technique (TQ)

This was calculated using the growth accounting formulae set out above. In using these Y is measured as:

EF - M - FCA - ONO - GN . 5.76

where M: total imports
ONO: net output of North Sea oil and gas, constant prices

sh is calculated as (W.N)/(EF£ - M£ - FCA£ - ONO£ - GGIE - GGOI)

where ONO£: net output North Sea oil and gas, current prices
GGOI: non-income from employment factor income generated in general government sector

In the empirical work reported, five-year backward looking moving averages of TQ have been employed.

7 Deviation of world activity from trend (DWT)

World trade volume has been measured as (WX£ - KX£)/[(WPX - SHKX.KPX)/(1-SHKX)]

where WX£: industrial countries' exports, $bn
KX£: UK exports, $ bn
WPX: $ UVI of industrial countries exports, 1980=100
KPX: $ UVI of UK exports, 1980=100
SHKX: KX£/WX£

Source: International Financial Statistics (IFS)

Deviations from trend of world activity were measured as the residuals from an (OLS) regression 'explaining' the log of the above measure of world trade in terms of a quintic polynomial in time.

8 Cyclically and inflation adjusted budget balance as a percentage of high employment GDP per man (FST)

Data on the cyclically adjusted budget balance as a percentage of high employment GDP for 1949-77 were taken from Ward and Nield (1978), Tables 4.1 and 4.2. This was updated to 1984 using estimates of the change in fiscal stance published in various issues of the National Institute Economic Review, especially the February 1984 edition, page 80. These estimates were adjusted to include the gain to the public sector arising from inflation erosion of the real value of its nominal liabilities as tax revenue. Data on the inflation gain to the public sector were taken from Taylor and Threadgold (1979), and the tables updating their calculations which have appeared in various editions of the Bank of England Quarterly Bulletin.

Since it is desired to have the cyclically and inflation adjusted budget balance expressed as a percentage of high-employment GDP per man, the data obtained as described above, which are expressed as a percentage of high-employment GDP, were multiplied by an index of high-employment civilian labour supply, defined as a five-year centred moving average of the sum of employees in employment, the self-employed and the registered unemployed, scaled to 1952=1.0. Data on numbers of self-employed were taken from British Labour Statistics Historical Abstract (BLSHA) and various issues of the Department of Employment Gazette (DEG).

9 Nominal interest rate (I)

This was identified with the London clearers' base rate (Bank rate before 1971). Source: Bank internal data.

10 Labour supply to the non-general government sector (LS)

Defined as N plus total registered unemployed.

11 Tax wedge (TX)

Three tax rates were constructed:

(i) effective personal direct tax rate (TXDR). This was formed as (TYJ + YJCN)/(YJ - YJG - YEC)

where TYJ: personal sector direct tax payments
YJCN: personal sector National Insurance contributions
YJ: personal sector income
YJG: current grants to personal sector by general government
YEC: employers' National Insurance and 'other' contributions

(ii) effective indirect tax rate (TXID). This is FCA£/EF£.

(iii) effective rate of payroll tax (TXEM). This is (YECN + YECS + TSET)/IE.

where YECN: employers' National Insurance contributions.

The tax wedge is TXDR + TXID + TXEM

12 Trade union wage pressure (TUWP)

Two measures of this were explored:

(i) trade union density. This was defined as a three-year centred moving average of the number of trade union members as a proportion of employees in employment; data on the former is taken from BLSHA and DEG.

(ii) trade union mark-up, as used in Layard and Nickell (1985 [1]).

13 Unemployment rate: national definition used

UK unemployment rate, excluding school leavers. Source: 'Unemployment adjusted for discontinuities and seasonality'. DEG, July 1985, 274-277.

14 Replacement ratio (RR)

The Department of Health and Social Security calculates the replacement ratios applicable to a male manual worker who if employed would receive average earnings but who is in fact unemployed for the whole of a fiscal year. They present 18 ratios relevant to this study: six family types are distinguished (single, married but no children and married with one, two, three or four children), as well as three possible benefit entitlements, namely standard rate of unemployment benefit only, standard rate plus earnings related supplement (ERS) and supplementary benefit plus rent addition only. A weighted average of these ratios was taken, using weights on type of family of .15, .44, .17, .14, .06 and .04 respectively, and assuming one-half of the unemployed (or those on the margin of deciding to become so) receive unemployment benefit only and one-half supplementary benefit only. When ERS was payable, this is assumed to be received by one-half of those drawing unemployment benefit. The source of the raw data for this calculation is 'Abstract of statistics for index of retail prices, average earnings, social security benefits and contributions', various issues.

15 Structural change (SC)

A proxy for the pace of structural change in the economy was formed as the sum of absolute changes in the percentage share of employment in each of eight sectors of the economy, namely agriculture, mining, manufacturing, utilities, construction distribution, transport and communication, and other services. The source of raw data is OECD Labour Force Statistics, various issues.

16 Relative manufactured wholesale prices (COMP)

This is the ratio in common currency of UK wholesale prices to an export weighted average of prices of seventeen competitor countries. The raw data on wholesale prices is taken from IFS.

17 Incomes policy dummy (IPDM)

Somewhat crudely, this takes the value of unity in 1967, 1973 and 1976, and zero otherwise.

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