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RELATIVE WAGE FLEXIBILITY IN FOUR COUNTRIES

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ABSTRACT

In this paper we estimate equations for relative hourly earnings for 50 industrial sectors from Sweden, Finland, Great Britain and the United States. We find that relative hourly earnings fluctuate less in Sweden than in the other three countries. In all four countries only a quarter to one third of the sectors show any influence of relative sector performance or labour requirement on relative hourly earnings. In the United States there are aggregate cyclical influences on relative earnings in most sectors, in the European countries only in a small minority of sectors.

RELATIVE WAGE FLEXIBILITY IN FOUR COUNTRIES

C. A. Pissarides and R. Moghadam

1. Introduction

The labour requirements of different sectors of the economy change continuously. The demand for final and intermediate goods shifts in response to changes in tastes and technology. Foreign competition changes the pattern of demand from home and abroad. And technological advances change labour requirements at given output and prices. Thus, in a modern economy there is a continuous need to reallocate labour between sectors.

The reallocation of labour can be brought about in two ways, via 'quantity signals' and via 'price signals'. The quantity signals consist of various measures taken by firms in the expanding sectors to recruit labour at given wages. New vacancies are opened up and intensive recruitment campaigns take place. New entrants to the labour market and unemployed workers are encouraged to look for jobs where they can be found, without much regard to expected earnings.

The price signals are transmitted through relative wages. Firms in the expanding sectors raise their relative wages to attract labour away from firms in the declining sectors. Job vacancies again rise in the expanding sectors, but not by as much as they do when relative wages are constant. Workers now look more intensely for the unfilled jobs in the expanding sectors because of their higher expected earnings. Thus, although a given job vacancy is eventually filled regardless of changes in relative wages, if the relative wage offered by the firm rises, the job vacancy can be filled more quickly.

An influential study by the OECD (1965) concluded that in practice the sectoral allocation of labour is brought about through the quantity

signals. The relative wage structure in manufacturing industries (for which comparable data are available) remains rigid in the face of big changes in employment shares. More recent work by the OECD (1985) has identified some changes in the industry wage structure of Member countries and some correlations between sectoral performance and sectoral wage change. But on the whole it did not overturn the results of the earlier study.

In a related study for Britain, Pissarides (1978) drew the distinction between the effectiveness of relative wage changes in bringing about employment change and the extent to which relative wages are used in order to speed up the relocation of labour. As in the OECD study, Pissarides found that relative wages in British manufacturing change by very little despite big changes in employment shares. But even small changes in relative wages are effective in bringing about big changes in employment shares. Thus, although relative wages do not change by much, they can contribute significantly to the sectoral reallocation of labour.

These studies highlight an important issue relevant for markets with friction. Relative wages do not have to change in response to changes in relative labour requirements, as the allocation function can be done with quantities. But relative wages may change temporarily to speed up the adjustment. Or they may change permanently, with queues building up in the expanding sectors. Although permanent change is not very likely, we argue in the next section that it is a possibility. What happens to relative wages in practice is, ultimately, an empirical question.

The purpose of this paper is to examine this question for four countries, two Scandinavian (Sweden and Finland), one other European country (Great Britain) and the United States. Wages in these countries are determined under different institutional arrangements. The two

extremes are Sweden and the United States. Sweden has very high union density and centralised wage bargaining. Union policy during negotiations has been dominated by the 'solidaristic wage policy' and the objective of wage equalisation across industrial groups. The explicit aim has been to rely on quantity signals and direct policy intervention to guide the sectoral reallocation of labour. Relative wages have not been treated as a tool for the reallocation of labour (see Flanagan, 1987).

In contrast, the United States is very thinly covered by unions and no egalitarian objectives have entered into wage negotiations. Wages are fixed mostly at the firm level and in principle one would expect them to reflect labour shortages. Of all the countries in our sample, the United States is the one most likely to exhibit relative wage flexibility and to rely on relative wages for the reallocation of labour.

The other two countries in our sample, Finland and Britain, are heavily unionised. But in contrast to Sweden, wage negotiations are not centralised. This is especially true of Britain, where unions are largely organised on occupational lines and even appear to compete with each other for the highest wage rises that can be secured for their members. But the occupational form of organisation suggests that along the industrial dimension, wage flexibility may not be very high.

In Finland there is less centralisation than in Sweden but still more than in Britain. The contrast with Britain is that wage setting is more geared towards industrial groupings than towards occupational ones. There is also less competition between unions, though much less cooperation for egalitarian wage policies than in Sweden.

Altogether we have comparable quarterly data for 50 industrial sectors from the four countries (17 from the Scandinavian countries), drawn mainly from manufacturing and from some activities outside. We regress relative

wages in each sector on some indices of sector performance (relative employment growth and relative productivity growth) and some indices of economy-wide performance (inflation change and vacancy or unemployment rates). Our main conclusions are three:

1. In terms of fluctuations in relative wages, the four countires fall into two groups, on the one hand Sweden with very little fluctuation and on the other the three other countries with more fluctuations of a similar order of magnitude.
2. Sector variables influence sector wages in one quarter to one third of the sectors. Performance in the four countries is comparable in this respect.
3. Relative wages in the United States respond more to the economic variables in our regressions than do relative wages in the three European countries. However, statistically the most important variables in the regressions are indices of economy-wide cyclical performance, not indices of sector performance.

In the next two sectors we discuss the theoretical ideas underlying our regressions. Our data and results are discussed in the sections that follow. An Appendix defines precisely the variables used in our regressions and gives the regression equation estimated in each of the 50 sectors.

2. The role of relative wages in sectoral adjustments

In order to analyse the question whether relative wages change in response to economics incentives, we acknowledge that wages may differ across sectors for 'equilibrium' reasons. We do not attempt to explain these determinants of wage differentials but to investigate their flexibility over time. We focus in particular on the influence of labour productivity, defined as output per employee, and on employment growth.

Our approach can best be motivated in terms of a three-equation model for each sector of the economy: one equation for the demand for labour, one for the supply of labour and one for wages. A full empirical model would estimate the three equations simultaneously, as they have many elements in common that can be exploited by a simultaneous technique. But at the sectoral level such estimation is over-ambitious, and even for aggregate economies few such models exist.[1] Our main interest here is in the wage equation and the three-equation model forms the background that is used to justify the inclusion of the explanatory variables that we use in our estimation.

The firm's demand for labour is derived from profit maximisation and gives labour demand as a positive function of output (or the capital stock), a negative function of the product wage (inclusive of taxes paid by employers), a positive or negative function of technical change (depending on the form that technical change takes and on the elasticity of substitution between factors), and possibly also as a function of other 'equilibrium' factors. Sectoral equations of this kind have been estimated for British industries by Nickell and Kong (1987).

The supply of labour to each sector is a little more complex, as now there is a sharp distinction between aggregate labour supply, which may be inelastic, and sectoral labour supply, which in the long run may be (and generally is) perfectly elastic. In the short run, and because of mobility costs associated with different skill requirements, information, physical considerations etc, there are strong inertia in the supply of labour to individual sectors. Workers move between sectors in response to differences in relative wages and relative job availability, but movement is slow. In order to provide the incentives to workers to move, expanding sectors have to offer either above-normal relative wages, or more plentiful supply of jobs, or both. Because movement is slow, the relative position of an expanding sector may stay above normal for a long time - certainly long enough to be detected, say, in quarterly data. But when, as may happen in a long run, the distribution of labour across sectors matches the relative demand for labour in each sector, both sectoral wages and sectoral job availabilities need differ from the aggregate only by the 'compensating' margins that reflect the underlying attractiveness of each sector. If sectors are small compared with the economy as a whole, practically any distribution of sectoral demands for labour can be matched by supply at the compensating differentials; i.e. the sectoral supply of labour in the long run is perfectly elastic.

Thus, if we define equilibrium as the state where sectoral employment shares are unchanging, there is a clear demarcation in the roles of supply and demand in equilibrium. Supply conditions determine the distribution of wages and job availabilities (employment probabilities) through household preferences for work in each sector. Demand conditions influence only the distribution of employment across sectors. Big sectors are big because there is more demand for their product, not because they offer higher wages. They may have become big by temporarily offering higher wages and better chances of employment, but once they reached their desired size both their wages and job availability returned to their compensating levels.

Now for employment shares to stay constant, relative productivity must also be unchanging, as productivity influences the demand for labour. If, as is normally the case, relative productivity and employment shares are changing, relative wages or relative job availabilities, or both, must reflect some influence besides compensating differentials. It is with these 'disequilibrium' influences on relative wages that we are concerned here.

Disequilibrium (meaning always non-compensating) differences in wages need not necessarily arise, despite changes in sector shares. The reason is that other factors, in particular changes in employment probabilities (as proxied, for example, by vacancy-unemployment ratios), can also induce sectoral employment change. Evidence for this was provided by one of us (Pissarides 1978) for industrial sectors in Britain. Both relative wages and relative vacancy-unemployment ratios induce sectoral mobility in Britain, so the adjustment of sectoral supplies to sectoral demands can be brought about through changes in relative vacancy-unemployment ratios, without changes in relative wages. Appendix A develops a formal model of sectoral adjustment that demonstrates that the same long-run equilibrium distribution of employment can be reached regardless of whether or not wages change during adjustment to reflect relative labour requirements.

This possibility leaves open the question of sectoral wage determination. Essentially what we need is a theory of wage determination that will tell us whether sectoral wages yield to the pressures of sectoral shifts in supplies and demand, even though they do not have to, or whether other considerations override supply and demand pressure. Such theory does not exist. What we have instead is a number of hypotheses about wage determination that imply certain independent influences on sectoral wages. What we intend to do here is to discuss briefly the main ones and derive their implications for the dependence of sectoral wages on sectoral productivities and employment shares.

3. Wage determination

We have argued that in the long run, and if sectoral demands and supplies are competitive and equal to each other, sectoral wage differentials compensate workers for the nonpecuniary characteristics of their sectors. However, sectoral labour markets are frequently noncompetitive and this introduces the possibility of other influences on wages, even in long-run equilibrium. We mention two possible influences.

First, efficiency-wage considerations may influence the determination of wages. In this case sectoral wages are tied down by the incentives that employers want to offer to their employees. Then, if incentives differ across sectors wages will also differ, and this may create 'equilibrium' excess demands or supplies in some sectors. Demand and supply may still have an influence on sectoral wages, but because now a third factor enters wage determination (incentives), wages may not be in compensating equilibrium even in the long run. In sectors where incentives are strong and wages high there will be excess supply of labour; conversely in other sectors. Then 'involuntary' unemployment and vacancies will persist. Kruger and Summers (1988) and Katz (1986) have argued that the persistence of 'unexplained' wage differentials across industries is evidence in favour of efficiency wage influences on relative wages.

Another influence on wages in full equilibrium is suggested by a bargaining approach. This approach assumes that the firm and its workers bargain over wages because of local monopoly elements in labour markets (Pissarides 1988). The agreed upon wage rate has both sectoral influences and economy-wide influences on it. The sectoral influences arise because sector performance influences the total revenue that the firm and its workers share, and the economy-wide influences arise because of their effect on the workers' alternative opportunities. However, Nickell and Kong (1987) show that if there are outside influences on wage bargains, in the long run they will dominate sectoral wage determination. Thus in the long

run they obtain an equation giving each sector's wage rate in terms of aggregate wages and possibly of other aggregate variables too.

To summarise the brief discussion of the long-run determination of sectoral wages, we have argued that in a competitive framework where sector demands are equal to sector supplies, sectoral wage differentials reflect only supply-side compensating influences. If efficiency-wage considerations are present, there are other influences on wages, with consequent excess supplies or demands in some sectors. But these other influences are not necessarily related to productivity or sector size. If explicit or implicit bargains under monopoly influence wages, some influences besides compensating differentials may still be present even in the long run. For example, the degree of unionisation of a sector and the openness of the sector to outside influences will influence the sector's wages. Productivity may also play a role, though not necessarily.

During adjustment the critical question is whether sectoral wages respond to the sectoral demand for labour in order to speed up the adjustment of supply, or whether they stay close to their long-run levels, leaving the burden of adjustment to relative excess demand. In each of the theories of long-run behaviour that we have outlined, employment adjustment to long-run equilibrium can be achieved without any wage adjustment. In the empirical work below we investigate whether there are short-run influences on wage differentials besides the long-run influences implied by each theory.

The important short-run questions that we investigate are two. First, do firms in an expanding sector offer higher wages to attract labour faster? For this we need a measure of the strength of the sectoral demand for labour. In our empirical work we use two measures, the relative job-vacancy rate of the sector (where available) and the change in the relative size of the sector. We interpret both these measures as proxies for an exogenous rise in demand. Although themselves endogenous, our interest is in whether relative wages are used as a recruitment

tool: both higher relative vacancies and growth in relative size indicate faster relative recruitment in the sector in question. As we saw in our discussion of the theory, short-run changes in relative size are due to exogenous labour demand shocks, as sectoral labour supply shocks are not likely to be important in the short-run (e.g. workers are not likely to change their taste for particular types of work within short periods of time).

Although as we have already stressed there is no need for wages in expanding sectors to rise, we would expect them to do so (at the very least) in cases where wages are determined competitively (see Appendix A). Also, if firms fix wages as monopsonists they may raise them when wanting to recruit more labour. But if, say, wages are determined by bargains with the existing labour force and recruitment from outside at going wages is easy, wages are less likely to respond to changes in size.

The second question that we investigate is whether wages are related to labour productivity, measured as output per employee. This would be implied, for example, by a model where wages are determined by bargains between employed workers and firms. Productivity gains are shared between the firm and its workers in such a situation, especially in the short run. In the long run and if outsiders have any influence on the wage bargain, through unions say, the influence of productivity on wages may be lost (Nickell and Kong, 1987).

In addition to these questions we investigate whether sectoral wage differentials respond to aggregate cyclical shocks. This would be the case if different sectors used different methods of determining wages: competitive wages are more likely to be cyclical than efficiency wages or bargain outcomes. We proxy cyclical shocks by two variables, first the vacancy rate in the European countries under study and the aggregate unemployment rate in the US, and second the change in the inflation rate. We consider the vacancy rate to be a better measure of aggregate cyclical conditions but the unavailability of a series for it in the US forces

us to use the unemployment rate. If relative wages responded to aggregate shocks there could be cyclical misallocations of relative labour supply, as workers try to move to high-wage sectors to take advantage of the cyclical benefits.

4. Empirical results

A full listing of our data and their sources are given in Appendix C. In Table 1 we list the sectors used in our analysis with their number and symbol, used to identify them in the Tables of the next section.

In terms of size, the sectors vary widely. The Swedish data are dominated by a huge sector, fabricated metals, which accounts for more than half the employment in our sample. The rest of the sectors are approximately of equal size, except for the smallest, mining and quarring. Finland has a big agricultural sector but apart from agriculture, employment shares range from approximately 5 to 15 per cent. Because the country is small, the absolute size of the Finnish sectors is tiny when compared with most sectors from the other countries in the sample. The British data are distinguished by a moderately big engineering sector but, with the exception of engineering and construction, the other sectors are small, with a share of less than 10 per cent each. The US sectors are more uniform in terms of size than the sectors of the other countries, though variations do exist because of a large number of small sectors.

The variables we use in our analysis are straightforward. For the three European countries we estimate equations for relative hourly earnings in terms of relative productivity, employment share, relative vacancy rates, aggregate vacancies, inflation and lagged values of the dependent variable. For the United States, where vacancy or unemployment data for individual sectors are unavailable we use the aggregate unemployment rate in place of the vacancy rate. A summary of the results for the four countries is given in Tables 2 and 3. The results for each country are compared with a naive autoregressive specification for relative hourly earnings. If the autoregressive specification for a given sector is found to dominate (statistically) the full regression that we estimate, then

wages in this sector can be said to change in response to other factors, not included in our regressions, and to return to their equilibrium values regardless of the values taken by our independent variables. The results of the statistical test that compares the autoregressive specification with our full specification are given in Tables 2 and 3. It is an F test for the exclusion of all regressors other than the lagged dependent terms and the relative wage.

The change in each sector's employment share and (in the European countries) the sector's relative vacancy rate are entered as proxies for the sector's relative labour requirement. The employment share is entered also in level. With quarterly data and if labour mobility is slow, the first difference in employment share may not pick up the general trend of in the sector's size. The level is less subject to error and to very short-lived fluctuations, that should not influence wage determination. Relative productivity is defined as the average of the previous four quarters and it is also entered in both level and first difference, for similar reasons. The other independent variables - change in aggregate wage inflation and the aggregate vacancy rate in the three European countries, and change in aggregate wage inflation, the aggregate unemployment rate and the change in the unemployment rate in the United States - are entered to capture any differences in the responses of sectoral wages to cyclical shocks, even if the shocks affect all sectors. The change in the vacancy rate was tried in the European regressions but it was left out of the final regressions because it was everywhere insignificant. The full specification of the estimated regressions is given in Appendix B.

Because of the large number of sectors in our analysis (50 altogether) we estimated the same specification of the equation everywhere. We did not

try to find the 'best' specification for particular sectors or countries, though undoubtably improvements in some sectors can be made. Thus when evaluating the results the caveat should be borne in mind that the differences found between countries may be due to differences in the appropriate specification (eg. in the number of lags), though we shall generally attribute them to differences in the overall effect of the explanatory variables on relative wages. Our regressions are particularly well suited for inter-country comparisons, the aspect of the results that we emphasise.

Giving the estimate and standard error of each estimated coefficient would not be of much use in the present discussion, so we report selectively some of the results. Table 2 gives the number of each sector, as defined in Table 1, for which the estimated coefficient on the variable listed is significant at the 10 per cent level. The table gives also the significance for the F test, for the exclusion of all non-wage variables. The dependent variable is the change in the log of hourly earnings of the sector in question relative to all other sectors in the country's sample (i.e. it is the sector's relative wage growth). There are three lags of the dependent variable on the right-hand side and there is also the level of the relative wage, lagged one quarter. The first row of Table 2 gives the number of each sector where at least one of the lagged dependent terms is significant. The second and third rows give the sector numbers for which the coefficient on the relative wage is significantly different from zero or from one. If the coefficient is significantly different from zero, the equation can be rewritten as a relative wage equation, with a unique long-run solution. If in addition the coefficient is significantly different fromm (minus) one, adjustment to the long-run level is lagged and takes four quarters or more. Otherwise adjustment is completed before the

end of the year. If the estimated coefficient on the lagged relative wage is zero, we have an equation in the first difference of the relative wage, without convergence. This could indicate, for example, that relative wages move within a narrow band of a trend, without systematic tendency to return to the trend when disturbed. When the disturbances are small, as in our regressions, this behaviour is not implausible.

Table 3 gives the estimated coefficients, when they are significantly different from zero at the 10 per cent level. These equations have the level of the relative wage on the left-hand side and the economic variables on the right-hand side, and they are derived by rearranging the wage terms in the estimated regressions summarised in Table 2. The diagnostics and F-tests reported are the ones of the estimated regressions, with the change in the relative wage as the dependent variable.

It is helpful to begin by looking at the standard deviations and diagnostics in Table 3. For Sweden, we find that the standard deviations of relative wages are extremely small. Only two sectors, mining and quarring and paper products, with total employment share less than 10 per cent, have standard deviations exceeding 2 per cent. Thus, in Sweden there is not much variation in relative wages to explain. The weighted average of the standard deviations (with employment shares as weights) is a mere 1.35 per cent. However what there is to explain is explained fairly well by our regressions. The standard error of the regression is everywhere significantly less than the standard deviation of the dependent variable, even though in two sectors, chemicals and nonmetalic minerals, it is very close to it. The tests for first-order autocorrelation, LM(1), and for autocorrelation up to fourth order, LM(4), pass in all sectors, except for LM(4) in the final sector.

Finland contrasts sharply in that the standard deviations of the dependent variables are much bigger than in Sweden. The smallest standard deviation is approximately at the level of the biggest one in Sweden. The weighted average of all deviations in Finland is 4.2 per cent. The regressions are again successful in explaining a significant proportion of the fluctuations in relative wages but the autocorrelation tests suggest that there is residual autocorrelation in six of the nine sectors.

The British standard deviations are between the Swedish and Finnish ones. Their weighted average is 3.1. The regressions are everywhere significant and the LM test for autocorrelation fails to reject it only in two sectors.

In the United States fluctuations in relative wages are again high, with a weighted average of the standard deviations of 3.5 per cent. The regressions here explain a larger fraction of the variance than in the other countries, though six out of the 17 sectors fail one of the LM tests for autocorrelation.

Thus, in terms of the standard deviations of relative wages we find that Sweden is the exception, with much smaller standard deviations than in the other countries. The regressions are significant everywhere, though in Finland the dynamic specification that we have imposed does not appear satisfactory in the majority of sectors. In Britain and Sweden it is satisfactory and in the United States adequate.

The most interesting test-statistic for our purposes is the one that compares an autoregressive specification for each sector with the one we have estimated. Our estimated regressions include all the lagged adjustments that are taken into account in the autoregressive specification. In addition, they include the 'economic variables' (employment share, relative productivity, etc) that may be the cause of the

fluctuations in relative wages.[3] If the specification that we have estimated dominates the autoregressive one, this is evidence that at least some fluctuations in relative wages are accounted for by our variables. The statistical test of whether or not our specification dominates the autoregressive one is an F-test. The results of this test are shown in the bottom row of Table 2 and the calculated value of F is given in Table 3. When the F is 'significant' (i.e. exceeding its critical value) there is evidence that our specification dominates the autoregressive one.

In Sweden three of the eight sectors have significant Fs, including the big fabricated metals sector. In Finland there is similar performance, with three significant Fs out of nine, and in Britain performance is again similar, with six significant out of 16. In both Finland and Britain about 30 per cent of the labour force is employed in sectors where our specification dominates the autoregressive one. In the United States significance is altogether higher, with 12 out of 17 sectors having significant Fs. The sectors with significant Fs employ about 75% of the labour force, which exceeds even Sweden's 72 per cent (though this measure for Sweden is not very meaningful because 52 per cent is accounted for by a single sector). Thus, the message that the F tests tell is that in the United States relative wages respond more to economic performance than they do in the European countries. The three European countries exhibit similar performance on this criterion.

Closer examination of the Swedish results shows that relative wages in two sectors, food products and wood products, can be said to respond to indices of sector performance. Both relative productivity and employment share influence relative wages significantly. Moreover, although the magnitude of the influence is small, adjustment in wages is completed within the year (see the level regressions in Table 3). Relative wages in

these two sectors exhibit also cyclical behaviour apparently unrelated to sector performance, as the significance of aggregate vacancies indicates. Relative wages for food products are procyclical whereas for wood products they are counter-cyclical.

Apart from these two sectors, however, there are some isolated significant estimates that do not dominate a single autoregressive specification for relative wages, and there is also overall significance in the largest sector, where as it tuns out two of the three important coefficients are incorrectly signed. In this sector (fabricated metal products), only the change in relative productivity has the predicted positive effect. There is also some cyclicality in this sector's relative wages, as shown by the significance of both aggregate vacancies and the change in inflation.

In Finland only three of the coefficients on the sector variables are significant. Relative productivity is significant in only one sector and employment share in none. Relative vacancies, however, are significant in two sectors. The autoregressive specification does well in six of the nine sectors and the evidence shows that where there are systematic fluctuations in relative wages these are cyclical, i.e. related to aggregate changes. However, given the large absolute change in Finland's relative wages and the performance of the LM tests for autocorrelation, we suspect that there is a potentially more successful dynamic specification for this country. The overall failure of our regressions to pick up significant sectoral variables may be partly related to dynamic misspecification, though the failure of relative employment growth in all sectors must indicate that the fluctuations in relative wages are not dominated by underlying labour requirements.

In Britain, relative vacancies are either insignificant or wrongly signed everywhere. Cyclicality in the data is less frequently observed than in the other countries, so in the small number of sectors where the autoregressive specification does not do well there are sector-specific influences on relative wages. Thus, relative productivity is significant and correctly signed in six sectors and employment share in seven sectors. This is more supportive of the view that wages reflect sector performance than in either of the Scandinavian countries, though it is still only a minority of the sectors that exhibits sectoral influences of any kind. There is overall significance of the sectoral variables in only four sectors (8, 12, 13, 16) and near-significance in the big engineering sector. This is the same order of overall performance of the sectoral variables as in the Scandinavian countries. There is partial adjustment of relative wages in Britain almost everywhere.

The results for the United States strongly support the view that relative wages are subject to cyclical influences. Sectoral variables perform poorly in the vast majority of sectors. Relative productivity or its first difference is incorrectly signed in two sectors and only four out of 34 estimated coefficients on relative productivity or its first difference are significant and of the predicted sign. Employment share does better, with seven coefficients correctly signed, two incorrectly signed and 25 not significantly different from zero. By contrast, the change in wage inflation is significant in 11 sectors and unemployment or its change in 8.

Thus relative wages in the United States are better explained by our regressions than in the European countries but only because of the influence of the aggregate variables. This influence is not related to changes in sectoral demands, and hence to sectoral labour requirements,

unless one believes that aggregate inflation and unemployment are driven by sectoral shocks. Lilien (1982) put this view forward for the United States, but as Abraham and Katz (1986) have argued, the correlation is more likely to be reversed: aggregate shocks that cause cyclical fluctuations in aggregate variables affect individual sectors at different speeds and to different degrees. The discussion so far in the literature has been in terms of sectoral employment change. Our evidence shows that sectoral wages are also influenced non-uniformly by aggregate shocks over the cycle. The existence of overlapping nominal contracts in most of US manufacturing could explain this pattern, as sectors respond at different times to observed changes in inflation and unemployment (see Taylor 1980). Their absence in Europe could also explain why we have failed to find as much cyclicality in relative wages in the European countries as we found in the United States.

In terms of relative productivity and employment share, performance in the United States is of about the same order of magnitude as in the European countries, with about one third of the sectors showing significant sector influences. As a further test of sectoral influences in the United States, and given the absence of sectoral vacancies, we tried sectoral inventory holdings. We have quarterly inventories for eight of the 17 sectors in our sample. A rise in inventory holdings in one sector over and above holdings in other sectors indicates that the sector needs to recruit less labour, since production exceeds sales. In three of the nine sectors (2, 3, 8) we find a significant negative coefficient on the sector's relative inventory holding, where we include it in the list of regressors. But in three other sectors (1, 6, 7) we find a significant positive coefficient and in the other two sectors (4, 5) no significant effect at all. Thus, although there is evidence of flexibility of relative wages

with regard to inventory holdings, there is no strong evidence that sectors with above normal inventory holdings reduce their relative wage rate.

5. Concluding Remarks

The hypotheses that we have examined are whether relative industrial wages fluctuate in response to economic change and whether, when they do, they reflect sectoral performance and labour requirements. We estimated altogether 50 regressions for relative industrial wages in four countries. One of the four countries, Sweden, is characterised by a centralised wage-setting mechanism with the explicit objective of wage equality across sectors. Our results show that wage setters have been largely successful in this objective. Relative industrial wages in Sweden have fluctuated by much less than in the other three countries in our sample. But we have also found that in two of the eight sectors in the Swedish sample, changes in relative wages, although small, have reflected sectoral performance. In the biggest sector (fabricated metal products) changes in wages have reflected other objectives and have even been perverse when compared to sector performance. Thus, Sweden's centralised institutions appear to have (a) made relative wages more rigid than in other countries, (b) insulated relative wages from aggregate economic changes, but (c) allowed some very limited response of relative wages to sectoral performance in some sectors.

In contrast to centralised Sweden, in the United States wage setting takes place at the firm level and it is largely free of union influences. Unions are concentrated in manufacturing, where most of our sample comes from, but they are still less influential than in the other countries in our sample. As expected, (a) relative wages in the United States fluctuate by much more than in Sweden, and (b) more of the fluctuations can be attributed to the economic variables in our regressions. But perhaps surprisingly, (c) most of the fluctuations in relative wages are in response to changes in aggregate inflation and unemployment, not in response to changes in sector performance. Thus, although in the United

States there are more 'economic' influences on relative wages, they do not appear to be related to the labour allocation function of relative wages.

Britain and Finland are between the two extremes of Sweden and the United States with regard to union coverage and centralisation of wage negotiations. British unions are less co-operant with each other than Swedish or Finnish unions, but they are mainly craft unions that cut across industrial boundaries. Finnish unions do not have as much craft base and they are more industry based. We found that (a) relative wages in both Finland and Britain fluctuate by more than in Sweden and by about the same order of magnitude as in the United States. But (b) economic influences do not appear to be as important as in the US, especially in Finland. In Finland, there is no evidence of strong sectoral influence on relative wages, though there is some evidence of aggregate cyclical influence. In Britain there is a little more influence at the sectoral level, but as in the other countries only about one third of the sectors appears to have relative wages that are responsive to sectoral performance.

Undoubtedly improvements to our study can be made. In some of the sectors the common dynamic specification that we have imposed is clearly inadequate. There is evidence of lagged adjustments in relative wages in virtually all sectors in our sample. We have allowed for unrestricted lags of up to a year, which proved satisfactory for Sweden and Britain, but in some US sectors and in most Finnish sectors there is evidence of dynamic misspecification. More disaggregated data - especially for Sweden where more than half of the labour force in the sample is employed in a single sector - may also shed more light on the issue.

Footnotes:

* We have benefited from the comments of many people, in particular D. Hibbs, A. Lindbeck (the discussants of the version read at the Wage Formation conference in Stockholm in April 1988), L. Calmfors, R. Jackman, B. Knight, R. Layard, M. Stewart and J. Symons. Help with the Scandinavian data was generously provided by A. Forslund (Sweden) and by T. Erikson (Finland). The data for Britain were compiled by I. McMaster, who also co-authored an early version of a paper on Britain (Pissarides and McMaster, 1984), dealing with similar issues and arriving to similar conclusions. Financial assistance from the Nordic Economic Research Council and the British ESRC is gratefully acknowledged.

1 See e.g. Bean, Layard and Nickell (1986) and other contributions in the same *Economica* volume. These papers take the supply of labour as exogenous. For a three equation country model with endogenous supply see Pissarides (1987).

2 That is, our specification nests the autoregressive one, so an F-test for the exclusion of the additional regressors is an appropriate test.

TABLE 1: Sectors used in the analysis

(a) Sweden

	Mean Employment, 000s	Share
1. MQ: Mining and quarrying	14.9	1.7
2. FR: Food products	85.4	9.9
3. WP: Wood products	84.8	9.8
4. PP: Paper products	63.4	7.3
5. CH: Chemicals	73.0	8.4
6. NM: Non-metallic minerals	31.7	3.6
7. BM: Basic metal industries	62.8	7.6
8. FM: Fabricated metal products	452.3	52.1
Total:	868.3	100.0

(b) Finland

	Mean Employment, 000's	Share
1. FR: Forestry	58.7	5.0
2. AG: Agriculture	272.0	22.9
3. BC: Building	131.0	11.0
4. OC: Other construction	51.7	4.3
5. TN: Transports	176.5	15.0
6. FD: Food, drink and tobacco	62.5	5.2
7. PW: Paper and wood	162.1	13.6
8. TX: Textiles	75.4	6.3
9. MT: Metal industry	198.0	16.7
Total	1187.9	100.0

(c) Britain

	Mean Employment, 000s	Share
1. FD: Food, drink and tobacco	718.8	7.8
2. CC: Coal, petroleum, chemical and allied industries	469.8	5.1
3. MM: Metal manufacture	514.2	5.5
4. EN: Engineering and electrical goods	1983.5	21.0
5. SM: Shipbuilding and marine engineering	178.6	1.9
6. VE: Vehicles	771.1	8.4
7. MG: Metal goods not elsewhere specified	551.7	6.0
8. TX: Textiles	553.3	6.0
9. LF: Leather, leather goods and fur	44.3	0.5
10. CF: Clothing and footwear	405.8	4.4
11. BP: Bricks, pottery, glass, cement, etc.	286.0	3.1
12. TF: Timber, furniture, etc.	260.2	2.8
13. PP: Paper, printing and publishing	571.0	6.2
14. OM: Other manufacturing industries	311.7	3.4
15. CN: Construction	1328.1	14.1
16. GE: Gas, electricity and water	367.6	4.0
Total	9225.8	100.0

(d) USA

	Mean employment, 000s	Share
1. PM: Primary metal industries	1162	7.4
2. FM: Fabricated metal products	1407	9.0
3. MA: Machinery, except electrical	1853	11.8
4. EE: Electrical and electronic equipment	1691	10.8
5. TX: Textile mill products	941	6.0
6. CH: Chemical products	939	6.0
7. PC: Petroleum and coal products	204	1.3
8. RP: Rubber and plastic products	543	3.4
9. LW: Lumber and wood products	700	4.5
10. SC: Stone, clay and glass products	620	4.0
11. TB: Tobacco manufactures	84	0.5
12. AP: Apparel products	1272	8.1
13. PP: Printing and publishing	1046	6.7
14. LE: Leather products	310	2.0
15. FF: Furniture and fixtures	418	2.6
16. TE: Transportation equipment	1841	11.8
17. PA: Paper products	636	4.1
Total	15667	100.0

TABLE 2: Significant sectors in each country (Sector number as in Table 1)

	Sweden (8 sectors)	Finland (9 sectors)	Britain (16 sectors)	USA (17 sectors)
Lagged dependent variable[1]	3,4,6,8	2,3,4,6, 7,9	1,2,5,8,9,10, 11,12,13,15	3,4,5,6,7,9, 10,11,13,15, 16
Relative wages ≠ 0	All but 4,6,7	All but 3, 4,6,9	All but 10, 12	All but 1,6,9 11,13,14,17
Relative wages ≠ -1	All but 2,3,7	All	All but 2,11 16	All but 5
Relative productivity	2,3		4,8,13,16	1,5,7*,8*
Change in relative productivity	2,8	7	12,15,16	8,12
Employment share	2,3,5,6*		2,4,9,12,16	1,2*,5,8,14
Change in employment share	6*,8*		1*,8,12,13,16	3,7,9,11*
Relative vacancies	6,8*	1,3	2*,8*,11*,12*	
Vacancies[2]	2,3,5,8	4,8	4	5,12,14,15
Change in unemployment				1,4,7,17
Change in inflation	8	2,3,4,6	4,9,14	1,2,3,4,5,6, 8,9,12,14,17
F-test[3]	2,3,8	3,7,8	2,8,12,13,16	1,2,3,4,5,6, 7,8,9,12,14, 17

Notes to Table 2:

The Table gives for each variable the sector number where a significant estimate was obtained at the 10% level. An asterisk indicates that the estimate was incorrectly signed. The Error Correction Model estimated is given in Appendix B. The dependent variable is the change is the log of the sector's relative wage and the regression includes also constant, seasonal dummies and three lagged dependent variables. The sample is quarterly for the following periods: Sweden, 1975Q2 - 1986Q2; Finland, 1973Q2 - 1985Q4; Britain, 1964Q2 - 1982Q4; USA, 1964Q2 - 1986Q4.

1. Sector listed when at lest one of the lagged dependent terms is significant.
2. For USA total unemployment rate is used instead of vacancies which are not available.
3. F-test for the exclusion of the seven economic variables following relative wages. The reported sectors are those for which exclusion is rejected (i.e. the F-statistic is significant).

TABLE 3: Estimated effects on relative hourly earnings*

(a) SWEDEN

	MQ (1)	FP (2)	WP (3)	PP (4)	CH (5)	NM (6)	BM (7)	FM (8)
Sum of lagged coefficients	0.71 (4.44)	–	–	0.90 (5.32)	0.49 (2.54)	0.56 (1.90)	0.50 (1.52)	0.73 (5.34)
Relative productivity	–	0.22 (4.20)	0.13 (4.78)	–	–	–	–	–
Change in relative productivity	–	0.64 (6.79)	–	–	–	–	–	0.31 (2.39)
Employment share	–	0.20 (3.55)	0.06 (2.31)	–	0.08 (1.81)	-0.08 (2.32)	–	–
Change in employment share	–	–	–	–	–	-0.15 (2.71)	–	-0.31 (2.26)
Relative vacancies	–	–	–	–	–	0.01 (2.15)	–	-0.01 (2.28)
Vacancies	–	0.62 (2.41)	-0.58 (2.85)	–	0.64 (1.74)	–	–	-0.74 (2.50)
Change in inflation	–	–	–	–	–	–	–	-0.14 (3.05)
Standard error	0.014	0.007	0.006	0.014	0.011	0.010	0.009	0.007
Standard deviation of dependent variable	0.028	0.012	0.011	0.027	0.015	0.012	0.012	0.012
LM(1)[1]	0.66	1.90	1.77	0.88	6.10	0.34	1.62	1.31
LM(4)[2]	0.98	1.96	2.11	1.36	2.25	1.87	1.14	3.42
F(7,30)[3]	1.45	7.62	4.53	1.50	0.81	2.02	1.03	2.40

(b) FINLAND

	FR (1)	AG (2)	BC (3)	OC (4	TN (5)	FD (6)	PW (7)	TX (8)	MT (9)
Sum of lagged coefficients	0.45 (2.30)	0.80 (4.26)	0.98 (14.20)	0.93 (6.94)	0.80 (6.15)	0.96 (5.65)	0.63 (2.17)	0.59 (2.57)	0.87 (5.44)
Relative productivity	–	–	–	–	–	–	–	–	–
Change in relative productivity	–	–	–	–	–	–	0.49	–	–
Employment share	–	–	–	–	–	–	–	–	–
Change in employment share	–	–	–	–	–	–	–	–	–
Relative vacancies	0.03 (2.02)	–	0.04 (3.68)	–	–	–	–	–	–
Vacancies	–	–	–	0.01 (1.80)	–	–	–	0.01 (2.97)	–
Change in inflation	–	-0.37 (2.09)	-0.27 (2.53)	0.27 (2.06)	–	-0.43 (2.39)	–	–	–
Standard error	0.040	0.021	0.013	0.015	0.010	0.021	0.023	0.012	0.008
Standard deviation of dependent variable	0.058	0.049	0.066	0.046	0.025	0.026	0.050	0.028	0.030
LM(1)[1]	0.36	8.13	5.73	5.93	1.18	0.56	4.65	4.56	3.20
LM(4)[2]	1.23	2.96	2.84	1.86	2.57	1.86	2.21	3.04	4.36
F(7,36)[3]	1.48	1.37	2.97	1.97	0.37	1.14	2.82	2.31	0.75

(c) BRITAIN

	FD (1)	CC (2)	MM (3)	EN (4)	SM (5)	VE (6)	MG (7)	TX (8)
Sum of lagged coefficients	0.48 (1.92)	–	0.50 (3.13)	0.58 (3.79)	0.69 (5.75)	0.74 (6.73)	0.81 (8.18)	0.66 (5.08)
Relative productivity	–	–	–	0.09 (1.77)	–	–	–	0.08 (1.95)
Change in relative productivity	–	–	–	–	–	–	–	–
Employment share	–	0.15 (2.07)	–	0.11 (1.97)	–	–	–	–
Change in employment share	-0.52 (1.82)	–	–	–	–	–	–	0.73 (2.89)
Relative vacancies	–	-0.06 (2.46)	–	–	–	–	–	-0.04 (2.32)
Vacancies	–	-0.03 (3.35)	–	0.01 (1.78)	–	–	–	–
Change in inflation	–	–	–	-0.11 (2.04)	–	–	–	–
Standard error	0.020	0.017	0.022	0.011	0.033	0.025	0.013	0.014
Standard deviation of dependent variable	0.030	0.028	0.025	0.017	0.044	0.046	0.024	0.027
LM(1)[1]	0.32	4.33	0.66	0.78	1.16	1.66	2.29	0.28
LM(4)[2]	0.81	1.48	0.91	3.17	1.34	0.41	1.58	0.23
F(7,60)[3]	1.47	4.24	1.41	2.01	0.81	1.70	1.23	2.34

(c) BRITAIN Contd....

	LF (9)	CF (10)	BP (11)	TF (12)	PP (13)	OM (14)	CN (15)	GE (16)
Sum of lagged coefficients	0.64 (4.03)	0.88 (11.13)	0.43 (1.30)	0.86 (6.83)	0.87 (8.70)	0.56 (2.80)	0.62 (3.48)	-
Relative productivity	-	-	-	-	0.22 (2.21)	-	-	0.27 (2.73)
Change in productivity	-	-	-	0.35 (2.15)	-	-	-0.73 (2.58)	0.99 (1.72)
Employment share	0.17 (1.85)	-	-	0.17 (2.45)	-	-	-	0.46 (2.33)
Change in employment share	-	-	-	0.42 (2.42)	0.67 (1.81)	-	-	1.81 (3.11)
Relative vacancies	-	-	-0.02 (1.78)	-0.03 (1.89)	-	-	-	-
Vacancies	-	-	-	-	-	-	-	-
Change in inflation	-0.20 (1.81)	-	-	-	-	-0.23 (3.40)	-	-
Standard error	0.021	0.016	0.012	0.017	0.016	0.013	0.029	0.041
Standard deviation of dependent variable	0.055	0.045	0.015	0.034	0.034	0.015	0.040	0.072
LM(1)[1]	0.22	0.59	0.08	0.52	0.07	0.17	0.10	0.29
LM(4)[2]	1.52	0.66	0.40	2.19	0.76	1.81	1.76	0.84
F(7,60)[3]	1.80	1.31	1.03	2.46	3.45	2.25	1.95	4.17

(d) USA

	PM (1)	FM (2)	MA (3)	EE (4)	TX (5)	CH (6)	PC (7)	RP (8)
Sum of lagged coefficients	0.96 (25.95)	0.59 (4.21)	0.82 (8.28)	0.96 (12.15)	0.46 (3.29)	0.75 (18.75)	0.61 (3.74)	0.67 (5.78)
Relative productivity	0.04 (2.27)	–	–	–	0.08 (2.48)	–	-0.10 (1.82)	-0.06 (1.90)
Change in relative productivity	–	–	–	–	–	–	–	-0.18 (1.89)
Employment share	0.04 (2.50)	-0.05 (2.10)	–	–	0.05 (2.12)	–	–	0.32 (8.93)
Change in employment share	–	–	0.08 (2.22)	–	–	–	0.14 (1.78)	–
Unemployment	–	–	–	–	-0.04 (3.98)	–	–	–
Change in unemployment	-0.04 (2.00)	–	–	0.04 (2.43)	–	–	0.16 (2.04)	–
Change in inflation	-0.47 (4.56)	-0.21 (3.48)	-0.35 (5.14)	-0.28 (3.16)	-0.24 (1.96)	-0.32 (4.07)	–	-0.43 (4.45)
Standard error	0.010	0.006	0.006	0.009	0.012	0.007	0.036	0.010
Standard deviation of dependent variable	0.061	0.010	0.013	0.016	0.021	0.036	0.072	0.038
LM(1)[1]	2.22	2.74	8.18	4.14	0.55	3.75	1.86	2.79
LM(4)[2]	1.33	1.63	5.04	3.39	0.98	1.73	2.56	1.22
F(7,68)[3]	5.56	3.17	6.83	3.77	5.01	4.52	2.18	18.5

(d) USA Contd....

	LW (9)	SC (10)	TB (11)	AP (12)	PP (13)	LE (14)	FF (15)	TE (16)	RP (17)
Sum of lagged coefficients	0.71 (14.79)	0.45 (2.37)	0.66 (10.65)	0.84 (13.13)	0.85 (7.02)	0.94 (15.93)	0.60 (4.38)	0.54 (3.00)	0.91 (35.00)
Relative productivity	–	–	–	–	–	–	–	–	–
Change in relative productivity	–	–	–	0.17 (1.90)	–	–	–	–	–
Employment share	–	–	–	–	–	0.02 (2.05)	–	–	–
Change in employment share	0.10 (2.34)	–	-0.11 (2.58)	–	–	–	–	–	–
Unemployment	–	–	–	-0.03 (3.42)	–	-0.01 (2.82)	-0.04 (2.69)	–	–
Change in unemployment	–	–	–	–	–	–	–	–	0.02 (1.82)
Change in inflation	-0.40 (4.08)	–	–	-0.45 (4.40)	–	-0.47 (5.31)	–	–	-0.34 (5.34)
Standard error	0.009	0.027	0.024	0.010	0.032	0.007	0.018	0.034	0.005
Standard deviation of dependent variable	0.035	0.031	0.143	0.063	0.055	0.064	0.036	0.046	0.041
LM(1)[1]	1.22	3.28	0.51	6.49	6.46	6.48	1.28	0.35	6.66
LM(4)[2]	1.40	1.04	0.40	2.29	3.25	3.02	1.10	0.33	3.58
F(7,68)[3]	4.71	0.87	1.46	6.27	0.58	8.51	1.53	1.42	6.22

Notes to Table 3:

* Coefficient estimates from the error-correction model given in Appendix B, with the level of the relative wage as dependent variable. Estimates not significant at 10% level or better indicated by dash. Sector symbols and numbers as in Table 1.

1. F test (LM) for first-order autocorrelation, critical value at 5% level:

Sweden	4.18
Finland	4.12
Britain	4.00
USA	3.98

2. F test (LM) for autocorrelation up to fourth order, critical value at 5% level:

Sweden	3.01
Finland	2.87
Britain	2.60
USA	2.58

3. F test for the exclusion of the seven non-wage economic variables. Critical value at 5% level:

Sweden	2.33
Finland	2.31
Britain	2.33
USA	2.13

4. Chow tests for parameter changes four and eight quarters before the end of each sample rejected at 5% in all cases.

APPENDIX A: The formal model

In this appendix we give a formal statement of the dynamic adjustments that take place at the sectoral level, following shocks to the sectoral demand for labour.

The firm's demand for labour in each sector i is derived from profit maximisation and can be written, in log-linear form, as

$$n_i^d = a_i - \alpha_i(w_i-p_i) - \beta_i(p_i-p) + z_i \qquad (1)$$

where n_i^d is (the log of) labour demand in sector i, a_i is an all-inclusive variable representing productivity change and other 'equilibrium' influences on labour demand, w_i is the wage paid in sector i, p_i the price of output, p the general price level and z_i a shock to labour demand. A rise in the sector's relative price, p_i-p, reduces output demand, reducing the sectoral demand for labour at given real wage. If firms are monopolistic competitors, the variable will enter their demand function, as in equation (1). But if they are perfect competitors it will not, as the firm can then sell everything it wants at the sector price p_i. The inclusion or exclusion of this variable is not important for our results.

Supply to sector i is given by the dynamic equation

$$\Delta n_i^s = \gamma_i + \delta_i(w_i-w) + \varepsilon_i(\theta_i-\theta) \qquad (2)$$

where n_i^s is the supply of labour to sector i, Δ is the difference operator, γ_i represents the 'compensating' differentials that exist in equilibrium because of underlying differences in the relative attractiveness of sectors, w is the aggregate wage rate, θ_i is the sector's excess demand position (e.g. vacancy-unemployment ratio) and θ is the average of the θ_i's. Nickell and Kong (1987) estimated equations like (1) for Britain and Pissarides (1978) estimated equations like (2), also for Britain.

Now suppose, without loss of essential generality, that

$$\theta_i = n_i^d - n_i^s, \qquad (3)$$

and that the aggregate supply of labour is fixed at $\bar{n}$. Then, substituting from (3) into (2) we get

$$\Delta n_i^s = \gamma_i + \delta_i(w_i - w) + \varepsilon_i(n_i^d - n_i^s - n^d + \bar{n}). \tag{4}$$

Equation (4) is a dynamic equation in labour supply and equation (1) is an equation in labour demand that holds both during adjustment and in stationary equilibrium. These equations jointly determine supply and demand for given wages. To close the model we require a theory of wages; what is interesting here is that long-run equilibrium can be reached regardless of wage behaviour during adjustment.

To show this suppose for simplicity and without loss of essential generality that prices are fixed (e.g. by international competition), so let $p_i = p$ for all i. It is natural to define long-run equilibrium by equality between supply and demand in all sectors and by stationary shares, i.e.

$$n_i^d = n_i^s \text{ for all } i \tag{5}$$

$$\Delta n_i^s = 0 \text{ for all } i \tag{6}$$

Then (4) implies

$$w_i - w = -\gamma_i/\delta_i, \tag{7}$$

sectoral wage differentials compensate for the underlying attractiveness of sectors. Sectors with higher attractiveness, $\gamma_i > 0$, pay less than average in equilibrium.

Aggregate wages are determined by the condition that all the supply of labour is employed,

$$\Sigma n_i^d = \bar{n}. \tag{8}$$

Substituting from (1) into (8) we get

$$\Sigma a_i - \Sigma\alpha_i(w_i-p) + \Sigma z_i = \bar{n}. \qquad (9)$$

In general equations (7) and (9) are solved for all the w_i. More simply, if α_i is independent of i, (9) is solved for $w(= \Sigma w_i)$ and then (7) gives the w_i. With knowledge of w_i, (1) gives employment in each sector. We adopt this simplification and write α_i without subscript, and we write also a and z for the aggregate a_i and z_i. Then (9) implies

$$w - p = -(\bar{n}-a-z)/\alpha, \qquad (10)$$

and so from (7)

$$w_i - p = -(\bar{n}-a-z)/\alpha - \gamma_i/\delta_i. \qquad (11)$$

Substituting into (1) we get employment in each sector

$$n_i = \bar{n} + a_i - a + z_i - z + \alpha\gamma_i/\delta_i \qquad (12)$$

Equation (12) implies that a structural shift in demands across sectors (change in z_i with z constant) reallocates labour across sectors one for one. But supply also has some influence on the equilibrium sectoral distribution of labour: more attractive sectors at given wages (γ_i higher) employ more labour.

Adjustment to the long-run equilibrium described by (11) and (12) can be brought about in a variety of ways. We consider two extremes, one where wages do not change at all and one where they change continuously to maintain equality between sectoral demands and supplies.

In the first case suppose all the w_i's are fixed by (11) throughout adjustment, i.e. (7) is satisfied and so (4) becomes

$$\Delta n_i^s = \varepsilon_i(n_i^d - n_i^s - n^d + \bar{n}). \qquad (13)$$

Labour demand is given by (12), and aggregate labour demand is equal to aggregate labour supply by definition (though actual employment is in general less than both

during adjustment, as there are unsatisfied excess demands in the expanding sectors). So (13) becomes, upon substitution of n_i^d from (12)

$$\Delta n_i^s = \varepsilon_i(\bar{n}+a_i-a+z_i-z+\alpha\gamma_i/\delta_i) - \varepsilon_i n_i^s. \tag{14}$$

Equation (14) is a stable difference equation in sectoral labour supply. Supply in each sector tends to its long-run equilibrium monotonically because of the influence of excess demand on the cross-sectoral mobility of labour ($\varepsilon_i>0$).

As an alternative to fixed-wage adjustment, suppose supply and demand in each sector are always equal to each other during adjustment. Then omitting superscripts in (4) we get the sectoral change in employment

$$\Delta n_i = \gamma_i + \delta_i(w_i-w). \tag{15}$$

But from (1),

$$\Delta n_i = \Delta a_i - \alpha\Delta w_i + \Delta z_i \tag{16}$$

so (15) becomes a difference equation in sectoral wages

$$\Delta w_i = (-\gamma_i+\delta_i w+\Delta a_i+\Delta z_i)/\alpha - (\delta_i/\alpha)w_i. \tag{17}$$

During adjustment w is fixed by (10), as aggregate labour demand is always equal to aggregate labour supply, so (17) is stable and sectoral wages tend to their long-run equilibrium (11).

The two extreme cases that we considered illustrate the nonuniqueness of wages during adjustment. In the first case wages are unresponsive to demand shocks, yet employment adjustment is complete. In the second case wages respond to sectoral shocks during adjustment. Employment adjusts to the same long-run equilibrium as before.

APPENDIX B

Relative Hourly Earnings Equation

The Error Correction Model estimated for Sweden, Finland and Britain is given below in log-linear form:

$$\Delta(\ln w_i - \ln w_{(i)}) = \alpha_0 + \sum_{j=1}^{3} \alpha_j \Delta(\ln w_i - \ln w_{(i)})_{-j} + \alpha_4 \Delta_1 \Delta_4 \ln w_{(i)} +$$

$$\alpha_5 \Delta\left[\ln(y/n)_i - \ln(y/n)_{(i)}\right] + \alpha_6 \Delta \ln(n_i/n) +$$

$$\alpha_7 (\ln w_i - \ln w_{(i)})_{-1} + \alpha_8 (\ln v_i - \ln v_{(i)})_{-1} + \alpha_9 \ln v_{(i)-1} +$$

$$\alpha_{10}\left[\ln(y/n)_i - \ln(y/n)_{(i)}\right]_{-1} + \alpha_{11} \ln(n_i/n)_{-1}.$$

Subscript (i) denotes aggregation over all sectors except i and subscript -j denotes j lags. Since no sectoral vacancy or unemployment data are available for the US, we used the log of the total unemployment rate instead of vacancies in the US regressions. The change in unemployment was also used as an independent variable in the US regressions. The estimates reported in Table 3 are derived from the above regressions by re-arranging terms so the dependent variable is in level. The symbols are as defined in Appendix C.

APPENDIX C

DATA DEFINITIONS AND SOURCES

(a) Sweden

Source: Allmän Månadasstatistik 1987 Supplement, quarterly data, 1974Q1-1986Q2.

n_i Employment in industry i.

V_i Vacancies in sector i.

w_i Average hourly earnings in industry i.

y_i Index of production in industry i, 1980=100.

(b) Finland

All the data for Finland were kindly supplied to us by Tor Erikson, Nationalekonomiska Institutionen vid Abo Akademi. Quarterly data, 1971Q1-1985Q4.

n_i Employment in sector i.

V_i Vacancies.

w_i Average hourly earnings.

y_i Index of production, 1974=100.

(c) Britain

All quarterly data, 1963Q1-1982Q4 (SIC 1968 Orders).

n_i Employees in employment, in sector i, end of quarter. Table 1.2 of Department of Employment (DE) Gazette.

V_i Vacancies in sector i. End of quarter data up to the second quarter of 1976. Quarterly data from 1976Q3 onwards. Source: Table 3.3 of the DE Gazette.

w_i Average hourly earnings. End of quarter data all employees. Table 5.3 of DE Gazette. Series for sectors CC and EN were obtained from the data on their component SIC orders (IV and V; VII, VIII and IX respectively) using employment as weights.

y_i Quarterly data of the Index of Industrial production. Monthly Digest of Statistics (MDS) Table

v_i Sectoral vacancy rate:

$$v_i = \frac{V_i}{n_i}$$

$v_{(i)}$ Vacancy rate in all industries but i:

$$v_{(i)} = \frac{\sum_{j \neq i} v_j}{\sum_{j \neq i} n_j}$$

$w_{(i)}$ Weighted average of hourly earnings in all industries but i:

$$w_{(i)} = \frac{\sum_{j \neq i} w_j n_j}{\sum_{j \neq i} n_j}$$

$(y/n)_{(i)}$ Output per person (productivity) in all sectors but i:

$$(y/n)_{(i)} = \frac{\sum_{j \neq i} y_j}{\sum_{j \neq i} n_j}$$

The measure of relative productivity used in the regressions, $[\ln(y/n)_i - \ln(y/n)_{(i)}]$, is smoothed; it is the simple arithmetic average of the previous four quarters. Current values were omitted to avoid endogeneity problems.

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