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WAGE GAPS, FACTOR SHARES,
AND REAL WAGES

by
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The original purpose of this paper was to investigate the reasons for differences in wage rigidities across countries, with special emphasis on the role of labour market institutions in general and wage bargaining structures in particular. In fact, most of the paper is concerned with the much narrower issue of the appropriate measure of the gap between the actual real wage and the real wage that is consistent with full employment. Measurement is logically prior to testing: to investigate the sources of wage rigidity, it is evident that one must first have a satisfactory measure of wage rigidity. One such measure that has enjoyed much prominence in the recent literature is the Bruno/Sachs/OECD "wage gap", which is defined as the cyclically adjusted increase in labour's share in manufacturing value added or national income between a base period in the late 1960s or early 1970s and the year or period under consideration. More generally, the evolution of factor shares in the manufacturing sector has been at the centre of much of the recent literature on European wage rigidities and unemployment [e.g. Malinvaud (1982), Sachs (1983), Bruno and Sachs (1984), Giersch and Wolter (1983), Kouri (1982), and Calmfors and Horn (1983)].

In the light of this considerable literature, an empirical analysis of the connection between wage rigidities and labour market structures would lack credibility if it ignored the behaviour of factor shares and reached conclusions that were inconsistent with conclusions based on this approach. On the other hand, it would be inappropriate to base a study on a measure of the wage gap that one believed to be inappropriate and potentially highly misleading. Our solution to this impasse was to devote most of the paper to an empirical examination of the linkages running from real wages to capital intensity to factor shares. This analysis

demonstrates rather conclusively that indicators based on changes in factor shares are not useful as indicators of the gap between the actual and full employment real wage. This is a point of some importance in the light of the major influence of the contrary point of view.

The analysis is not primarily negative, however, as in the course of investigating the wage gap issue, the paper provides international evidence testing the proposition that firms are on their neoclassical labour demand curves, as well as evidence relating to changes in factor shares and capital intensity over time and across countries. The analysis also generates alternative measures of the wage gap that are argued to be appropriate, as well as an analytical framework for testing the connection between labour market structures and wage rigidities.

It should be emphasized at the outset that in no way does the evidence to be presented rule out the possibility that European wages have in fact been above the level that is consistent with full employment. The argument is simply that conventional wage gaps do not provide reliable answers to this question. In fact, the evidence provides rather strong support for the neoclassical labour demand curve, a finding that does not imply that real wages are rigid or that unemployment is classical, but does suggest that a lower product wage may be a necessary condition for an increase in employment.

The remainder of the paper is organized as follows. The first section sets out the theoretical framework which is based on a standard CES (constant elasticity of substitution) production function. The model generates two key

equations that are subjected to a variety of empirical tests. The first equation relates the share of capital income to capital intensity and possibly the rate of technical progress (depending on whether technical progress is Hicks- or Harrod-neutral). The second equation states that capital intensity depends on the product wage and technical progress. This second equation is simply a conventional labour demand curve written in an unconventional form in order to focus on the mechanisms running from the product wage to capital intensity to factor shares. Empirical tests relating to these two equations are reported in Sections II and III respectively. The fourth section interprets the results and considers the implications for wage gaps, while the fifth section outlines a possible approach for future research and the final section draws conclusions.

I - Theoretical Framework

There are two main limitations to the production function approach adopted in this paper. First, as is standard in much work of this kind, the capital stock is treated as an exogenous variable. Clearly it would be desirable to include an analysis of the determinants of investment, but that is outside the scope of this paper. The second limitation is that the production function excludes energy as an input, implying that energy and materials are "weakly separable" from capital and labour. The existing literature offers little help in indicating the nature of the bias that this assumption may introduce to the analysis. On the one hand, Berndt and Wood (1979) and others have found that energy and capital should be viewed as complements. On the other hand, the cross-country studies by

Griffin and Gregory (1976) and Pindyck (1979) find strong substitutability between capital and energy as well as between labour and energy. While these latter studies offer some support for the separability assumption, nevertheless the omission of energy from the production function is an acknowledged limitation of this paper.⁽¹⁾

The analysis begins with a CES production function with constant returns to scale and Hicks-neutral technical progress:

$$(1) \quad Y = Ae^{\lambda t} [(1-\delta)N^{-\beta} + \delta K^{-\beta}]^{-1/\beta}$$

where Y is net output or real value added, λ is the rate of Hicks-neutral technical progress, and N and K are the flows of labour and capital services. The parameter β is equal to $(1-\sigma)/\sigma$, where σ is the elasticity of substitution between labour and capital. The possibility that technical progress is Harrod-neutral will be introduced shortly. The next step is to follow Kmenta (1967) and Artus (1984) in adopting the following linear approximation for equation (1):⁽²⁾

$$(2) \quad y = a + \lambda t + (1-\delta)n + \delta k - \beta\delta(1-\delta)(k-n)$$

where y , a , n , and k are the logarithms of the corresponding upper case variables.

Assuming that the product wage (W) is equal to the marginal product of labour, it follows that:

$$(3) \quad \frac{\partial y}{\partial n} \equiv \frac{N}{Y} \frac{\partial Y}{\partial N} = \frac{NW}{Y} \equiv 1 - S^K$$

where S^K is the share of capital income in total income (or the "profit share"). After carrying out the partial differentiation of (2), equation (3) becomes:

$$(4) \quad S^K = \delta - \beta\delta(1-\delta)(k-n) \qquad \beta = (1-\sigma)/\sigma$$

This equation states that the capital share depends negatively or positively on the capital labour ratio as the elasticity of substitution is less than or greater than one. In the Cobb-Douglas case of $\sigma = 1$, it can be seen that $\beta = 0$ and factor shares are constant.

The next step is to recognize the link between capital intensity and the real wage. Holding capital constant, the demand for labour curve corresponding to (1) may be written in the form:

$$(5) \quad k-n = \text{constant} + (\sigma/S^K)(w - \lambda t)$$

where w is the logarithm of the product wage. For given k , the elasticity of demand for labour with respect to the product wage is σ/S^K , or simply the reciprocal of the profit share in the Cobb-Douglas case. While it is more conventional to write equation (5) with n on the left-hand side, it is here written with $(k-n)$ as the dependent variable because of our desire to focus on the mechanisms linking factor shares, capital intensity, and the real wage.⁽³⁾ Assuming that $\sigma < 1$, it can be seen from (4) and (5) that the profit share will be falling when the capital labour ratio is rising and that this will be the case when the real wage is rising faster than the rate of Hicks-neutral technical progress.

There is also the possibility that technical progress is Harrod-neutral rather than Hicks-neutral. In that case λ is set equal to zero, and N is replaced with $Ne^{\gamma t}$, where γ is the rate of Harrod-neutral technical progress. Equations (4) and (5) become respectively:

$$(4a) \quad S^K = \delta - \beta\delta(1-\delta)(k-n-\gamma t)$$

$$(5a) \quad k-n-\gamma t = \text{constant} + (\sigma/S^K)(w-\gamma t)$$

With $\sigma < 1$, the profit share will be falling when the capital-labour ratio is rising faster than the rate of Harrod-neutral technical progress, and this will be the case if the product wage is rising faster than the rate of Harrod-neutral technical progress.

It is not clear which if either of these two forms of technical progress is the appropriate assumption. Beckman and Sato (1969), for example, conducted tests based on the experiences of Germany, Japan, and the United States, and while the tests provided no strong conclusions, Solow-neutral or capital-augmenting technical progress actually performed somewhat better than the more standard Hicks and Harrod formulations. (If technical progress is capital-augmenting, the capital-labour ratio must be falling over time in order to maintain constant factor shares.) On the other hand, most studies of the manufacturing sector appear to be based on the assumption of Hicks-neutral technical progress; and Griffin and Gregory (1976), citing unpublished work by E.R. Berndt and D.O. Wood, claim that the Hicks-neutral assumption is appropriate. In any case, in view of the possible importance of this matter for the subject at hand, both versions will be tested empirically.

The final step is to follow Bruno and Sachs (1984, p. 178) in defining the wage gap as the difference between the actual product wage and the wage that is consistent with full employment. Using asterisks to denote full employment values, it then follows from equation (5) or (5a) that for a given capital stock, the wage gap is defined by:

$$(6) \quad \text{WGAP} = w - w^* = -(S^K/\sigma)(n-n^*)$$

One may also define a profit share "gap" (SGAP) in an analogous fashion using equation (4) or (4a):

$$(7) \quad \text{SGAP} = \beta\delta(1-\delta)(n-n^*)$$

We take up the issue of the appropriate definition of n^* in Section IV below.

It is clear that this production function approach pre-supposes that the economy is on its labour demand curve, implying that for a given capital stock, a higher level of employment requires a lower product wage. The standard procedure to test this proposition would seem to be the estimation of a labour demand curve such as (5), possibly augmented with demand-side variables to test the hypothesis that firms may on occasion be supply-constrained and hence off their labour demand curves. Lagged values of the real wage and/or the dependent variable could also be included to allow for adjustment costs. Beginning with the Tarshis-Dunlop studies of the 1930s, there has been much research along these lines, including recent work by Symons and Layard (1983), Geary and Kennan (1982), and Bruno and Sachs (1982; 1984, p.173). There is also a more micro-oriented literature in this area, e.g. Clark and Freeman (1977), Hamermesh (1976).

The approach taken in this paper differs somewhat from this literature, mainly because we wish to integrate this traditional approach with the more recent emphasis on wage gaps, factor shares, and capital intensity. More specifically, the empirical work to be presented in the next two sections focuses first on equation (4) which relates factor shares to capital intensity and then on equation (5) which relates capital intensity to the real wage and technical progress. Armed with empirical results in these two areas, we will then be in a

position to consider both the implications of our findings and their relation to the Bruno-Sachs approach.

II - Factor Shares and Capital Intensity

The objective is to estimate equations (4a) and (4b) for as many countries and over as many years as possible for both the aggregate economy and the manufacturing sector. For the aggregate economy, the following data were used:

K/N - Per capita capital input divided by per capita labour input, with 1970 level for the United States set equal to 1.00. Taken from Christensen et al. (1980) and available over the period 1955-1973 for Canada, France, Germany, Japan, the United Kingdom and the United States. Linked to 1973-79 series on gross capital stock per person employed, which was based on data from OECD, Flows and Stocks of Fixed Capital 1955-1980 and Historical Statistics 1960-1981.

s^K - Ratio of "operating surplus" to domestic factor incomes from OECD, National Accounts, various issues.

For the aggregate economy, only the Hicks-neutral version of equation (4) was estimated, and so no data on technical progress were used.

The following are the data and sources for the manufacturing sector:

- K|N - Gross constant price capital stock in the manufacturing sector divided by total hours worked, from OECD, Flows and Stocks, op. cit. and U.S. Bureau of Labor Statistics respectively. Converted to common currency at purchasing power parity exchange rates taken from Kravis et al. (1979), with 1970 U.S. value set equal to 1.00 as for the aggregate economy.⁽⁴⁾ Available from 1960 (or later) to 1980 for Canada, France, Germany, Japan, Sweden, United Kingdom and United States.
- S^K - Ratio of gross operating surplus to gross value added; data provided by OECD (generally the same as data in Historical Statistics, op. cit.). Available from 1955 (or later) for countries mentioned above.
- X - Estimates of Hicks-neutral technical progress, averages for 1955-73 and 1974-79, taken from Artus (1984). Converted (very roughly) to Harrod-neutral rates of technical progress by dividing by 2/3 (approximately labour's share). Available for seven countries mentioned above, minus Sweden.
- t - Time trend, set equal to zero in 1970, +1 in 1971, -1 in 1969, etc. (Notice that with t defined in this way and k-n set equal to zero for the United States in 1970, the constant terms of equations (4a) and (4b) are interpreted as capital's share for an economy with the level of capital intensity that prevailed in the United States in 1970.)

Figures 1 to 3 provide an overview of the evolution of factor shares since 1955 (the dotted and dashed lines may be ignored for the moment). Figure 1 provides a clear picture of a process of convergence. The chart plots the

FIGURE 1
Aggregate Profit Share 1955-79

FIGURE 2
Profit Share in Manufacturing Sector, 1955-1982

FIGURE 3

Profit Share in Manufacturing Sector, Five Countries
1955-1982

aggregate profit shares for Japan, Europe (the average of the three largest countries), and the United States. It can be seen that while all three regions have experienced a downtrend in the profit share, that trend has been strongest in Japan, which had the highest initial profit share, and weakest in the United States, which had the lowest initial profit share. Europe lies in the middle in terms of both initial position and trend. A similar picture can be found for the manufacturing sector, as shown in Figure 2 (in this case the chart plots the profit share for West Germany rather than Europe as a whole). The relative trends and starting positions are as for the aggregate economy, and the German profit share shows a very definite long term downward trend as before. However, the picture of Japan is more in the nature of two plateaus rather than a monotonic downtrend.

Figure 3 plots manufacturing profit shares for five other countries. Sweden, the United Kingdom and Italy display steady and substantial long term downtrends, albeit with major cyclical effects. Canada is subject to a weaker negative trend and major upswings in the profit share in the resource-boom years 1973-4 and 1979-80. Only France displays a distinct plateau effect, with a drop of some five percentage points from one relatively stable profit share up to 1974 to a lower but apparently equally stable level after 1976. It should be noted, however, that the data for both France and Italy are distinctly inferior to the data for the other countries.⁽⁵⁾ In brief, then, casual inspection of the evidence suggests relatively steady long term downtrends for all regions or countries in terms of aggregate profit shares and for all but France and Japan in the case of manufacturing profit shares.

Regression results are set out in Table 1. The regressions for the aggregate economy were based on pooled data covering the six countries over the twenty-five year period 1955-79. For both the aggregate economy and the manufacturing sector, regressions were run on the basis of both annual data and business cycle reference years as set out in Giersch and Wolter (1983, p. 53). However, the results were virtually identical under both approaches, and so only the results based on annual data are reported here. Line 1 of the table reports the regression result for the aggregate economy when both parameters of equation (4) are constrained to have the same values for all countries. It can be seen that the single explanatory variable $(k-n)$ can explain a relatively high proportion ($\bar{R}^2 = .60$) of the variations in profit shares both across the six countries and over the twenty-five year time period. The standard error falls from .053 to .017 when the country-specific intercepts are introduced, but there is not much further increase in explanatory power when σ is also allowed to vary across countries. The country-specific estimates for σ range from .46 to .72 as shown in Table 2.

Lines 3 and 4 of Table 1 report results for the manufacturing sector under Hicks- and Harrod-neutral technical progress when σ is constrained to be the same for all countries but δ is allowed to vary across countries. (The results for the manufacturing sector are based on six countries over the twenty year period 1960-1979). It can be seen that the two equations have approximately equal explanatory power but that the estimated value of σ is considerably higher under Hicks-neutrality than under Harrod-neutrality (.72 versus .45). Country-specific estimates are again reported in Table 2. Four of the six countries display a mild preference for Hicks neutrality, but for both France and Japan the data solidly reject Hicks neutrality in favour of Harrod neutrality.

TABLE 1
 Regression Results: Profit Share Equations*
 (t-statistics in brackets)

	a_0	a_1	St.error	R^2	$\hat{\sigma}$
A. <u>Aggregate economy</u>					
(1) <u>Hicks-Neutral</u>	.269 (47.6)	-.097 (15.1)	.053	.60	.67
	D**	-.100 (28.7)	.017	.96	.66
B. <u>Manufacturing sector</u>					
(1) <u>Hicks-Neutral</u>	D	-.088 (14.2)	.025	.93	.72
(2) <u>Harrod-Neutral</u>	D	-.273 (15.1)	.024	.93	.45

* Regressions are: $S^K = a_0 + a_1(k-n)$ Hicks-neutral

$S^K = a_0 + a_1(k-n-\gamma t)$ Harrod-neutral

** Denotes the use of country intercept dummies.

TABLE 2
Estimated Parameters, Seven Countries

	Aggregate economy		Manufacturing sector: Hicks-neutral		Manufacturing sector: Harrod-neutral	
	$\underline{\delta}$	$\underline{\sigma}$	$\underline{\delta}$	$\underline{\sigma}$	$\underline{\delta}$	$\underline{\sigma}$
Canada	.29	.70	.26	.77	.26	.89
France	.32	.68	.33	.83	.36	.50
Germany	.31	.72	.33	.74	.33	.46
Japan	.27	.65	.49	.75	.43	.43
Sweden	NA	NA	.32	.65	NA	NA
United Kingdom	.17	.60	.29	.56	.31	.39
United States	.23	.46	.26	.77	.26	.89

The reason for this last result can be seen clearly from the dotted and dashed lines of Figures 1 to 3. The former represent the predicted profit shares under Hicks neutrality when σ is constrained to be the same for all countries; hence the relative slopes of the dotted lines reflect the relative rates of capital deepening. It can be seen that while these dotted lines generally track the long term trend in profit shares rather well, they do not capture the French and Japanese manufacturing sector plateau effects that were mentioned earlier. On the other hand, these plateau effects are quite well accounted for under the assumption of Harrod-neutral technical progress, as can be seen from the dashed lines giving the Harrod-neutral results for Japan and France. These two countries had the highest pre-1973 rates of technical progress and the largest post-1973 drops in these rates. Growth rates of capital-labour ratios did not generally exceed rates of technical progress prior to 1969 in Japan and prior to 1973 in France, and the sharp drops in the rate of technical progress after 1973 were not immediately accompanied by corresponding drops in the growth rates of capital-labour ratios in these two countries. It is these features that account for the Harrod-neutral prediction of a two-step plateau effect for Japan and France, but not, it might be noted, for the other four countries.

Before drawing conclusions, it is convenient to present one more piece of evidence on the connection between factor shares and capital intensity. A drawback of the above analysis is that it was restricted to a small number of countries because of data limitations pertaining to the capital stock. However, a test involving more countries is possible if one is prepared to use an indicator of the stage of a country's stage of economic development as a proxy for capital intensity. The method adopted was to estimate the following regression based on pooled data for 14 countries:

$$S_{jt}^K = a_0 + a_1 \text{GAP}_{jt}$$

where S^K is the profit share in manufacturing as before and GAP is the negative of the logarithm of the ratio of the per capita GDP of country j to that of the United States. Hence GAP is always zero for the United States and rises with the country's distance from the United States in terms of per capita GDP. Profit shares are defined as period averages for 1955-59, 1960-67, 1968-73, and 1974-79, while GAP is defined on the basis of the first year of each sub-period.⁽⁶⁾

With GAP defined according to either the Kravis et al. (1979) data (GAP1) or at 1981 exchange rates (GAP2), the results of the regressions were as follows:

$$S^K = .249 + .227 \text{GAP1} \quad \text{SE} = .055 \quad \bar{R}^2 = .59$$

(14.9) (6.8)

$$S^K = .274 + .236 \text{GAP2} \quad \text{SE} = .045 \quad \bar{R}^2 = .73$$

(25.5) (9.2)

It can be seen that there is a highly significant positive relation between GAP and S^K according to both equations. Furthermore, when dummy variables are added for three of the four time periods, the coefficients are consistently small (not larger than .01) and insignificant (t-statistics less than 0.5 in absolute value). These results based on fourteen countries would seem to provide additional support to the results based on only six or seven countries.

The basic conclusion to be drawn from this analysis is that the longer term evolution of factor shares over time and across countries is well explained by a conventional CES production function in which the elasticity of substitution

is less than unity. Cyclical effects have also played an important role in the short run, as can be seen from the charts, although these effects were not estimated directly in the above analysis. Hence the convergence of profit shares shown in Figure 2 has been largely the result of a convergence of capital-labour ratios over the course of the post-war period.⁽⁷⁾ The analysis also suggested an explanation for the more sudden drop in manufacturing profit shares in Japan and France as compared with the other countries, although it should be noted that this point is not essential to the central themes of the paper and that there may be other possible explanations. Having established the relation between factor shares and the capital-labour ratio, we turn now to the determinants of the capital-labour ratio.

III - Capital Intensity and Wages

The next step is the estimation of equation (5), which concerns the relationship between capital deepening and real wages. The two forms of that relationship corresponding to Hicks- and Harrod-neutral technical progress may be written:

$$(5) \quad k-n = b(w-\lambda t) + \text{constant}$$

$$(5a) \quad k-n-\gamma t = b(w-\gamma t) + \text{constant}$$

where w is the logarithm of the product wage, λ and γ are rates of Hicks- and Harrod-neutral technical progress, and $b = \sigma/S^K$.

In general the results were as expected. When estimated as written, the equations yield values of b on the order of 1.75 under Hicks-neutral technical progress and 0.8 in the Harrod-neutral case. Levels of statistical significance are, not surprisingly, very high. If time trends are added to the equations, the coefficients b are reduced in magnitude but almost always remain statistically significant. These latter estimates are analogous to the results for labour demand curves obtained by Bruno/Sachs and others.⁽⁸⁾ Again Japan displays a strong preference for Harrod neutrality and North America for Hicks neutrality, but the preferences for the European countries are mixed and not in general consistent with the results of the previous section.

Rather than present these results in any detail, it was decided to conduct a rather more stringent test by estimating equation (5) in first difference form over cyclical peak years. Hence, if we define $x \equiv k-n$ as the logarithm of the capital-labour ratio, the equation becomes:

$$\dot{x} = b (\dot{w} - \lambda)$$

where dots denote annual percentage growth rates between reference years taken from Giersch and Wolter (1983) as before. Data were obtained for four cycles for each of the United States, Canada, Germany, France, and the United Kingdom, and there are three cycles for Japan.⁽⁹⁾ Hence there are 23 observations.

The regression equations with and without Japan were respectively:

$\dot{x} = 1.76 + 1.30 (\dot{w} - \lambda)$ (4.1) (9.3)	St.error = 1.08	$R^2 = .79$
$\dot{x} = 2.09 + 1.11 (\dot{w} - \lambda)$ (4.3) (5.5)	St.error = .91	$R^2 = .61$

The coefficients on $(\dot{w}-\lambda)$ are highly significant both with and without Japan, but the positive and significant constant term suggests that the Hicks-neutral assumption is incorrect. However, the results deteriorate very markedly if Harrod neutrality is imposed. If the constant term is constrained to equal zero, the b coefficients rise to about 1.8, but the explanatory power of the equations drops substantially.

A further test was based on only two cycles, the first covering the whole period 1960-73 and the second for the period 1973-79 or thereabouts (the precise reference years are country-specific as already mentioned). The advantage of this approach is that the single long period 1960-73 is more likely to be free of cyclical effects; the disadvantage, of course, is that we have only 12 observations. These 12 observations are plotted in Figure 4.

The chart describes what is essentially a cross-country neoclassical labour demand curve in first difference form, except that a conventional demand curve would have the technology-adjusted real wage $(\dot{w}-\lambda)$ on the vertical axis and employment per unit of capital $(-\dot{x})$ on the horizontal axis. The most basic point to note is that, as in the regressions just reported, there is a strong positive relation between $\dot{x}$ and $\dot{w}-\lambda$, whether or not Japan is included. Broadly speaking, between 1960-73 and 1973-79, Japan and Germany slid down the curve ($\dot{w}-\lambda$ fell), France moved up the curve, and the United Kingdom and Canada stayed in the same place. The United States moved vertically upwards. It can also be seen, however, that while the cross-country relationship within each period was very close, the pre-1973 regression line is much steeper than the post-1973 line. This is confirmed by the following regressions for the sub-periods 1960-73 and 1973-79 respectively (including Japan):

FIGURE 4

Country code: C - Canada, F - France, G - Germany, J - Japan, UK - United Kingdom, US - United States.

$$\dot{x} = -.21 + 1.94 (\dot{w}-\lambda)$$

(0.4) (11.8)

$$SE = .62 \quad \bar{R}^2 = .97$$

$$\dot{x} = 2.78 + .75 (\dot{w}-\lambda)$$

(10.8) (8.6)

$$SE = .37 \quad \bar{R}^2 = .94$$

It is noteworthy that the constant term is very close to zero for 1960-73 (as expected if technical progress is Hicks-neutral) but very definitely positive for 1973-79. There are several possible explanations for this apparent twist of the relationship after 1973, but there are not enough observations to test the alternative hypotheses.⁽¹⁰⁾

Finally, it might be asked whether the above results are sensitive to the assumptions regarding rates of technical progress. It is possible, for example, that part of the estimated post-1973 slowdown in rates of technical progress was in fact a cyclical effect (see previous footnote), and the assumption of disembodied technical progress may itself be questioned. In the light of these points, it might be noted that if λ is dropped from the equation altogether and we simply regress $\dot{x}$ on $\dot{w}$, the relationship remains highly significant, albeit somewhat weaker.⁽¹¹⁾

The general conclusion, then, is that the results of this section, in combination with the findings reported in the literature cited above, would seem to provide considerable support for the neoclassical labour demand, at least when it is applied to cyclical peak years. In the present context, it can be said that there has been a strong link between changes in capital intensity and changes in the product wage both across countries and over time.

IV - Implications for Wage Gaps

There are two main implications for wage gaps. First, the empirical support for the neoclassical labour demand justifies the use of the wage gap equation (6), at least for cyclical turning points. With an estimated elasticity of demand for labour of approximately two, this wage gap equation may be written:

$$\text{WGAP} \equiv w - w^* = -.5 (n - n^*)$$

The direct approach to measuring the wage gap is to obtain an independent estimate of the employment gap ($n^* - n$) and then simply to multiply this gap by the reciprocal of the elasticity of demand for labour, which in this case is one half. One approach to measuring ($n - n^*$), followed by Artus (1984), is to assume that the manufacturing employment gap ($n^* - n$) is proportional to the gap between the actual and "full employment" unemployment rates ($U - \bar{U}$) for the aggregate economy at cyclical peak years. A key problem with this approach is how to estimate $\bar{U}$. A further problem relates to considerations of external balance. The Artus approach implies that if $U = \bar{U}$, then both WGAP and ($n - n^*$) are zero. If, however, one is interested in the sustainable real wage at full employment, then $U = \bar{U}$ is no longer a sufficient condition for a zero wage gap: it is also necessary that the current account of the balance of payments be in a sustainable position. If, for example, there is an unsustainable current account deficit at $U = \bar{U}$, then it would follow that $n < n^*$ for the traded goods sector as a whole and so the wage gap is positive.

These considerations suggest that in practice it may be difficult to measure wage gaps directly on the basis of unemployment rates, and for this reason it may be useful to have an indirect measure such as that proposed by Bruno

and Sachs. To consider the merits of the Bruno-Sachs wage gap, it is convenient to reproduce the factor share equations (4) and (7), with rounded values of the estimated parameters:

$$(4) \quad S^K = .3 - .1[(k-n^*) + (n^*-n)]$$

$$(7) \quad SGAP = -.1(n^*-n)$$

The capital-labour ratio in equation (4) has been decomposed into its two components: the full employment ratio $(k-n^*)$ and the employment gap (n^*-n) .

It can be seen that cyclically adjusted changes in S^K will provide a good approximation to changes in the true wage gap only if full employment capital labour ratios have been constant over time and across countries. International comparisons will be valid (up to a constant) only if $(k-n^*)$ has grown at the same rate in different countries. But a central point of our analysis of factor shares is that this condition has most definitely not been satisfied. Over the course of the post-war period $(k-n^*)$ has increased most rapidly in Japan and least rapidly in the United States, with Europe occupying the middle ground. This implies that the Bruno/Sachs wage gaps, which do not adjust for this factor, will overstate wage gaps in Japan and Europe relative to the United States.

Indeed, if one takes a longer term perspective, changes in $(k-n^*)$ have been the dominant reason for cross-country differences in the behaviour of factor shares. To give one example, between 1955 and 1979 Germany's manufacturing profit share fell by 13.9 percentage points, and even if the employment gap increased by as much as 20 percentage points over this period, equation (4)

implies that only some 2 percentage points of this drop would have been due to changes in (n^*-n) , with the remaining 11.9 points due to changes in $(k-n^*)$.

The solution, as Bruno and Sachs acknowledge in principle, is to adjust the estimated wage gaps for differences in the growth rate of $(k-n^*)$. But in order to make this adjustment, one must first have an independent estimate of $(n-n^*)$. So we are back to the original problem. Now of course one could choose to speak in terms of the share gap equation (7) rather than the wage gap equation (6), but there would seem to be nothing to be gained from focusing on factor shares rather than on real wages directly, and there may be something to be lost as it seems likely that factor shares will have a higher noise-to-signal ratio than real wages.

In essence, then, it does not seem possible to calculate wage gaps except on the basis of outside information on the employment gap (n^*-n) . Clearly in such a situation it is no longer possible to test the role of the wage gap by treating it as an independent variable explaining employment or unemployment. But it is not clear that such regressions offer advantages over the more conventional labour demand equation. Furthermore, if the above analysis is correct, it follows from (4) that the Bruno/Sachs measure of the wage gap that they use in their regressions is a linear function of $(k-n)$, and so it is not perhaps surprising that regressions of n or U on a linear function of $(k-n)$ produce some statistically significant results.

As noted in the introduction, none of this is to deny the possibility that real wages in Europe may have been too high or may still be too high. But

it is to deny that the observed behaviour of factor shares constitutes evidence that wage gaps have been larger in Europe than in America.

V - Wage Rigidities and Labour Market Institutions: An Analytical Framework

On the basis of the preceding analysis, we now proceed to develop an analytical framework for testing the relation between wage rigidities and labour market institutions. Both a direct approach and an indirect approach will be considered.

The neoclassical labour demand curve (5) may be written in the form:

$$(8) \quad n = a_0 + k - a_1[s - p + (p - p^y) - \lambda t]$$

where s is the logarithm of the money wage and p and p^y are the logarithms of consumer and producer prices respectively. Hence the product wage (labelled w above) is equal to $s - p^y$, and in equation (8) w is expressed as the sum of the real wage $(s - p)$ and the relative price term $(p - p^y)$. The labour demand curve may also be expressed in terms of the wage gap and the unemployment gap (UGAP). If it is assumed that:

$$(9) \quad n - n^* = -a_2 \text{ UGAP},$$

and if n^* is subtracted from both sides of equation (8), the result may be written:

$$(10) \quad \text{UGAP} = \theta(s - p - \mu)$$

where $\theta = a_1/a_2$ and $\mu = \lambda t + a_0/a_1 + (1/a_1)(k-n^*) - (p-p^y)$ is the real wage corresponding to full employment. Hence UGAP is proportional to the wage gap $(s-p-\mu)$, as is also implied by equation (6) above.

To the labour demand curve (8) or (10) is now added the following labour supply curve:

$$(11) \quad \text{UGAP} = -\Omega(s-p^e-\mu^e)$$

where the superscript e denotes an expected or target value. This equation may be viewed either as a conventional labour supply curve or as a function describing union decision-making. Now, eliminating s from (10) and (11), the result is given by:

$$(12) \quad \text{UGAP} = k(\hat{p} - \hat{\mu})$$

where $k = \theta\lambda/(\theta + \lambda)$ and a hat denotes the difference between an actual value and an expected or target value (i.e. $\hat{p} = p - p^e$ and $\hat{\mu} = \mu - \mu^e$). If inertia with respect to $\hat{p}$ is interpreted broadly to include the effects of nominally fixed contracts as well as sluggish price expectations, then equation (12) may be interpreted as follows: $\hat{p} > 0$ is the case of nominal wage rigidity and Keynesian unemployment, while $\hat{\mu} < 0$ is the case of real wage rigidity and classical unemployment. Note, however, that by assumption firms are always on their labour demand curve, whether unemployment is Keynesian or classical.

Writers such as Crouch (1983), Bruno and Sachs (1984), and McCallum (1983) have argued that certain institutional features (e.g. "corporatism", high

"social consensus" as represented by low strike rates, centralized wage bargaining) have had favourable effects on the degree of real wage flexibility. If such institutional characteristics are designated I and if $\hat{\mu}$ is our measure of real rigidity, then this hypothesis can be represented by the following linear approximation:

$$(13) \quad \hat{\mu} = b_0 + b_1 I$$

We are now in a position to distinguish between the direct approach and the indirect approach: the former involves the direct estimation of equation (13) on a cross-country basis, while the latter involves the substitution of (13) into (12) and the estimation of the resulting expression relating UGAP to $\hat{p}$ and I . The direct approach has the advantage that it permits the direct estimation of the link between rigidities and institutions. On the other hand, in contrast to the indirect approach, the direct approach requires that we have reliable measures of the real wage rigidity variable $\hat{\mu}$, and these may be difficult or impossible to obtain. The remainder of this section is devoted to a brief review of each of the two approaches.

The authors just mentioned have met with some success in terms of the indirect approach. To give one example, suppose that we are concerned with the six year period 1974-79, covering the post-OPEC I years up to the time of OPEC II and the world recession of the 1980s. Let UGAP equal the average standardized unemployment rate in 1974-79 minus the corresponding average for 1968-73. Suppose also that the "expected" inflation rate ($p^e - p_{-1}$) is equal to the previous period's inflation rate ($p_{-1} - p_{-2}$). Then $\hat{p}$ becomes $-\ddot{p}$, implying that if $\hat{\mu} = 0$, then UGAP is positive when inflation is falling ($\ddot{p} < 0$) and vice versa. The average value

of $\dot{p}$ for 1974-79 is $-(\dot{p}_T - \dot{p}_0)/6$, or one sixth of the negative of the change in inflation between 1973 and 1979. To avoid placing undue weight on any one year, let $\dot{p}_T$ and $\dot{p}_0$ be the average rates of consumer price inflation in 1977-79 and 1971-73 respectively. Let I be an indicator of the degree of corporatism as developed initially by Crouch (1983) and used by Bruno and Sachs (1984) and McCallum (1983). The range of I is from zero to one. Finally, let (13) be substituted into (12) and the resulting equation estimated on the basis of a sample containing the fourteen countries for which the OECD publishes standardized unemployment rates. (12)

The estimated equations, with and without Japan, are respectively:

$$\text{UGAP} = 3.13 - .24 (\dot{p}_T - \dot{p}_0) - 2.48I \quad \text{SE} = .87 \quad \bar{R}^2 = .46$$

(6.6) (2.4) (3.6)

$$\text{UGAP} = 3.82 - .38 (\dot{p}_T - \dot{p}_0) - 3.16I \quad \text{SE} = .57 \quad \bar{R}^2 = .77$$

(10.7) (5.0) (6.5)

On the basis of the equation excluding Japan, a totally non-corporatist country ($I=0$) had to choose between an average UGAP of 3.8 percentage points and a 10.0 point rise in the inflation rate (or some combination of the two), while for a fully corporatist country ($I=1.0$) these numbers were respectively 0.7 and 1.7.

While these results are quite striking (and replicated in various forms in the work just cited), they do not establish a direct link between institutions and wage rigidity: one must infer such a link from the fact that I was substituted for $\hat{\mu}$ in equation (12). While this constitutes an argument for the direct approach, how is one to measure $\hat{\mu}$? Certainly not by the wage gap. To regress

UGAP on the wage gap is to estimate the labour demand curve (10), since the wage gap is defined as $(s-p-\mu)$. If only the wage gap variable is significant in such a regression (and demand-related variables and/or an estimate of $\hat{p}$ are not significant), the implication is that firms are on their labour demand curve. The implication is not that real wages are rigid or that unemployment is classical, since, as stated in equation (12), it is possible to have Keynesian unemployment while at the same time firms are on their neoclassical labour demand curves. After all, Keynes himself assumed that firms were on their labour demand curves. What is needed is a measure of ex ante real wage rigidity rather than an ex post measure of the actual deviation of the real wage from its full employment level.⁽¹³⁾

One much measure has been proposed by Grubb, Jackman, and Layard (1983a), hereafter designated GJLa. They begin with a labour demand curve almost identical to (10) except that they write it as a price equation with p on the left hand side. Then, instead of adopting a supply curve such as (11), they estimate wage Phillips curves of the form:

$$(14) \quad \dot{s} = c_0 + c_1 \dot{p} + (1-c_1) \dot{s}_{-1} - c_2 U + c_3 t$$

where U is the unemployment rate, t is a time trend, and the other variables are as already defined. Their definition of real wage rigidity (RWR) is the number of point years of unemployment that are required to achieve a one percent reduction in the real wage, given that there is no permanent increase in the inflation. This may be written:⁽¹⁴⁾

$$(15) \quad RWR = \frac{d(\Sigma U)}{d(-\mu)} \bigg|_{\ddot{p} = 0} = c_1/c_2$$

Hence RWR depends positively on the coefficient on $\dot{p}$ in the wage equation (c_1) and negatively on the absolute value of the slope of the Phillips curve (c_2). Nominal inertia in wage setting (low c_1) is therefore a "good thing" except to the extent that it also implies a flat Phillips curve. This qualification is rather important in the case of the United States, for while c_1 is much lower for the U.S. than for Europe, c_2 is also much lower for the United States, with the result that the estimated values of RWR are almost identical in the two cases: 1.09 for the United States versus an average of 1.03 for the 14 European countries included in the sample.

To the extent that the GJLa rigidity indicator is judged appropriate, it could be used as a proxy for $\bar{u}$, and equation (13) could then be estimated directly. While the general rationale for the indicator seems convincing, nevertheless two possible weaknesses might be mentioned. First, because there is no allowance for any direct downward shift in real wage expectations, all of the adjustment necessarily comes via unemployment. GJLb did test for such a direct effect by including trend productivity growth in their wage equations, and they reported that their equations were not improved by this addition. Nevertheless, it seems fair to say that this finding does not constitute a conclusive rejection of a direct role for real wage expectations in the wage equations. Second, the time trend coefficients (c_3) vary considerably across countries, and indeed it is cross-country differences in c_3 that account for the bulk of the cross-country differences in unemployment performance (GJLb). While the reasons for these different time trends are not clear, it may be that a large value of c_3 is indicative of real rigidities and that the "true" measure would depend on the factors affecting

c_3 as well as on c_1/c_2 . While preliminary investigation indicates a significant correlation of the expected sign between corporatism/strike variables and a weighted average of c_2/c_1 , and c_3 ,⁽¹⁵⁾ the above considerations suggest that it is very difficult to obtain reliable measures of ex ante real wage rigidity.

VI - Conclusions

In line with the implications of a conventional CES production function with elasticity of substitution less than one, falling profit shares are well explained by capital deepening, while the rate of capital deepening is itself well explained by the growth rate of product wages in relation to the rate of technical progress. Both of these propositions received strong empirical support. There are two major implications for wage gaps. First, estimates of the wage gap based on cyclically adjusted changes in factor shares are inappropriate and give rise to upwardly biased estimates for Japan and Europe relative to the United States. Second, in light of the empirical support for the neoclassical labour demand curve, wage gaps are appropriately measured by an estimate of the "employment gap" divided by the reciprocal of the elasticity of demand for labour.

While most of the paper was concerned with the issues just discussed, the last section set out a framework within which to test hypotheses relating to linkages between wage rigidities and institutional features of the labour market. Although indirect tests of such hypotheses have generated highly suggestive results,

direct tests have so far been limited by the lack of reliable measures of ex ante real wage rigidity. The development of such measures would constitute a major step in the direction of more powerful empirical tests.

FOOTNOTES

- (1) Energy may be said to be weakly separable from capital and labour if K/N is independent of the relative price of energy. The elasticities reported by Griffin and Gregory (1976, p. 851) imply only very small effects on K/N as a result of changes in energy prices: the estimated values of the elasticity of substitution between capital and energy (σ_{KE}) are close to 1.0 while the values for σ_{LE} are on the order of 0.85. The results of Pindyck (1977) are more variable, with σ_{KE} approximately 1.5 for Canada and the United States and 0.6 for Europe and Japan, while σ_{LE} is very low for North America (0.4 or less) and greater than 1.0 for Europe and Japan.
- (2) Equation (2) is obtained by writing (1) in log form, applying a Taylor's series expansion to y about a value of β which is then allowed asymptotically to approach zero, and dropping the terms involving powers of β higher than one.
- (3) This formulation, based on a fixed stock of capital, is what Clark and Freeman (1977) call the "real wage model". This may be contrasted with the "relative factor price model", which is based on long run optimization with respect to both capital and labour. In this case the first order condition equating the marginal product of capital to the real cost of capital (c) also comes into play, and the capital-labour ratio becomes (in terms of logarithms):
$$k-n = \sigma(w-c) + \text{constant}$$
While the relative merits of the two models have been debated in the literature (e.g. Clark and Freeman, 1977), from the standpoint of this paper a major practical reason for choosing the real wage model is the lack of data on c for all of the countries in our sample.
- (4) However, the PPP conversion factors do not pertain directly to the capital stock in manufacturing, and so it is not clear that level differences are comparable across countries. This point is not critical from the present standpoint, but it does mean that the cross-country differences in manufacturing

sector δ shown in Table 2 below should be treated as suspect.

- (5) For countries other than France and Italy, the profit share is the ratio of gross operating surplus to gross value added as defined by the OECD. For France, on the other hand, the OECD publishes data provided by INSEE which include stock appreciation and which are available only for the period 1967-79. Data are also available from the U.S. Bureau of Labor Statistics over the period 1950-1982, but in this case the profit share has to be defined as one minus the ratio of labour cost to "gross product at market prices less value added tax". The data used in the regressions and shown in Figure 3 are the INSEE figures for 1967-79, linked to the BLS series for earlier and later years. The Italian data shown in Figure 3 are from the Bureau of Labor Statistics and suffer from similar problems.
- (6) The profit share data are from the OECD as before. Details on country coverage and data are available from the author on request.
- (7) More importance is attached to the results for the manufacturing sector, partly because important structural changes out of self-employment have influenced factor shares for the aggregate economy, and the connection between this and capital intensity is not altogether clear.
- (8) The equation $k-n = a_0 + a_1(w-\lambda t) + a_2 t$ was estimated for each of the seven countries. When a_2 is constrained to equal zero, a_1 is consistently in the range of 1.6 to 2.1, with t-statistics of 10 or better. With the equation estimated as written, the estimates of the coefficient a_1 and its t-statistic were as follows: Canada, 1.20 (3.7); France, .51 (6.3); Germany .92 (2.2); Japan, .53 (2.1); Sweden, .30 (2.2); United Kingdom, .35 (2.6); and United States, .75 (1.5).
- (9) In the case of Canada and the United States, the first cycle was defined as 1955-66 rather than 1962-66.

- (10) Possible factors contributing to a post-1973 shift in the relationship are: (i) the change in energy prices; (ii) the possibility that the post-1973 slowdown in rates of technical progress is overstated because a part of the post-1973 growth slowdown was cyclical in nature [evidence supporting this view, particularly for France and Japan, is given in Helliwell et al. (1984)]; and (iii) the possibility that some countries have been off their labour demand curves because of sales constraints.

- (11) For example, for the full sample of 27 observations (the original 23 plus 4 for Sweden, which is included now that data on λ are not required), the estimated equation is:

$$\dot{x} = 1.03 + .77 \dot{w}$$

(1.9) (8.6)

St.error = 1.14 $\bar{R}^2 = .74$

- (12) The Crouch corporatism indicator is based on four criteria: union movement centralization, low shop floor autonomy, employer coordination, and works councils. "Yes" in each of these categories gives the maximum score, and "no" in each category gives the minimum score. The corporatism index used in the regressions was the Bruno and Sachs (1984, p. 227) index divided by 4 in order to give a range of zero to one. The 14 countries included in the regression, together with their corporatism scores on a scale of 0 to 4 were: Australia (0), Austria (4), Belgium (.5), Canada (0), Denmark (3), Finland (1.5), France (0), Germany (4), Italy (.5), Japan (1.5), Netherlands (4), Norway (4), Sweden (4), United Kingdom (0), and United States (0).
- (13) It is certainly not suggested that Bruno and Sachs (1984) are unaware of this distinction, as their empirical analysis of the dynamics of price and wage setting behaviour is in some respects similar to the GJL analysis discussed below. However, it is suggested that their wage gap is inappropriate, and the GJL measure of real wage rigidity (see below) also casts doubt on the validity of the Bruno-Sachs argument regarding the benefits of nominal wage inertia. In terms of equations (14) and (15) below, Bruno-Sachs focus attention on c_1 while neglecting c_2 . If GJL are correct, this is inappropriate because c_2 is likely to be positively related to c_1 .

- (14) This result may be derived formally by substituting (14) into the first difference of (10) taking the sum to infinity of the resulting expression, and setting $\Sigma \dot{U}$ and $\dot{p}$ equal to zero. Intuitively, the conclusion $RWR = c_1/c_2$ can be derived from the wage equation alone if one assumes that the full adjustment occurs in one period. If s is fixed then a permanent one percent reduction in μ , implies that $\dot{p}$ rises by one point for one period only. It can be seen from (14) that if s is to remain fixed, the increase of c_1 that would otherwise occur must be offset by a one-period rise in U equal to c_1/c_2 .
- (15) If the corporatism indicator is regressed on the GJLa parameters c_2/c_1 and c_3 , then R^2 is .38 for a sample of 18 countries or .39 excluding Japan. The corresponding values of R^2 when the corporatism indicator is replaced with the logarithm of average working days lost per employee over the period 1950-78 are respectively .45 and .64. These results are effectively estimates of equation (13), with $\hat{\mu}$ set equal to a weighted average of c_2/c_1 and c_3 and the weights determined by the regression.

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