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## ABSTRACT

### Explaining Movements in the Labour Share*

In this paper we study the evolution of the labour share in the OECD since 1970. We present a theoretical model showing that it is essentially related to the capital-output ratio; that this relationship is shifted by factors like the price of imported materials or the skill mix; and that discrepancies between the marginal product of labour and the real wage (due to, e.g. product market power, union bargaining, and labour adjustment costs) cause departures from it. We estimate the model with panel data on 15 industries and 14 countries for 1973–93 and derive the evolution of the wage gap in Germany and the United States.

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## NON-TECHNICAL SUMMARY

The proportion of income that accrues to labour, as opposed to capital, is a key magnitude, from both an economic and a political point of view. Somewhat surprisingly, however, the labour share does not very often generate an interest among economists, partly because its constancy is taken as a granted 'stylized fact of growth'.

And yet, there have been considerable medium-run movements in the labour share in OECD countries over the last 35 years. Moreover, there are large cross-country differences in its behaviour. In the United Kingdom the labour share shows large short-run fluctuations around a stable level, while in the United States it goes through large short-run fluctuations around a mild downward trend, which becomes flat in the 1980s. In Japan, on the contrary, it experiences a sharp rise, which slows down considerably after 1975. The picture for continental Europe is typically hump-shaped, with the labour share going up and then down, but actual country experiences are heterogeneous. Even though most OECD countries are relatively similar from a technological point of view, the labour share has not converged among these countries. Lastly, in the policy debate, movements in the labour share are often interpreted as movements in real wages, although a cursory inspection of the data reveals that the correlation between changes in wages and changes in the labour share is not tight. As a result, a systematic investigation of the determinants of the labour share is called for.

In this paper we explore the factors driving the observed movements in the labour share in OECD countries from 1970 to now. The constancy of the labour share, as usually assumed in most economic models, is true only in the case of a Cobb-Douglas production function. We present a model showing that, once we depart from the Cobb-Douglas assumption, the labour share provides a compact way of looking at labour demand. We show that as long as labour is paid its marginal product, which must be the case in the long-run, there should be a one-for-one relationship between the labour share and the ratio of the capital stock to output. This relationship, which we label the *benchmark share schedule*, already takes into account the role of factors such as wages, labour-embodied technical progress and capital. Thus, any change in the labour share which shows up as a deviation from that relationship must arise from a shift in labour demand not due to changes in real wages, capital accumulation, or technical progress. In this connection, we identify a set of factors which shift the benchmark share schedule, like changes in the price of imported materials or labour heterogeneity in production. Another set of

factors puts the economy off that schedule, by changing the gap between the shadow marginal cost of labour and the wage, namely changes in markups of prices over marginal costs, in union bargaining power, and current and expected adjustment costs.

We also analyse the performance of the model empirically, using data on a panel of 15 industries in 14 OECD countries, over the period 1973–93. We estimate the relationship between the labour share and the capital-output ratio, controlling for variables proxying for some of the remaining factors mentioned above. The estimation is carried out following a recent proposal by Arellano and Bover of a system estimator for panel data, which allows us to exploit the relationship between the variables in both levels and first differences. We find that there is a significant relationship between the two key variables, which suggests that there are departures from the Cobb-Douglas production function. The covariation is positively signed in 11 out of 15 industries, indicating that labour and capital are most often complements, rather than substitutes. But there is also evidence of movements in the labour share due to either shifts of the benchmark share schedule, arising from changes in the real price of oil, and of movements off this schedule, arising from labour adjustment costs and changes in workers' bargaining power.

As an application of the theory, we revisit the issue of the so-called wage gap, i.e. the difference between wages and the marginal product of labour. In the economics literature it has often been concluded that wage gaps were high in European economies in the second half of the 1970s (and this was associated with unemployment being 'Classical'), but they disappeared in the 1980s (so that unemployment was 'Keynesian'). Our model provides an alternative way of computing and decomposing wage gaps, starting from estimates of the labour share relationship. Thus, we carry out separate estimations of a labour share equation for Germany and the United States, and use them to compute the evolution of their wage gaps, decomposing them into their main elements.

Taking 1973 as the reference year (=100) in both countries, our computations indicate that that the German wage gap suffers large swings, reaching a peak of 12% in 1975, and not attaining the 1973 level again until 1990–1, after which it rises. In contrast, after a mild rise in 1975, the US wage gap hovers around 98% of the 1973 level. Our results therefore indicate higher and more persistent wage gaps in Germany than traditionally estimated, but strikingly similar results for the United States. As to its decomposition, we find that, quite naturally given the definition of the wage gap, in both countries its evolution has been the result of changes in the discrepancy between the wage and the marginal product of labour (in other words, shifts off the benchmark share schedule), themselves arising from labour adjustment costs and union bargaining power.

# 1 Introduction

In this paper we explore the factors driving the observed movements in the labor share in OECD countries from the 1970 to now. The labor share does not very often generate an interest among neoclassical economists, partly because its constancy is taken as a granted "stylized fact of growth".[1] Yet, as Figures 1 to 4 show for several countries, there have been considerable medium-run movements in the labor share over a period of 35 years.

Another striking fact is given by the large cross-country differences in its behavior. The UK exhibits the closest approximation to the "growth stylized fact", with the labor share experiencing large short-run fluctuations around a stable level (Figure 1). In the US the labor share undergoes sizable short-run fluctuations around a mild downward trend, becoming essentially flat in the 1980s (Figure 2). In Japan, on the contrary, it experiences a sharp rise, slowing down considerably after 1975 (Figure 3). The picture for continental Europe is typically hump-shaped, with the labor share going up and then down. But actual country experiences are heterogeneous: in Germany and France the labor share peaks in the early 1980s (Figure 4), while in other countries like Italy, the Netherlands, and Spain it does so in the mid-1970s.

From a cross-country perspective, it should be noted that these large differences across countries take place even though they are relatively similar from a technological point of view. Table 1 shows the evolution of the labor share in the business sector of 14 OECD countries since 1970. As evidenced by its first three columns, the labor share has not converged among these countries during the 1980s (the standard deviation has actually increased). In 1990, some countries like Fin-

[1] Recent exceptions are Blanchard (1997) and Caballero and Hammour (1997).

land, Sweden or the UK showed labor shares around 72%, while others like France, Germany or Italy had values around 62%.

Lastly, in the policy debate, movements in the labor share are often interpreted as movements in real wages. It is for example usually heard that because the labor share is currently low in Europe, there is no real wage problem. Of course, this is clearly mistaken, since it all depends on the elasticity of labor demand. A comparison of the last two columns of Table 1 indicates that the correlation between changes in wages and changes in the labor share is not tight (in other words, labor productivity behaves differently across countries). For example, from 1970 to 1990 France had one of the sharpest drops in the labor share and an above-average increase in the average real wage, while Sweden had one of the largest increases in the labor share and one of the lowest increases in real wages.[2] Thus, there is no clear pattern, and a more systematic exploration of the determinants of the labor share is called for.

What do we expect to learn from analyzing the labor share? As we shall see, it is a compact way of looking at labor demand, which allows us to control for the role of factors such as wages, labor-embodied technical progress and capital (or alternatively, real interest rates). We show below that, as long as labor is paid its marginal product, there should be a one-for-one relationship between the labor share and the capital-output ratio, which we label the *benchmark share schedule*. As long as that condition holds –and it must, at least in some *long-run* equilibrium–, changes in any of the just mentioned variables will generate changes of both the labor share and the capital-output ratio along that schedule. Any change in the labor share which shows up as a deviation from that relationship must arise from

[2]The correlation coefficient between labor share changes and real wage changes over the period 1970-90 across these 14 countries is 0.61.

a shift in labor demand which is not due to real wages, capital accumulation or technical progress, and therefore has to be explained by other considerations. In what follows, we study the role of factors which displace the schedule, like changes in the price of imported materials or in the skill mix, and also those which put the economy off the schedule, by changing the gap between the shadow marginal cost of labor and the wage, like changes in markups of prices over marginal costs, in union bargaining power, and current and expected adjustment costs.

We then analyze the performance of the model empirically, using panel data on a sample of 15 industries in 14 OECD countries, over the period 1973-93. We estimate the relationship between the labor share and a number of the variables listed in the previous paragraph for which data is available. One novelty is that in our estimation we follow a recent proposal by Arellano and Bover (1995) of a system estimator for panel data, i.e. a generalized method of moments estimator with instrumental variables which exploits the information contained in the relationship between the variables in both levels and first differences. This estimator is very useful in raising the efficiency of the estimation. We find evidence in favor of a significant relationship between the labor share and the capital-output ratio, and also that most of the relevant variables shift it. We then exploit this finding to revisit the so-called wage gap, i.e. the difference between wages and the marginal product of labor.

As an application of the theory, we revisit the issue of the so-called wage gap, i.e. the difference between wages and the marginal product of labor. In the economics literature it has often been concluded that wage gaps were high in European economies in the second half of the 1970s (and this was associated with unemployment being "Classical"), but they disappeared in the 1980 (so that unemployment was "Keynesian"). Our model provides an alternative way of computing and decomposing wage gaps, starting from estimates of the labor share relationship. Thus, we carry out separate estimations of a labor share equation for Germany and the US, and use them to compute the evolution of their wage gaps, decomposing them into their main elements.

The paper is structured as follows. Section 2 presents a neoclassical model of the determination of the labor share. After introducing the stripped-down model, which yields the key relationship between the labor share and the capital-output ratio, we show how the relaxation of various assumptions may affect such relationship. Section 3 presents empirical evidence on the performance of the model on international panel data. Section 4 exploits the empirical relationship to estimate and decompose wage gaps in Germany and the US. Section 5 contains our conclusions.

# 2 Theory

We first sort out, from an analytical point of view, the various factors which may explain variations in the labor share.

## 2.1 The labor share and the capital-output ratio

When trying to explain variations in the labor share we need to depart from the usual assumption of a Cobb-Douglas production function. We show that under the assumptions of constant returns to scale and labor embodied technical progress, there are strong restrictions on the behavior of the labor share, in the sense that there should be a one-for-one relationship between it and the capital-output ratio.

**Proposition 1** *Assume a constant returns to scale, differentiable production function by which output (Y) is produced with two factors of production (capital, K, and labor, L) and labor-augmenting technical progress (B):*

$$Y = F(K, BL)$$

*Then, under the assumption that labor is paid its marginal product, there exists a unique function g such that:*

$$s_L = g(k) \tag{1}$$

*where* $s_L \equiv (wL)/(pY)$ *is the labor share, with w denoting the wage and p the product price, and* $k = K/Y$ *is the capital-output ratio.*

PROOF. Let us rewrite the production function as $Y = Kf(BL/K) = Kf(l)$, where $l \equiv BL/K$. In equilibrium we have:

$$\frac{w}{p} = Bf'(l) \tag{2}$$

where the prime denotes the first derivative, implying that the labor share is equal to:

$$s_L = \frac{BLf'(l)}{Kf(l)} = \frac{lf'(l)}{f(l)} \tag{3}$$

The capital-output ratio is then equal to:

$$k = \frac{1}{f(l)} \tag{4}$$

Eliminating $l$ between equations (3) and (4) we find a univariate relationship between $s_L$ and $k$. Q.E.D.

Proposition 1 is interesting because it tells us that even though the production function is not Cobb-Douglas, there is a stable relationship between the labor share and an observable variable, the capital-output ratio. From now on, we shall refer to this relationship as the *Benchmark Share* ($BS$) schedule (or curve). This relationship is unaltered by changes in factor prices or quantities, or in labor-augmenting technical progress. That is to say, any change in the labor share which is triggered by changes in wages, interest rates, labor-augmenting technical progress, etc., will be along that schedule, so that such shifts cannot explain any deviation from it, i.e. any residual in equation (1). Note that equations (1) and (3) are essentially the same relationship, but $l$ cannot be computed directly from the data since one would first have to compute $B$, labor-augmenting technical progress. We can dispense with that by simply looking for a relationship such as equation (1).

Our aim is thus to decompose changes in the labor share between those explained by the capital-output ratio –due to changes in factor prices and labor-augmenting technical progress– and those explained by the residual –i.e., due to other factors–.

To illustrate Proposition 1 more concretely, let us consider what happens when the production function has a constant elasticity of substitution (CES):

$$Y = [(AK)^{\varepsilon} + (BL)^{\varepsilon}]^{1/\varepsilon} \tag{5}$$

where $A$, $B$ and $\varepsilon$ are technological parameters.

In this case, the labor share is equal to:

$$s_L = \frac{(BL)^{\varepsilon}}{(AK)^{\varepsilon} + (BL)^{\varepsilon}} \tag{6}$$

while the capital-output ratio is simply equal to:

$$k = \left[\frac{K^{\varepsilon}}{(AK)^{\varepsilon} + (BL)^{\varepsilon}}\right]^{1/\varepsilon} \tag{7}$$

From equations (6) and (7) we have:

$$s_L = 1 - (Ak)^{\varepsilon} \tag{8}$$

We therefore see that the relationship between $s_L$ and $k$ is very simple in this case. It is monotonic in $k$, either increasing or decreasing depending on the sign of $\varepsilon$: if labor and capital are substitutes, a lower capital intensity will increase the labor share, and conversely if they are complements. For more general production functions, the relationship need not be monotonic, so that the labor share can go up and then down as some variable driving changes in $k$ (such as real wages or interest rates) increases.

## 2.2 Deviations from a stable BS relationship

We now analyze the factors that generate deviations from this simple relationship. To do so, let us first define more precisely the $BS$ curve, as the relationship between $k = 1/f(l)$ and $\eta \equiv lf'(l)/f(l)$, the employment elasticity of output. Then the economy is on the $BS$ curve in the $(k, s_L)$ plane if and only if $s_L = \eta$, i.e. the marginal product of labor is equal to the real wage. We shall distinguish between two types of sources of deviations, depending on whether they cause movements *of* the $BS$ curve or movements *off* it.

First, the $BS$ curve is stable if only labor-augmenting technical progress affects the aggregate production function. Other factors that affect it, such as $A$ in equation (8), i.e. capital-augmenting technical progress will shift the $BS$ curve if they are not constant. This is the first possible reason for not having a stable one-to-one relationship between $s_L$ and $k$.

The other type comprises factors which create a wedge between the real wage and the marginal product of labor. While they do not affect the relationship between $\eta$ and $k$, they create a gap between $s_L$ and $\eta$. These factors therefore do not shift the $BS$ curve, but put the economy off that schedule in the $(k, s_L)$ plane.

Let us take each type of source in turn.

## 2.3 Non-neutralities in the aggregate production function

We first discuss sources of deviations which shift the $BS$ schedule by changing the aggregate production function in a non-labor-augmenting way. We consider two sources: imported materials and heterogeneity in the composition of the workforce.

### 2.3.1 Imported materials

What if there are imported materials whose price fluctuates? Unless very restrictive conditions hold, these fluctuations will affect the relationship between $s_L$ and $k$. In general, the $BS$ schedule will shift when the real price of imported materials shifts, and the direction will depend on the characteristics of the production function.

Let us assume, for example, that we have $Y = F(K, BL, M)$ where $M$ denotes raw imported materials (say oil), with price $q$. This can be rewritten as $Y = Kf(l, m)$, with $l \equiv BL/K$, as above, and $m \equiv M/K$. $L$ and $M$ are set so as to maximize profits. The first order conditions are:

$$f_1'(l,m) = \frac{w}{p}$$

$$f_2'(l,m) = \frac{q}{p} \tag{9}$$

Value added is now defined as (see Bruno and Sachs 1985, Appendix 2B, for a discussion): $\tilde{Y} \equiv Y - (q/p)M$, and the $BS$ curve is now a relationship between $\tilde{s}_L$, the share of labor in value added given by $\tilde{s}_L \equiv (wL)/(p\tilde{Y})$, and $\tilde{k} \equiv K/\tilde{Y}$, the capital-value added ratio. We now have, instead of (4):

$$\tilde{k} = \frac{1}{f(l,m) - \frac{q}{p}m} \tag{10}$$

implying:

$$\tilde{s}_L = \frac{l f_1'(l,m)}{\tilde{k}} \tag{11}$$

Equations (9) and (10) now define $l$ and $m$ as functions of $\tilde{k}$ and $q/p$. Plugging these into equation (11) we get a relationship where $\tilde{s}_L$ is a function not only of $\tilde{k}$ but also of $q/p$.

To get a grasp of the effects at work when the labor share changes as $q/p$ increases, we can differentiate equations (9) to (11), to get the change in the labor share holding $\tilde{k}$ constant:

$$d\tilde{s}_L = \frac{1}{\tilde{k}} \left[ m + \frac{l f_{12}''}{f_{22}''} + \frac{lm}{f_1' f_{22}''} H \right] \tag{12}$$

where $H = f_{11}'' f_{22}'' - (f_{12}'')^2 > 0$ is the Hessian of the production function.

The first term in the brackets of (12) is positive; it is due to the fact that to maintain a constant ratio between capital and value added as import prices rise, the labor-capital ratio must rise, which pushes the labor share upwards. The second term is typically negative as long as imported materials increase the marginal product of labor. It captures the fact that given $l$, imports fall when $q/p$ increases, which reduces the marginal product of labor and therefore wages and the labor share. The third term is also negative. It captures the fall in wages induced by the required increase in the labor capital ratio (taking into account the indirect effect of the induced effect on $m$).

Thus, the price of imported materials shifts the $BS$ schedule in an ambiguous direction. To illustrate this, let us look at what happens in the CES case. Assume the following production function:

$$Y = [(AK)^{\epsilon} + (BL)^{\epsilon} + (CM)^{\epsilon}]^{1/\epsilon}$$

where $A$, $B$, $C$, and $\varepsilon$ are the technological parameters now. Then the first-order condition for profit maximization with respect to $M$ is:

$$[(AK)^{\varepsilon} + (BL)^{\varepsilon} + (CM)^{\varepsilon}]^{1/\varepsilon - 1} C^{\varepsilon} M^{\varepsilon-1} = \frac{q}{p}$$

This equation can be solved for $M$, yielding:

$$M = C^{-1} \left[ \frac{\left(\frac{q}{p}\right)^{\frac{\varepsilon}{\varepsilon-1}}}{C^{\frac{\varepsilon}{\varepsilon-1}} - \left(\frac{q}{p}\right)^{\frac{\varepsilon}{\varepsilon-1}}} \right]^{1/\varepsilon} [(AK)^{\varepsilon} + (BL)^{\varepsilon}]^{1/\varepsilon}$$

Given the definition of value added we have:

$$\tilde{Y} = C^{-1} [(AK)^{\varepsilon} + (BL)^{\varepsilon}]^{1/\varepsilon} \left[ C^{\frac{\varepsilon}{\varepsilon-1}} - \left(\frac{q}{p}\right)^{\frac{\varepsilon}{\varepsilon-1}} \right]^{\frac{\varepsilon-1}{\varepsilon}} \tag{13}$$

The last term in brackets is decreasing in $q$ and captures the effect of the price of oil on total factor productivity defined in terms of value added; it is multiplicative in output. Equation (13) defines a functional form similar to (5) so that by making the appropriate substitutions in (8) we can recover the effect of the price of oil on the labor share:

$$\tilde{s}_L = 1 - \left(\frac{A}{C}\right)^{\varepsilon} \left[ C^{\frac{\varepsilon}{\varepsilon-1}} - \left(\frac{q}{p}\right)^{\frac{\varepsilon}{\varepsilon-1}} \right]^{\varepsilon-1} \tilde{k}^{\varepsilon} \tag{14}$$

We can thus in principle take into account the impact of changes in the price of oil on the labor share by estimating (14) or a linearized variant of it. Note that the $BS$ schedule will shift upwards when $q/p$ rises if and only if $\varepsilon > 0$. The more labor is a substitute for capital, the lower the wage fall required to increase $l$ so as to maintain $\tilde{k}$ constant when imported materials fall, and the larger the increase in the labor share.

### 2.3.2 Labor heterogeneity

How is the labor share affected if there are several types of labor, say skilled and unskilled? In general, there will be again a breakdown in the $BS$ schedule as captured by equation (3). However, under some restrictions in the production function, property (3) still holds. These restrictions are less strong, for example, than the ones needed for the price of oil not to affect the residual.

**Proposition 2** *Assume there are three inputs, capital and two types of labor ($L_1$ and $L_2$), and that the production function is given by:*

$$Y = H\left(K, G(B_1 L_1, B_2 L_2)\right)$$

*where $B_1$ and $B_2$ are the respective technological parameters, and functions $G(.,.)$ and $H(.,.)$ are homogeneous of degree 1. Then there exists a one-to-one relationship between $s_L$ and $k$:*

$$s_L = g(k)$$

*where $g$ only depends on $H$.*

PROOF. The first-order conditions for maximization with respect to $L_1$ and $L_2$, with respective wages are $w_1$ and $w_2$, are:

$$\frac{\partial Y}{\partial L_1} = \frac{w_1}{p} = B_1 \frac{\partial H}{\partial G} \frac{\partial G}{\partial (B_1 L_1)}$$

$$\frac{\partial Y}{\partial L_2} = \frac{w_2}{p} = B_2 \frac{\partial H}{\partial G} \frac{\partial G}{\partial (B_2 L_2)}$$

The labor share is then equal to:

$$\begin{aligned} s_L &= \frac{w_1 L_1 + w_2 L_2}{pY} = \frac{B_1 L_1 \frac{\partial H}{\partial G} \frac{\partial G}{\partial (B_1 L_1)} + B_2 L_2 \frac{\partial H}{\partial G} \frac{\partial G}{\partial (B_2 L_2)}}{H(K,G)} \\ &= \frac{G \frac{\partial H}{\partial G}}{H(K,G)} = \phi\left(\frac{G}{K}\right) \end{aligned} \tag{15}$$

where we have used the homogeneity of $G$ and then that of $H$. The capital-output ratio is then simply equal to $K/H(K,G)$, which also only depends on $G/K$. Substituting into equation (15) we may then find a relationship between $s_L$ and $k$. Q.E.D.

Proposition 2 tells us that if skilled and unskilled labor enter production through any aggregate function which is homogeneous of degree one, then there is still a relationship between the labor share and the capital-output ratio, and this relationship is unaffected by relative prices and relative factor supplies. Moreover, it is also unaffected by any change in the relative demand of unskilled labor due to technology, provided such change shows up in $G$, but not in $H$.

A particular example where Proposition 2 holds is a production function which is CES in capital and a labor aggregate, itself CES in skilled and unskilled labor:

$$Y = \left[(AK)^{\varepsilon} + [(B_1L_1)^{\eta} + (B_2L_2)^{\eta}]^{\varepsilon/\eta}\right]^{1/\varepsilon}$$

This production function includes as a special case, when $\eta = \varepsilon$, a CES in all three inputs:

$$Y = [(AK)^{\varepsilon} + (B_1L_1)^{\varepsilon} + (B_2L_2)^{\varepsilon}]^{1/\varepsilon}$$

It is however often argued (see, for example, Krusell *et al.* 1997) that there is more complementarity between skilled labor and capital than between unskilled labor and capital. How does this affect the *BS* relationship? Following Krusell *et al.* (1997), let us consider the special case where the production function is:

$$Y = [(AK + B_1L_1)^{\varepsilon} + (B_2L_2)^{\varepsilon}]^{1/\varepsilon}$$

Intuitively, this production function means that tasks can be done either by capital or unskilled labor, but that skilled labor is needed to monitor tasks.

We can show that there is now a relationship between the labor share, the capital-output ratio, and the premium of skilled over unskilled labor, $\omega \equiv w_2/w_1$.

To see this, note that wages must be equal to:

$$w_2 = \left[(AK + B_1L_1)^{\varepsilon} + (B_2L_2)^{\varepsilon}\right]^{1/\varepsilon - 1} B_2^{\varepsilon} L_2^{\varepsilon - 1}$$

$$w_1 = \left[(AK + B_1L_1)^{\varepsilon} + (B_2L_2)^{\varepsilon}\right]^{1/\varepsilon - 1} (AK + B_1L_1)^{\varepsilon - 1} B_1$$

implying that the labor share is equal to:

$$s_L = \frac{(B_2L_2)^{\varepsilon}}{(AK + B_1L_1)^{\varepsilon} + (B_2L_2)^{\varepsilon}} + \frac{B_1L_1 (AK + B_1L_1)^{\varepsilon - 1}}{(AK + B_1L_1)^{\varepsilon} + (B_2L_2)^{\varepsilon}} \tag{16}$$

and the wage premium to:

$$\omega = \frac{B_2 (B_2L_2)^{\varepsilon - 1}}{B_1 (AK + B_1L_1)^{\varepsilon - 1}}$$

This last equation can be inverted as:

$$AK + B_1L_1 = B_2L_2 f(\omega) \tag{17}$$

where $f(\omega) = (B_1\omega/B_2)^{\frac{1}{1-\varepsilon}}$.

We can also compute the capital-output ratio, writing:

$$(Ak)^{\varepsilon} = \frac{(AK)^{\varepsilon}}{(B_2L_2)^{\varepsilon} (1 + f(\omega)^{\varepsilon})}$$

which implies:

$$AK = AkB_2L_2 (1 + f(\omega)^{\varepsilon})^{1/\varepsilon} \tag{18}$$

Substituting equation (18) into equation (17) we may express $B_1L_1$ as a function of $B_2L_2$ and $\omega$, which we may then substitute, together with (18) and (17), into (16) to get:

$$s_L = 1 - Akf(\omega)^{\varepsilon-1}\left(1 + f(\omega)^{\varepsilon}\right)^{1/\varepsilon-1}$$

where we see that the labor share depends on the skill premium as well.

## 2.4 Differences between the marginal product of labor and the real wage

We now turn to those factors that put the economy off the $BS$ curve by generating a gap between the marginal product of labor and the real wage. We consider three of them: product market power, union bargaining, and labor adjustment costs.

### 2.4.1 Variations in the markup

Assume firms are imperfectly competitive, so that there is a markup $\mu$ of prices on marginal costs. Accordingly, the optimality condition (2) should be replaced with:

$$\frac{\partial F}{\partial L} = Bf'(l) = \mu\frac{w}{p}$$

so that we now have:

$$s_L = \mu^{-1}\frac{lf'(l)}{f(l)} = \mu^{-1}\eta$$

implying a relationship such as $s_L = \mu^{-1}g(k)$. Clearly, if the markup is constant, there should still be a stable relationship between $s_L$ and $k$. However, variations in the markup will affect that relationship and will show up in the "residual". For example, if markups are counter-cyclical, the labor share will tend to be pro-cyclical once we have controlled for $k$.

Note that the above relationships are actually used by macroeconomists in order to *compute* the markup (see Hall 1990; Rotemberg and Woodford 1991 and 1992;

and Bénabou 1992). From our point of view, this is unfortunate: many deviations of the labor share from the predicted $BS$ schedule may be due to factors other than the markup (see the qualifications in Rotemberg and Woodford 1997). Ideally, one would want to correlate these deviations with direct measures of the markup.

### 2.4.2 Bargaining

Another source of deviations from the $BS$ curve is the existence of bargaining between firms and workers. Indeed, increases in the labor share are customarily interpreted as increases in workers' bargaining power, and it is often hastily concluded that employment consequently has to decline. The issue is more complicated, though, because everything depends on what bargaining model is assumed.

**Right to manage** Under the *right to manage* model, firms and unions first bargain over wages and then firms set employment unilaterally, taking wages as given. Although it lacks solid microfoundations, this model is widely believed to be a realistic description of how bargaining actually takes place in many countries (see, e.g., Layard *et al.* 1991, chapter 2). But then, because firms are wage takers when setting employment, the marginal product equation (2) remains valid, and so does Proposition 1. Under that model, changes in the bargaining power of workers may move the labor share, but along the $BS$ curve, not away from it, and the direction clearly depends on the elasticity of substitution between labor and capital (see equation (8)). More specifically, we can represent the right to manage model as follows. Wages are first set to maximize the following Nash maximand:

$$\max_{w} \left[V^{*}(w,K) - \bar{V}\right]^{\theta} \left[\Pi^{*}(w,K) - \bar{\Pi}\right]^{1-\theta}$$

where $V^*(w,K)$ and $\Pi^*(w,K)$ are the reduced-form union utility and profits, respectively, while $\bar{V}$ and $\bar{\Pi}$ are the appropriate threat points. $\theta$ is a parameter weighting the two objective functions, which can be labeled as union bargaining power. In the second stage of the game, the firm determines employment by maximizing its profit:

$$\Pi^*(w,K) = \max_L \Pi(w,L,K) = pF(K,BL) - wL$$

This defines an optimal employment level, $L^*(K)$, a reduced form profit, $\Pi^*(w,K)$, and the reduced form utility, $V^*(w,K) = V(w,L^*(K))$. Now, the first-order condition for profit maximization is clearly (2), so that (3) and (4) are still valid. Thus the relationship between $s_L$ and $k$ is unaffected by $\theta$.[3]

**Efficient bargaining** If, on the other hand, firms and workers bargain over both wages and employment, they will set employment in an efficient way, implying that the marginal product of labor is equal to its real opportunity cost $(\bar{w}/p)$:

$$Bf'(l) = \frac{\bar{w}}{p}$$

In the sort run, an increase in the bargaining power of workers will affect the labor share but will not be reflected in employment. In the long-run, adjustment of the capital stock will indeed imply that changes in the labor share will also affect employment.

How does efficient bargaining affect the position of the economy in the $(k, s_L)$ plane? A simple Nash bargaining model would imply that the wage is a weighted

[3]Here we have assumed that bargaining over wages takes place after the capital stock is determined. Our conclusions would be unaffected if instead the capital stock was determined by the firm after wage setting, or even if bargaining took place over the capital stock, as long as employment is determined by profit maximization given wages.

average of the *average* product of labor and its opportunity cost, with the weight on the average product equal to workers' bargaining power, $\theta$ (see, e.g., Blanchard and Fischer 1989, chapter 9):

$$\frac{w}{p} = \theta \frac{Bf(l)}{l} + (1-\theta)\frac{\bar{w}}{p}$$

This in turns implies that $w/p = \theta[Bf(l)/l] + (1-\theta)Bf'(l)$, hence (recalling the definition of $l$):

$$s_L = \theta + (1-\theta)\frac{lf'(l)}{f(l)} = \theta + (1-\theta)\eta = g(k)$$

This is a well-defined relationship between the labor share and the capital-output ratio. Increases in workers' bargaining power reduce the sensitivity of the labor share to the capital-output ratio according to this relationship. For example in the CES case we get:

$$s_L = 1 - (1-\theta)(Ak)^{\varepsilon}$$

### 2.4.3 Labor adjustment costs

We now consider how the introduction of labor adjustment costs alters the *BS* relationship. Adjustment costs affect the behavior of the labor share for two reasons. First, the labor share is no longer equal to wages divided by value added. Labor costs now consist of two parts: wage costs and non-wage adjustment costs. The latter will enter the labor share if they are a resource cost which uses labor –for example if new hires have to be recruited by an employment agency, or if they have to be trained by the firm's existing workforce, thus diverting it from direct productive activity–. They will also enter the labor share if they are payments from the firm to the worker, as is the case for severance payments. Other components of firing costs such as court and arbitration procedures will have a strong labor cost component. Second, adjustment costs will introduce a gap between the marginal revenue of labor and the wage, since the relevant marginal cost of labor is no longer equal to the wage. More precisely, the marginal cost now consists of three terms: the current wage, the current marginal adjustment cost generated by an extra unit of labor, and the "shadow" expected future adjustment costs generated by that unit. The second component will push the marginal cost of labor above the wage when the firm is hiring and below it when it is firing.

As far as empirical work is concerned, a rough way to control for current adjustment costs when trying to recover a relationship such as (1) is to add the change in net employment:

$$s_{Lt} = a_1 F(k_t) + a_2 D(\Delta L_t) \qquad (19)$$

where $\Delta$ denotes the first-difference operator.

We expect $D(.)$ to be decreasing in its argument, and ideally equal to 0 for $\Delta L_t = 0$. When the firm is hiring the marginal cost of labor is above the wage, so that the labor share under-estimates the employment elasticity of output, and the opposite is true when firing (see, e.g., Bentolila and Bertola 1990). We might also want to separate out gross hiring and firing, to capture the possibility of asymmetric adjustment costs.

On the other hand, shadow expected future adjustment costs depend, among other things, on the degree of uncertainty. Among others, Bentolila and Bertola (1990) have shown that, with linear labor adjustment costs, the response of labor demand to revenue shocks depends on the degree of uncertainty attached to those shocks. In general, given the size of the realization of the shock, larger uncertainty induces a lower response of labor demand, so the expected sign is negative. This element is also taken into account at the empirical stage below.

# 3 Evidence

We now investigate empirically the factors driving the evolution of the labor share in 14 OECD countries since 1970. In the preceding section we have discussed a variety of variables that should be correlated with the labor share. Data availability precludes analyzing the relevance of all of them. We focus on four sources of variation: movements along the $BS$ relationship –i.e., changes in the prices of capital and labor, and labor-augmenting technical progress–; one shifter of the $BS$ curve, namely changes in the price of raw materials; and two sources of movements off the $BS$ schedule, namely changes in union bargaining power and labor adjustment costs.

We start by documenting a few stylized facts present in the data, we then discuss the equation to be estimated and the econometric techniques used, and we finally show the empirical results.

## 3.1 Stylized facts

The $BS$ schedule is a technological relationship, and so it is more appropriate to investigate it at the industry level than at the country level. We use industry data from the OECD International Sectoral Data Base (ISDB), which includes information on output, employment, capital, and factor shares for 14 OECD countries over the period 1970-93, disaggregated at the 1- or 2-digit level. The industries analyzed do not span the whole economy, but come close to doing so. Details on the database and definitions of variables are given in Appendix A.

Our key variables are the labor share ($s_L$) and the capital-output ratio ($k$). The variable $s_L$ is defined as the share of labor in nominal value added and $k$ as the ratio of the real capital stock to real value added.[4] Table 2 presents the overall statistics of these two variables for all industries, countries, and years. More interestingly, Table 3 shows that both variables vary more widely across industries than across countries. Taking the data at face value, the range for the labor share, for example, goes from 20% in agriculture to 93% in Government services. These numbers help us make the case for the industry approach to the data followed in this section.

## 3.2 Empirical specification

The basic equation we estimate is the following:

$$\begin{aligned} \ln s_{L,ijt} &= \lambda + \sum_i \beta_{1i} \, (d_i \times \ln k_{ijt}) + \sum_i \beta_{2i} \, (d_i \times \ln(q_{jt}/p_{jt})) \\ &\quad + \beta_3 \, \Delta \ln n_{ijt} + \beta_4 \, \tilde{\sigma}_{ijt} + \beta_5 \, \widetilde{lcr}_{jt} + v_{ijt} \end{aligned} \quad (20)$$

where the subindexes denote: industries ($i = 1, ..., 15$), countries ($j = 1, ..., 14$), and time ($t =$ 1973-93).[5]

This equation captures the essence of the $BS$ schedule, through the presence of the capital-output ratio, $k_{ij}$, plus a few extra terms. Following section 2.3, the real price of imported oil, $q_j/p_j$, enters as a shifter of the $BS$ relationship. Note that coefficients which are expected to capture technological parameters, i.e. those on $\ln k_{ij}$ and $\ln\,(q_{jt}/p_{jt})$, are allowed to vary by industry through interactions with the $d_i$ dummies.

[4]The remaining variables will be introduced below.

[5]The data start in 1970, but the period of estimation is 1973-93 because we lose the first 3 years due to the dating at $t$–2 of instrumental variables in first differences.

Following section 2.4, we also introduce three variables which move the economy off the $BS$ relationship. First, current labor adjustment costs are captured through the employment net growth rate ($\Delta \ln n_{ij}$).[6] Although we would like to separate out gross increases and reductions in employment, these flows are not available in our dataset. Second, the effects of future expected adjustment costs are captured through a measure of uncertainty: the standard deviation of the growth rate of output ($\sigma_{ij}$). Given the length of the sample period, we compute this variable as a 5-year, backward-looking, moving average (denoted by $\sim$). Lastly, workers' bargaining power ($\theta$), which might enter in an efficient bargains setup, is proxied for by the number of labor conflicts normalized by the number of employees in the preceding year. This variable is also measured as a 5-year backward-looking moving average and it is denoted by $\widetilde{lcr}_j$. Lastly, $v$ denotes the equation residual. Note that we estimate the equation in the logs of the main technology variables, so as to avoid imposing a linear relationship.

We exploit variation in the labor share across industries, countries, and time. Hence, regressors also vary across those three dimensions, except for the real price of oil and the labor conflict rate, which vary by country and time only. The choice regarding the oil price is made to mitigate endogeneity problems. The labor conflict data are only available at the national level. Sample statistics of these variables are shown in Table 2.

[6] Employment here refers to the number of employees.

## 3.3 Econometric methods

### 3.3.1 General issues

Equation (20) is estimated using panel data techniques. In our case, individual units of observation are industry-country units. Also, since some observations are missing –always either at the beginning or the end of the sample period–, we have an unbalanced panel (see Table A1 for the number of observations by country, year, and industry).

An important consideration for estimation purposes is that the labor share and the capital-output ratio are jointly determined variables appearing in the basic $BS$ relationship, which is a first order optimality condition. In the more general specification with adjustment costs, the same is true regarding the rate of change of employment. This feature makes the variables jointly endogenous and requires them to be instrumented, since ordinary least squares (OLS) estimation would be biased. We discuss the choice of instrumental variables below.

We expect the presence of individual fixed effects in the equation. If these are omitted and correlated with any of the regressors included, the resulting estimates are biased. A standard way of solving this problem is to estimate the equation in the first differences of the data. It is then typical to use predetermined variables in levels, like e.g. lags of the regressors, as instrumental variables. However, the absence of information about the parameters of interest in the levels of the variables usually gives rise to the loss of a substantial part of the variation in the data, which often results in poor estimates. This problem can, however, be overcome if we are willing to assume that some of the regressors have a constant correlation with the fixed effects, an assumption whose validity only requires stationarity in mean of the regressors given the effects, and which can be tested using the overidentifying restrictions. Arellano and Bover (1995) note that, in this case, the first differences of the predetermined variables are valid instruments for the equation in levels. In effect, they propose, in addition to using instruments in levels for equations in first differences, to use instruments in first differences for equations in levels. The model behind this first-differences plus levels, or *system*, estimator is an intermediate case between the *fixed-effects* model, in which all explanatory variables are potentially correlated with the effects and the *random effects* model, in which none is. Arellano and Bover (1995) present simulations showing that the system estimator may yield large efficiency gains vis-a-vis the pure first-difference estimator (see also Blundell and Bond, 1997).

We follow this proposal here. We use levels of predetermined variables as instruments for the first-differences estimation and first differences of those variables as instruments for the levels estimation. The estimation is carried out with the dynamic panel data program DPD98, which implements the Arellano-Bover system estimator. This is an extension of the Generalized Method of Moments (GMM) procedure proposed by Arellano and Bond (1991), which exploits the appropriate orthogonality conditions for the chosen instruments, minimizing the difference between the sample moments and their zero population value.

### 3.3.2 Techniques

We can rewrite equation (20) in the form:[7]

$$y_{it} = \beta' x_{it} + \delta_i + v_{it}$$

where subindex $i$ denotes an $(i, j)$ industry-country unit $(i = 1, ..., N)$, $y_{it} = \ln s_{L,ijt}$, $x_{it} = (d_i \times \ln k_{ijt}, d_i \times \ln(q_{jt}/p_{jt}),\ \Delta \ln n_{ijt}, \tilde{\sigma}_{ijt},\ \widetilde{lcr}_{jt})$, $v_{it} = v_{ijt}$, $\delta_i$ denotes fixed

[7]This closely follows Arellano and Bover (1995) and Arellano and Bond (1998).

effects, and $\beta$ the parameter vector. The number of units is $N = 210$ and $t = 1, ..., T_i$, where $T_i \leq 21$ is the number of time periods available on the $i$-th unit. The $v_{it}$ are assumed to be independently distributed across units with zero mean, but arbitrary forms of heteroskedasticity across units and time are allowed for.

The $T_i$ equations for industry-country unit $i$ can be written in the stacked form:

$$y_i = x_i\beta + \iota_i\delta_i + v_i$$

where $x_i$ is a data matrix of the time series of the $x$'s and $\iota_i$ is a $T_i \times 1$ vector of ones. We compute the following linear GMM estimator of $\beta$:

$$\widehat{\beta} = \left[\left(\sum_i x_i^{*\prime} Z_i\right) A_N \left(\sum_i Z_i^{\prime} x_i^*\right)\right]^{-1} \left(\sum_i x_i^{*\prime} Z_i\right) A_N \left(\sum_i Z_i^{\prime} y_i^*\right)$$

where

$$A_N = \left(\frac{1}{N}\sum_i Z_i^{\prime} H_i Z_i\right)^{-1}$$

and $x_i^*$ and $y_i^*$ denote a transformation of $x_i$ and $y_i$, in our case a combination of first differences and levels. $Z_i$ is a matrix of instrumental variables and $H_i$ a weighting matrix. We report DPD98's two-step estimates for coefficients and $t$-ratios, which uses $H_i = \widehat{v}_i^* \widehat{v}_i^{*\prime}$, where $\widehat{v}_i^*$ are one-step residuals, since it is more efficient when the $v_{it}$ are heteroskedastic (White, 1982).[8]

In the estimation of the equations in levels we do not explicitly allow for fixed effects, since this would significantly expand the number of parameters to be estimated. However, these can be computed ex-post by averaging the residuals $\widehat{v}_i$ of the levels equations for each industry-country unit over the sample period (see below).

[8] Arellano and Bond (1991) present simulations suggesting that, in first-difference estimation, two-step estimators of asymptotic standard errors may be too small. However, results in Blundell and Bond (1997) indicate that this is much less true for the system estimator used here.

### 3.3.3 Instruments and specification tests

As discussed before, we take some of the variables to be uncorrelated with the individual effects $\delta_i$, so that we can use these variables as instruments for the equations in levels. This implies a set of moment conditions relating to the equations in first differences and another set relating to the equations in levels, which are combined to obtain the efficient GMM estimator. The instrument set is then of the form: $Z_i = \begin{pmatrix} \mathbf{Z}_i^D & 0 \\ 0 & \mathbf{Z}_i^L \end{pmatrix}$, where $\mathbf{Z}_i^D$ is the matrix of instruments for the equations in first differences and $\mathbf{Z}_i^L$ is that for the equations in levels.

Regarding the actual choice of the instrument set, besides the labor share and the capital-output ratio, we also treat the real oil price as potentially endogenous. This leaves two variables, the proxies for labor conflicts and uncertainty –constructed as backward-looking moving averages– as predetermined variables. In the case of the latter variable, the assumption of its being predetermined is later relaxed, to check its effects on the empirical estimates.

We use three types of instruments. The first type of instruments consists of lagged values of regressors, which can also be taken as predetermined, i.e. the capital-output ratio and the rate of change in employment ($\ln k_{ij}$ and $\Delta \ln n_{ij}$). In the first-differences part of the system estimation, we use the level of the real capital stock ($\ln K_{ij}$) rather than $\ln k_{ij}$ itself, so as to raise the plausibility of its being predetermined. This procedure is, however, not feasible in the levels part, due to its being inconsistent with the assumption of stationarity needed for the validity of the differenced instruments. We do not use the lags of either the labor share or the real oil price as instruments, because they yielded values of the statistic for the validity of the instrument set too close to the critical value. On the other hand, we found the squared value of the log capital stock $(\ln K_{ij})^2$ to be a valid instrument, so we added it to capture potential further non-linearities (again, $(\ln k_{ij})^2$ in the estimation in levels). Since differencing induces a first-order moving average of the residuals, we use the second lags of these variables.

As a second type of instrument we use the contemporaneous values of the predetermined regressors, $\tilde{\sigma}_{ij}$ and $\widetilde{lcr}_j$, and also the first and second lag of the former variable, because we will later perform a nested test for its predeterminedness (by leaving the second lag alone as an instrument). Lastly, we add the growth rate of national GDP $(\Delta \ln y_j)$, lagged twice, which has only variation across countries and time, but not industries. Lastly, for the estimation in levels we dropped the (first-differenced) lagged employment growth rate from the instrument set, because it produced a relatively high value of the test for the validity of the instruments.

For reasons of degrees of freedom, we cannot interact all instruments with industry dummies, so we chose to do it only for the lagged capital stock (capital-labor ratio in the levels equation), the labor conflict rate, and the growth rate of GDP.

The specification is checked by means of the Sargan statistic, a test of overidentifying restrictions for the validity of the instrument set, which is distributed as a $\chi^2$ with degrees of freedom equal to the number of instrumental variables $q$ minus the number of parameters $k$.[9] Since the set of instruments used for the equations in first differences is a strict subset of that used in the system of first-differenced and

[9] If $A_N$ has been chosen optimally for any given $Z_i$, the statistic

$$S = \left(\sum_i \widehat{v}_i^{*\prime} Z_i\right) A_N \left(\sum_i Z_i' \widehat{v}_i^*\right)$$

is asymptotically distributed as a chi-square with as many degrees of freedom as overidentifying restrictions, under the null hypothesis of the validity of the instruments. See Arellano and Bond (1991).

levels equations, we also report a more specific test of the additional instruments used in the levels equations, the Difference Sargan test, which compares the Sargan statistics for the system estimator and for the corresponding first-differenced estimator.[10]

We also report a statistic for the absence of second-order serial correlation in the first-differenced residuals, $\widehat{v}_{it} - \widehat{v}_{i,t-1}$, labeled $m_2$. This is based on the standardized average residual autocovariances, which are asymptotically $N(0,1)$ variables under the null of no autocorrelation, and should not be significantly different from zero if the residuals in levels are serially uncorrelated (note that, due to differencing, first-order autocorrelation is expected ex-ante).

### 3.4 Empirical results

As a benchmark, we present OLS estimates of equation (20), in Table A3. Here, the evidence for the benchmark share schedule ($BS$) is weak. Only the change in employment and, marginally, the real price of oil are significant, with differences across industries in the latter case. As already discussed, OLS estimates should be biased as a result of the joint determination of the labor share and several variables in the right-hand side in the relationship of interest.

Thus Table 4 contains our basic specification with instrumental variables, which provides support for the $BS$ schedule: the capital-output ratio shows up significantly, which suggests the presence of departures from the Cobb-Douglas production function. The covariation is positively signed in 11 out of 15 industries, indicating that labor and capital are most often complements, rather than substitutes

[10] Let $S_d \sim \chi^2_{q_1-k}$ be the Sargan statistic for the first-difference estimation, with $q_1$ the number of instruments, so that $q = q_1 + q_2$. The Difference Sargan test is distributed as $DS = S - S_d \sim \chi^2_{q_2-k}$.

(see equation (8) for the CES case). Of course, we might have found that there was substitutability with unskilled labor if we had been able to obtain data on wages for skilled and unskilled workers separately. As to shifters of the $BS$ relationship, the real price of oil attracts negatively signed coefficients (with the exception of agriculture and government services) thus resolving the theoretical ambiguity (see equation (12)).

Turning to movements off the $BS$ curve, in Table 4 both variables approximating labor adjustment costs, the growth rate of employment and output uncertainty are significant, and both show the expected negative sign. In order to provide further evidence on the robustness of the latter finding, we dispose with the assumption of predeterminedness of our measure of uncertainty, by instrumenting it with its second lag. Table 5 reveals that the remaining variables are not much affected, while the coefficient on $\tilde{\sigma}_{ij}$ becomes positive but non-significant. This need not mean that the variable is endogenous, but rather that the realized value of uncertainty, as opposed to its predicted value, is the proper variable affecting the labor share.

The labor conflict rate, our proxy for workers' bargaining power, attracts a negative coefficient, which is unexpected.[11] An interpretation of a negative sign is possible, but we need to implicitly model the cyclical behavior of bargaining power. Given the definition of our proxy, the interpretation would go along the lines of Goodwin's (1967) model of business cycles, in which unions tend to strike when the capital share goes up. In his own words: "The improved profitability carries the seed of its own destruction by engendering a too vigorous expansion of output and

[11] We obtain the same qualitative result if, instead of the number of conflicts, we use either the number of workers involved or the number of work-days not worked due to labor conflicts as the numerator of the labor conflict rate.

employment, thus destroying the reserve army of labor and strengthening labor's bargaining power." (p. 58). An alternative interpretation would arise in the context of the model of delayed responses in Caballero and Hammour (1998) (see section 4).

Test statistics for the validity of the instrument set and for second-order correlation in the residuals do not show any problems, although the Sargan test for the validity of the extra instruments used in the system estimation, vis-a-vis the reduced set for the first-differenced one, is passed only at the margin.

Our empirical results may be affected by measurement error. In our data, $s_L$ is computed as the share of the remuneration of employees in value added. In general, part of the remuneration of the self-employed is a return to labor and not to capital. However, there is no natural way of imputing that part. A very rough way of doing it is to assume that the self-employed earn the same wage as employees. In Table A4 of Appendix B we present the estimation results for equation (20), using the labor share adjusted following this assumption (denoted $s_L^*$).[12] The table indicates that our finding of a $BS$ curve is not robust to this change in definition: the results are very different from those for the unadjusted labor share, and only the bargaining power variable retains significance.

# 4 Application: wage gaps revisited

## 4.1 Another look at the wage gap

The preceding exercise has allowed us to test our model of the determination of the labor share, albeit without imposing tight restrictions from the theory. Having

[12]The number of observations of industry-country pairs is now smaller, because indirect taxes, which are needed to compute the adjusted labor share, are missing more often than the remaining variables.

checked that the theory is a reasonable guide to the behavior of the labor share, we now use it in revisiting the issue of the so-called "wage gap" (see Artus, 1984; Bruno and Sachs, 1985).

The wage gap approach typically takes the evolution of wages as exogenous and compares them to the marginal product of labor at full employment. That is, recalling the production function $Y_t = F(K_t, B_t L_t)$, at time $t$ the wage gap is defined as:

$$WG_t = \frac{w_t/p_t}{B_t F_2'(K_t, B_t \bar{L})} - 1 \tag{21}$$

where $\bar{L}$ is the full employment level. Then, assumptions are typically made about the production function and the behavior of productivity in order to estimate a path for the denominator. The wage gap approach thus essentially amounts to looking at the evolution of wages vis-a-vis labor productivity. This is quite close to looking at the labor share, so that in most of continental Europe, where the labor share has risen and then fallen to its 1970 level (see Figure 4), it is generally concluded that the wage gap has disappeared. The question is then how to reconcile this with the persistence of high unemployment. In the wage gap literature, a low wage gap is generally interpreted as an indication that most unemployment is "Keynesian", i.e. due to persistent slack associated with the failure of nominal prices and wages to adjust. Given the persistence of high unemployment in Europe, we find that interpretation hard to believe.

How can our approach shed light on these issues? We have shown that we can break down movements in the labor share into three components: *(i)* movements *along* the $BS$ schedule, that represent the optimal adjustment of firm's desired employment to changes in prices and labor-augmenting technical progress; *(ii)* movements *of* the $BS$ schedule itself, that may arise from non-neutral technical progress, or equivalently changes in the price of imported materials; and *(iiii)* movements *off* the $BS$ schedule, that represent discrepancies between the marginal product of labor and the wage. Possible sources of such discrepancies include adjustment costs (which imply a role for both the current change in employment and the volatility of the environment), wage bargaining, and markups.

The first source of shocks always generates a negative relationship between the wage gap and employment: it simply captures the fact that, given the production function, the marginal product of labor is decreasing with employment.

The second source will typically affect the marginal product of labor at full employment. Its effect on the wage gap will in general depend on how wages react to such shocks. If they fail to adjust downwards, for example, such adverse shocks will trigger concomitant movements along the $BS$ schedule, so that unemployment and the wage gap will increase. But these shocks also have an impact of their own on the wage gap, to the extent that they affect the employment elasticity of the marginal product of labor. If it is unchanged, these shocks will only affect the wage gap to the extent that they affect unemployment, thus triggering further movements along the $BS$ curve.

The last source of shocks may increase the gap between the marginal product of labor and the wage, so that it may both reduce the wage gap and increase unemployment. This will be the case, for example, if under adjustment costs there is an increase in volatility that increases the shadow cost of labor given the wage.

Analytically, this argument runs as follows. Let us rewrite equation (21) as $1 + WG_t = w_t/[p_t B_t F_2'(K_t, B_t \bar{L}_t, Z_t)]$, where $Z_t$ captures shift factors in the aggregate production function other than labor-augmenting technical progress. Then, the first-degree homogeneity of the production function and the definition $l_t \equiv$

$B_t L_t / K_t$, imply that:

$$1 + WG_t = s_{Lt} \frac{Y_t}{B_t L_t F_2'(K_t, B_t \bar{L}_t, Z_t)} = s_{Lt} \frac{f(l_t, Z_t)}{l_t f_1'(\bar{l}_t, Z_t)} \tag{22}$$

where $\bar{l}_t \equiv B_t \bar{L}_t / K_t$.

Now, our decomposition of movements in the labor share, assuming a multiplicative form (in accordance with the log-linear specification of our regressions), can be written as:

$$s_{Lt} = g(k_t, Z_t) h(X_t),$$

where $g(.)$ captures the $BS$ relationship, which is affected by $Z_t$, while $X_t$ contains the factors that contribute to a discrepancy between the marginal product of labor and the wage: markups, volatility, etc. Making use of the identity between $g(k)$ and $lf'(l)/f(l)$ given by equation (3), equation (22) boils down to:

$$1 + WG_t = h(X_t) \frac{f_1'(l_t, Z_t)}{f_1'(\bar{l}_t, Z_t)}$$

This equation tells us that the wage gap is the product of the component of the labor share which is off the BS schedule, times the ratio between the marginal product of labor at current employment and at full employment.

Note that our empirical estimates allow us to recover $h(X_t)$. Moreover, they also allow us to approximate the second factor, so that we can construct a series for the wage gap and its two components. We have:

$$\begin{aligned} \Delta WG_t &\approx \Delta \ln(1 + WG_t) \\ &\approx \Delta \ln h(X_t) + \Delta \ln f_1'(l_t, Z_t) - \Delta \ln f_1'(\bar{l}_t, Z_t) \end{aligned}$$

Noting that $f_1'(l_t, Z_t) = g(k_t, Z_t)/k_t$ and denoting $\bar{k}_t = 1/f(\bar{l}_t, Z_t)$ this can be expressed as:

$$\Delta WG_t \approx \Delta \ln h(X_t) + [\Delta \ln g(k_t, Z_t) - \Delta \ln \; g(\bar{k}_t, Z_t)]$$

$$-\left(\Delta \ln k_t - \Delta \ln \bar{k}_t\right) - \left(\Delta \ln l_t - \Delta \ln \bar{l}_t\right)$$

Now, using equations (3) and (4), and neglecting second order terms in $u$ we have that $\ln \bar{k}_t \approx \ln k_t - g(k_t, Z_t)u_t$ and $\Delta \ln l_t \approx \Delta \ln \bar{l}_t - \Delta u_t$. If we further assume that $g$ is isoelastic in $k$ and log-separable in $k$ and $Z$, which is implied by our specification, we have that $g(k_t, Z_t) \equiv k_t^{\eta}\gamma(Z_t)$, hence the above equation can be rewritten as:

$$\Delta WG_t \approx \Delta \ln h(X_t) + (\eta - 1)\Delta[k_t^{\eta}\gamma(Z_t)u_t] + \Delta u_t$$

This decomposition can be rewritten as:

$$\begin{aligned} \Delta WG_t \approx\ & \Delta \ln h(X_t) + [1 - k_t^{\eta}\gamma(Z_t)]\ \Delta u_t \\ & +[(\eta - 1)\Delta(k_t^{\eta}\gamma(Z_t))]\ u_t + \eta k_t^{\eta}\gamma(Z_t)\ \Delta u_t \end{aligned} \quad (23)$$

The first term is the contribution to the wage gap of changes in the discrepancy between the wage and the marginal product of labor, such as changes in markups. The second term is the contribution to the wage gap of changes in the discrepancy between the marginal product of labor at current employment and at full employment, *holding the employment elasticity of output (i.e., $g(k, Z)$) constant.* The (composite) third term represents the contribution of all changes in the employment elasticity of output, whether induced by shifts in the production function captured by the shift factor $Z$ or by variation of that elasticity as $k$ and $u$ change. That is, the second term captures the fact that the marginal product schedule (in the log space) is decreasing and the third one the fact that the shape of that schedule can change. Biased technical change would be part of this term.

In the Cobb-Douglas case we have $\eta = 0$, and $\gamma(Z) = \alpha$ is the exponent of labor in the production function. The second term is then equal to $(1 - \alpha)\Delta u$ and captures the direct relationship between unemployment and the marginal product given the production function. The last term, $-u\Delta\alpha$ captures the fact that if $\alpha$ falls the marginal product schedule is steeper, so that the same unemployment level must be associated with a higher wage gap.

## 4.2 The evolution of wage gaps in two countries

In this type of application, it would be natural to employ the estimates in section 3 by considering each country as a composite of industries and applying the estimated coefficients to the particular industry configuration in the country. However, parameter estimates from the panel result from averaging underlying coefficients which may significantly vary across countries.

Thus, in trying to account for the evolution of the wage gap, we follow a different approach. We estimate equation (20) separately for two economies, namely the US and (West) Germany, the only large ones for which there are data for all 15 industries over the full period. The specification is as for the 14-country panel except that, given the reduced cross-sectional dimensionality, we do not allow coefficients on the capital-labor ratio and the real price of oil to vary by industry. The latter carries through to the set of instrumental variables where, moreover, we also exclude any lags of the predetermined variables (since the number of instruments was still larger than the number of units). As a result of the shortcomings of the data, which force this specification, these estimates may only provide a coarse approximation to wage gaps.

Our estimates, along with data on unemployment rates, allow us to perform the decomposition in equation (23). One problem is how to implement it at the industry level, absent data on industry unemployment. The definition of a wage gap concept at the industry level is full of conceptual problems. In addition to the fuzzyness of the concept of industry unemployment, industry rents may generate discrepancies between the marginal product of labor in one industry and its value elsewhere in the economy, thus contributing to a positive wage gap in that industry regardless of the degree of slackness in the labor market. We have dealt with this issue by computing geometric averages for the aggregates in equation (23), weighting industry-varying variables by their employment shares. Recalling the notation in equation (20), the precise empirical implementation of equation (23) is as follows (we suppress country subindex $j$ for simplicity):

$$\begin{aligned}\Delta WG_t \;\approx\; & \Delta\ln h(X_t) + \overline{[1 - k_t^{\widehat{\beta}_1}(q/p)_t^{\widehat{\beta}_2}]}\;\Delta u_t \\ & +[(\widehat{\beta}_1 - 1)\;\Delta(k_t^{\widehat{\beta}_1}(q/p)_t^{\widehat{\beta}_2})]\;\overline{u}_t + \widehat{\beta}_1\overline{[k_t^{\widehat{\beta}_1}(q/p)_t^{\widehat{\beta}_2}]}\;\Delta u_t\end{aligned}$$

where: $k_t = exp(\sum_i \omega_{it}k_{it})$, $\ln h(X_t) = \sum_i \omega_{it}(\widehat{\lambda}+ \sum_{i=3}^{5} \widehat{\beta}_i x_{it} + \widehat{\delta}_i)$, $x_{it} = \{\Delta \ln n_{it}, \widetilde{\sigma}_{it}, \widetilde{lcr}_t\}$, $\widehat{\delta}_i = \sum_t(\ln s_{it} - \widehat{\ln s_{it}})$, $\omega_{it}$ is the employment share of industry $i$ in period $t$, the symbol $\widehat{}$ denotes estimates, and, $\overline{r}_{ijt} = (r_{ij,t-1} + r_{ijt})/2$.[13]

Table A5 of Appendix B presents the estimates of the labor share equation for Germany and the US. The evidence is weaker than with the full international panel, with the coefficients essentially retaining the same signs but with less significance, in particular in the US case. This is not surprising in view of the lower degrees of freedom. Overall, Germany shows larger changes in the wage gap than the US, changes which take place in the mid-1970s and late 1970s-early 1980s. Figure 5 depicts wage gaps levels calculated by accumulating changes taking 1973 as the reference year (=100) in both countries. The figure reveals that the German wage

[13] This moving average correction is employed so as to avoid missing second order terms in the products of differences of variables.

gap suffers large swings, reaching a peak of 12% in 1975, and it never attains the 1973 level again until 1990-91, after which it rises again (although German unification may distort post-1990 figures). In contrast, after a mild rise in 1975, the US wage gap hovers around 98% of the 1973 level.

Recently Caballero and Hammour (1997) and Blanchard (1997) have sought to explain the different evolution of the labor markets in continental European and Anglo-Saxon countries since the 1970s. Caballero and Hammour (1997) note that a benchmark wage gap, measured simply as the ratio of the wage to the marginal product of labor (which corresponds to the Cobb-Douglas case), is zero in 1973, positive from the mid-1970s to the mid-1980s –reaching a peak of 8% in 1980– and increasingly negative in the subsequent 10 years. The US gap, measured to be around 3% in 1973, shows smaller peaks (5% in 1974, 3% in 1982), hovering around zero since 1983. Our results show higher and more persistent wage gaps in Germany than those implied for France by these simple computations, but strikingly similar results for the US (noting that we take 1973=100).

Caballero and Hammour (1997) go on to account for the evolution of the labor share (and, implicitly, wage gaps) in France, which is taken as the prototypical continental European country. They present a model with substitution of capital for labor in a putty-clay aggregate production function. They then simulate the evolution of the wage share and other variables in France as resulting from delayed factor substitution caused by institutional changes raising labor's capability of appropriating rents (firing costs, unemployment benefits, social security contributions) and increases in "specificity".[14] In a similar vein, Blanchard (1997) explains increases in the labor share in continental Europe as resulting from delayed responses to

[14]Note that the Caballero-Hammour model implies a negative relationship between past labor conflict rates and the contemporaneous labor share, as we have found in our empirical results.

"labor supply shocks" in the 1970s (oil shocks, the productivity growth slowdown, changes in labor institutions) and labor demand shocks in the 1980s. His attempt to disentangle shifts in the distribution of rents and biased technological change as sources of the latter is however inconclusive.

By distinguishing between factors that cause movements along the $BS$ schedule, shifts of the curve, and movements off it, we can provide an alternative account of changes in wage gaps, which does not rely on delayed capital adjustments. Table A6 presents the decomposition of the evolution of the wage gap as indicated by equation (20). All components show some variation, but the first one shows by far the largest changes over time in both countries. Moreover, the second and third terms are very strongly negatively correlated (the coefficient is above -0.9 in both cases). Thus, quite naturally given the definition of the wage gap, it is essentially changes in ln $h(X_t)$, i.e. changes in the discrepancy between the wage and the marginal product of labor (in other words, shifts off the $BS$ curve), in our case arising from labor adjustment costs and union bargaining power, that account for changes in the wage gap.

# 5 Conclusions

In this paper we have shown that movements in the labor share can be fruitfully decomposed into movements along a technology-determined curve –the benchmark share ($BS$) schedule–, shifts of this locus, and deviations from it. Movements along the $BS$ curve capture changes in factor prices such as wage pushes and changes in real interest rates, as well as the contribution of labor-augmenting technical progress. The curve is itself shifted by factors such as non-labor embodied technical progress or changes in the price of imported materials. Lastly, other sources of variation of the labor share are represented by movements off the $BS$ curve, and are accounted for by deviations from marginal cost pricing such as changes in markups, labor adjustment costs, and changes in workers' bargaining power.

We have also analyzed the performance of the model empirically, using data on a panel of 15 industries in 14 OECD countries, over the period 1973-93, by estimating the relationship between the labor share and the capital-output ratio, controling for variables which proxy for some of the factors mentioned above. In our estimation we have followed a recent proposal by Arellano and Bover (1995) of a system estimator for panel data, i.e. a generalized method of moments estimator with instrumental variables which exploits the information contained in the relationship between the variables in both levels and first differences.

We have found a significant relationship between the two key variables, which suggests that there are departures from the Cobb-Douglas production function. The covariation is positively signed in 11 out of 15 industries, indicating that labor and capital are most often complements, rather than substitutes (but data unavailability precluded separate estimation for skilled and unskilled labor). There is also evidence of movements in the labor share due to either shifts of the benchmark share schedule, arising from changes in the real price of oil, and of movements off such schedule, arising from labor adjustment costs and changes in workers' bargaining power. The relationships found are, however, not robust to an enlarged definition of the labor share in which labor is imputed a fraction of self-employment income.

We have then exploited the model in trying to account for wage gaps, i.e. the difference between wages and the marginal product of labor, in two large economies, the US and Germany. We performed a simulation exercise using labor share equations estimated with disaggregated data for each of the two economies. The results indicate similar wage gaps as had been estimated previously for the US, but larger and more persistent gaps in Germany. In both countries, movements in wage gaps are the result of deviations away from the $BS$ curve.

# Appendix A
# Data sources and definitions of variables

The variables we use in the econometric estimation are constructed from the OECD International Sectoral Data Base (ISDB) 1996, documented in OECD (1996). Although it starts in 1960, disaggregated data on a sufficient scale are only available for the period 1970-93. The variables we use are as follows (original ISDB variables denoted by their own acronyms in capital letters):
*Labor share:* $s_L = 1 - OP$.
*Capital-output ratio:* $k = KTVD/GDPD$.
*Real oil price:* $q/p =$ Nominal price of oil/GDP deflator
$= (PO \times ER)/(GDP/GDPV)$.
*Labor conflict rate:* $lcr$ = Number of labor conflicts (strikes+lock-outs) /Number of employees in the preceding year (Source: CEP-OECD Data Set (1950-1992), documented in Bell and Dryden 1996).
*Adjusted labor share:* $s_L^* =$

$$1 - [(GDP - WSSS\ (ET/EE))/(GDP\ (1 - IND))]$$

where:
- $OP$ = Ratio of gross operating surplus to value added minus net indirect taxes.
- $KTVD$ = Gross capital stock, at 1990 prices and 1990 PPPs (US dollars).
- $GDPD$ = Value added at market prices, at 1990 prices and 1990 PPPs. (US dollars).
- $PO$ = Price of oil in dollars (Source: International Monetary Fund, *International Financial Statistics*, IFS).
- $ER$ = Exchange rate vis-a-vis the dollar (Market rate/Par or Central rate, period average. Source: IFS).
- $GDP$ = Value added at market prices, current prices, national currency.
- $GDPV$ = Value added at market prices, at 1990 prices, national currency.
- $WSSS$ = Compensation of employees, at current prices, national currency.
- $EE$ = Number of employees.
- $ET$ = Total employment.
- $IND$ = Ratio of net indirect taxes to value added.

The sectoral breakdown used distinguishes between 15 industries. The number of observations available for the econometric estimation by country, year, and industry are in Table A1.

TABLE A1

NUMBER OF OBSERVATIONS AVAILABLE FOR ECONOMETRIC ESTIMATION

BY COUNTRY, YEAR, AND INDUSTRY

| Country | No. | Year | No. | Year | No. |
|---|---|---|---|---|---|
| United States | 315 | 1973 | 73 | 1987 | 179 |
| Canada | 275 | 1974 | 127 | 1988 | 179 |
| Japan | 240 | 1975 | 127 | 1989 | 177 |
| Germany | 315 | 1976 | 127 | 1990 | 177 |
| France | 180 | 1977 | 134 | 1991 | 177 |
| Italy | 230 | 1978 | 157 | 1992 | 144 |
| United Kingdom | 137 | 1979 | 157 | 1993 | 93 |
| Australia | 119 | 1980 | 177 | | |
| Netherlands | 76 | 1981 | 177 | | |
| Belgium | 258 | 1982 | 177 | | |
| Denmark | 266 | 1983 | 177 | | |
| Norway | 266 | 1984 | 178 | | |
| Sweden | 280 | 1985 | 179 | | |
| Finland | 315 | 1986 | 179 | | |

| Industry | ISIC code | No. |
|---|---|---|
| Agriculture, hunting, forestry and fishing | 1 | 260 |
| Mining and quarrying | 2 | 200 |
| Food, beverages and tobacco | 31 | 207 |
| Textiles, wearing apparel and leather products | 32 | 207 |
| Paper, paper products, printing and publishing | 34 | 198 |
| Chemicals, petroleum, coal, rubber and plastic | 35 | 203 |
| Non-met. mineral products excl. petrol. and coal | 36 | 188 |
| Basic metal industries | 37 | 187 |
| Fabricated metal prods., machinery and equipment | 38 | 207 |
| Electricity, gas and water | 4 | 257 |
| Construction | 5 | 257 |
| Wholesale and retail trade | 61+62 | 191 |
| Transport, storage and communications | 7 | 239 |
| Community, social and personal services | 9 | 221 |
| Producers of Government services | - | 250 |

NOTE.– Missing industries: Wood and wood products (32); Restaurants and hotels (63); and Finance, insurance, real estate and business services (8).

# Appendix B
# Additional empirical results

TABLE A2
ESTIMATION OF LABOR SHARE EQUATION
Dependent variable: ln $s_{L,ijt}$

| | Capital-output ratio $\ln k_{ijt}$ | $t$-ratio | Real oil price $\ln(q_{jt}/p_{jt})$ | $t$-ratio |
|---|---|---|---|---|
| *Industry:* | | | | |
| Agriculture | -0.15 | (0.54) | 0.23 | (1.55) |
| Mining | 0.08 | (0.62) | -0.16 | (0.34) |
| Food | 0.03 | (0.68) | 0.02 | (1.61) |
| Textiles | 0.05 | (0.75) | 0.08 | (1.95) |
| Paper | -0.06 | (0.31) | 0.09 | (2.01) |
| Chemicals | -0.00 | (0.52) | 0.03 | (1.59) |
| Non-met. minerals | 0.06 | (0.77) | 0.05 | (1.78) |
| Basic metal | 0.09 | (0.82) | 0.02 | (1.53) |
| Machinery | -0.04 | (0.37) | 0.11 | (2.10) |
| Elec., Gas & Water | -0.20 | (0.19) | 0.00 | (1.49) |
| Construction | 0.01 | (0.53) | 0.06 | (1.83) |
| Trade | 0.18 | (1.05) | 0.03 | (1.56) |
| Transport & Comm. | 0.02 | (0.63) | 0.03 | (1.62) |
| Social services | -0.12 | (0.12) | 0.01 | (1.46) |
| Govt. services | 0.07 | (0.80) | 0.14 | (2.31) |
| Joint significance ($p$): | 24.65 | (0.04) | 72.37 | (0.00) |
| Constant | -0.62 | (8.00) | | |
| Employment change ($\Delta\ln n_{ijt}$) | -0.57 | (3.54) | | |
| Output volatility ($\widetilde{\widetilde{\sigma}_{ijt}}$) | -0.58 | (0.95) | | |
| Labor conflict rate ($\widetilde{lcr}_{jt}$) | -0.38 | (0.21) | | |
| $m_2$ | -2.20 | | | |

NOTE.– Method: Ordinary Least Squares. See note to Table 4.

TABLE A3
ESTIMATION OF ADJUSTED LABOR SHARE EQUATION
Dependent variable: $\ln s^*_{L,ijt}$

| | Capital-output ratio $\ln k_{ijt}$ | $t$-ratio | Real oil price $\ln(q_{jt}/p_{jt})$ | $t$-ratio |
|---|---|---|---|---|
| *Industry:* | | | | |
| Agriculture | 0.43 | (1.21) | -0.01 | (0.06) |
| Mining | -0.16 | (1.28) | -0.08 | (0.36) |
| Food | 0.37 | (0.16) | -0.18 | (0.94) |
| Textiles | 0.20 | (0.65) | 0.09 | (0.58) |
| Paper | 0.08 | (0.98) | 0.06 | (0.43) |
| Chemicals | 3.42 | (5.00) | -1.26 | (5.02) |
| Non-met. minerals | 0.37 | (0.16) | -0.04 | (0.19) |
| Basic metal | 1.88 | (1.61) | -0.85 | (2.20) |
| Machinery | 0.29 | (0.39) | 0.04 | (0.28) |
| Elec., Gas & Water | -0.28 | (1.52) | -0.01 | (0.01) |
| Construction | 0.08 | (0.89) | 0.15 | (0.99) |
| Trade | 0.22 | (0.60) | 0.07 | (0.50) |
| Transport & Comm. | -0.15 | (1.52) | 0.16 | (0.99) |
| Social services | -0.16 | (1.63) | 0.10 | (0.64) |
| Govt. services | 0.06 | (1.02) | 0.15 | (0.88) |
| Joint significance ($p$): | 127.38 | (0.00) | 50.57 | (0.00) |
| Constant | -0.63 | (4.67) | | |
| Employment change ($\Delta\ln n_{ijt}$) | 0.03 | (0.16) | | |
| Output volatility ($\widetilde{\sigma}_{ijt}$) | 0.15 | (0.27) | | |
| Labor conflict rate ($\widetilde{lcr}_{jt}$) | -2.13 | (2.15) | | |
| Sargan: $p$ and d.f. | 0.84 | (65) | | |
| Diff. Sargan: $p$ and d.f. | 0.61 | (48) | | |
| $m_2$ | 0.26 | | | |

NOTE.– No. of observations: 2663, no. of industry-country units: 152. Method: Instrumental variables, system estimator. See other information in note to Table 4.

TABLE A5

ESTIMATION OF LABOR SHARE EQUATION FOR GERMANY AND THE US

Dependent variable: ln $s_{L,ijt}$

| | Germany | US |
|---|---|---|
| Constant | -0.03 | -0.37 |
| | (0.09) | (3.98) |
| Capital-output ratio (ln $k_{ijt}$) | -0.77 | -0.19 |
| | (3.20) | (1.19) |
| Real oil price (ln $(q_t/p_{jt})$) | 0.04 | 0.04 |
| | (3.74) | (1.92) |
| Employment change ($\Delta$ln $n_{ijt}$) | -1.04 | -0.03 |
| | (3.86) | (0.14) |
| Output volatility ($\tilde{\sigma}_{ijt}$) | -1.35 | -3.14 |
| | (1.05) | (2.39) |
| Labor conflict rate ($\widetilde{lcr}_{jt}$) | -223.86 | 14.59 |
| | (3.19) | (2.02) |
| Sargan: $p$ and d.f. | 0.32 | 0.54 |
| | (6) | (6) |
| Diff. Sargan: $p$ and d.f. | 0.05 | 0.24 |
| | (5) | (5) |
| $m_2$ | 0.36 | -0.62 |

NOTE.– No. of observations: 315, no. of industries: 165, Period: 1973-93. Method: Instrumental variables, system estimator. $t$-ratios below the coefficients. See other information in note to Table 4. Instruments. (a) Differences: ln $K_{ij,t-2}$, (ln $K_{ij,t-2})^2$, $\Delta$ln $n_{ij,t-2}$, $\tilde{\sigma}_{ijt}$, $\widetilde{lcr}_{jt}$, and $\Delta$ln $y_{j,t-2}$. (b) Levels: $\Delta$ln $k_{ij,t-2}$, $\Delta$(ln $k_{ij,t-2})^2$, $\Delta\tilde{\sigma}_{ijt}$, $\Delta\widetilde{lcr}_{jt}$, and $\Delta^2$ln $y_{j,t-2}$.

TABLE A6

DECOMPOSITION OF CHANGES IN THE WAGE GAP (%)

| Year | Germany | | | | United States | | | |
|---|---|---|---|---|---|---|---|---|
| | Total | (1) | (2) | (3) | Total | (1) | (2) | (3) |
| 1974 | 3.68 | 3.96 | 0.37 | -0.66 | -0.18 | 0.24 | 0.07 | -0.49 |
| 1975 | 7.74 | 7.91 | 0.60 | -0.78 | 0.52 | 1.03 | 0.25 | -0.77 |
| 1976 | -2.76 | -2.65 | -0.01 | -0.10 | -1.50 | -1.58 | -0.07 | 0.16 |
| 1977 | -1.38 | -1.37 | -0.04 | 0.03 | -0.11 | -0.20 | -0.06 | 0.14 |
| 1978 | -1.68 | -1.71 | -0.05 | 0.08 | -0.58 | -0.84 | -0.08 | 0.34 |
| 1979 | -3.52 | -3.42 | -0.14 | 0.05 | 0.08 | 0.24 | -0.01 | -0.14 |
| 1980 | 0.01 | -0.03 | -0.00 | 0.05 | 0.41 | 0.66 | 0.08 | -0.33 |
| 1981 | 1.87 | 2.05 | 0.41 | -0.59 | -0.48 | -0.44 | 0.03 | -0.08 |
| 1982 | 2.70 | 2.88 | 0.63 | -0.82 | 0.19 | 0.57 | 0.18 | -0.55 |
| 1983 | 1.53 | 1.66 | 0.51 | -0.64 | -0.82 | -0.91 | -0.01 | 0.10 |
| 1984 | 0.15 | 0.27 | 0.00 | -0.12 | -1.50 | -1.87 | -0.19 | 0.56 |
| 1985 | -1.96 | -1.98 | 0.02 | -0.01 | 0.88 | 0.81 | -0.03 | 0.09 |
| 1986 | -1.42 | -1.75 | -0.12 | 0.45 | 0.48 | 0.15 | -0.02 | 0.35 |
| 1987 | 0.19 | 0.17 | -0.02 | 0.03 | -0.38 | -0.49 | -0.08 | 0.19 |
| 1988 | -1.75 | -1.75 | -0.00 | 0.01 | 0.16 | -0.09 | -0.07 | 0.32 |
| 1989 | -1.62 | -1.58 | -0.26 | 0.22 | 0.36 | 0.34 | -0.02 | 0.04 |
| 1990 | -1.91 | -1.78 | -0.22 | 0.09 | 0.49 | 0.57 | 0.03 | -0.10 |
| 1991 | 0.13 | 0.23 | 0.15 | -0.25 | 0.64 | 0.79 | 0.13 | -0.28 |
| 1992 | 1.27 | 1.31 | 0.34 | -0.38 | -0.22 | -0.10 | 0.08 | -0.20 |
| 1993 | 2.42 | 2.13 | 0.42 | -0.12 | -0.48 | -0.67 | -0.07 | 0.26 |
| St. dev. | 2.58 | 2.63 | 0.27 | 0.34 | 0.64 | 0.77 | 0.10 | 0.33 |

NOTE.– Decomposition of the wage gap according to the formula:

$\Delta WG_t \approx$

(1) $\Delta \ln h(X_t)$

(2) $[1 - k_t^\eta \gamma(Z_t)]\ \Delta u_t$

(3) $[(\eta - 1)\Delta(k_t^\eta \gamma(Z_t))]\ u_t + \eta k_t^\eta \gamma(Z_t)\ \Delta u_t$.

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TABLE 1

THE LABOR SHARE AND REAL WAGES IN 14 OECD COUNTRIES

| | Labor share | | | | Real wage |
|---|---|---|---|---|---|
| | Levels | | | Changes | Changes |
| | 1970 | 1980 | 1990 | 1970-90 | 1970-90 |
| United States | 69.7 | 68.3 | 66.5 | -3.3 | 0.4 |
| Canada | 66.9 | 62.0 | 64.9 | -2.0 | 1.3 |
| Japan | 57.5 | 69.1 | 68.0 | 10.5 | 3.5 |
| Germany | 64.1 | 68.7 | 62.1 | -2.0 | 2.0 |
| France | 67.6 | 71.7 | 62.4 | -5.2 | 2.2 |
| Italy | 67.1 | 64.0 | 62.6 | -4.5 | 2.1 |
| United Kingdom | 71.4 | 70.8 | 71.8 | 0.4 | 2.1 |
| Australia | 64.8 | 65.9 | 62.9 | -1.9 | 1.2 |
| Netherlands | 68.0 | 69.5 | 59.2 | -8.8 | 1.8 |
| Belgium | 61.6 | 71.6 | 64.0 | 2.4 | 2.9 |
| Denmark | 68.7 | 71.5 | 63.3 | -5.5 | 1.6 |
| Norway | 68.4 | 66.4 | 63.9 | -4.5 | 2.2 |
| Sweden | 69.7 | 73.6 | 72.6 | 2.9 | 1.6 |
| Finland | 68.6 | 69.6 | 72.3 | 3.7 | 3.5 |
| Mean | 66.7 | 68.8 | 65.5 | -1.3 | 2.0 |
| Standard deviation | 3.5 | 3.1 | 4.0 | 4.7 | 0.8 |

NOTE.– All variables in percentages. The labor share corresponds to the business sector, the real wage is the real compensation per employee in the private sector. Source: *OECD Economic Outlook* Statistics on Microcomputer Diskette.

TABLE 2
DESCRIPTIVE STATISTICS OF THE MAIN VARIABLES
(All observations in the sample; 1973-93)

| | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| Labor share | 59.9 | 21.2 | 2.4 | 100.0 |
| Capital-output ratio | 3.9 | 4.1 | 0.3 | 49.1 |
| Real price of oil | 3.3 | 0.5 | 1.7 | 4.6 |
| Employment growth rate | -0.4 | 4.3 | -24.1 | 20.5 |
| Outpult volatility | 2.2 | 2.0 | 0.0 | 43.4 |
| Labor conflict rate | 0.9 | 1.1 | 0.0 | 6.5 |

NOTE.– All variables in percentages, except the capital-output ratio and the real price of oil. The data correspond to an unbalanced panel of 15 industries and 14 countries. Total number of observations: 3272. Source: OECD International Sectoral Data Base (ISDB) (see Appendix A).

TABLE 3

DESCRIPTIVE STATISTICS OF THE LABOR SHARE AND THE CAPITAL-OUTPUT RATIO BY INDUSTRY AND BY COUNTRY (1973-93)

| Industry | Labor share | Capital-output ratio | Country | Labor share | Capital-output ratio |
|---|---|---|---|---|---|
| Agriculture | 20.5 | 5.7 | United States | 64.3 | 3.1 |
| Mining | 43.0 | 4.0 | Canada | 59.6 | 3.8 |
| Food | 59.7 | 2.2 | Japan | 54.3 | 3.1 |
| Textiles | 74.1 | 2.1 | Germany | 62.9 | 3.0 |
| Paper | 69.1 | 2.9 | France | 60.3 | 2.7 |
| Chemicals | 58.5 | 3.5 | Italy | 52.9 | 3.1 |
| Non-met. minerals | 67.0 | 2.9 | U. Kingdom | 51.2 | 4.7 |
| Basic metal | 67.9 | 5.0 | Australia | 54.1 | 6.6 |
| Machinery | 74.8 | 1.7 | Netherlands | 47.5 | 3.8 |
| Elec., Gas & Water | 35.7 | 9.7 | Belgium | 61.5 | 2.7 |
| Construction | 67.2 | 0.8 | Denmark | 63.9 | 4.4 |
| Trade | 64.1 | 1.5 | Norway | 59.6 | 6.3 |
| Transport & Comm. | 60.3 | 7.3 | Sweden | 67.6 | 3.6 |
| Social services | 52.8 | 2.2 | Finland | 59.8 | 5.2 |
| Govt. services | 93.3 | 5.4 | | | |
| Standard deviation | 16.9 | 2.3 | | 5.5 | 1.2 |

NOTE.– The labor share is in percentage terms. Source: OECD International Sectoral Data Base (ISDB). See number of observations by country, year, and industry in Table A1.

TABLE 4

ESTIMATION OF LABOR SHARE EQUATION

Dependent variable: $\ln s_{L,ijt}$

| | Capital-output ratio $\ln k_{ijt}$ | $t$-ratio | Real oil price $\ln(q_{jt}/p_{jt})$ | $t$-ratio |
|---|---|---|---|---|
| *Industry:* | | | | |
| Agriculture | -1.48 | (5.01) | 0.30 | (2.12) |
| Mining | -0.09 | (3.66) | -0.20 | (3.16) |
| Food | 0.02 | (5.15) | -0.10 | (2.67) |
| Textiles | 0.05 | (5.18) | -0.05 | (2.26) |
| Paper | 0.23 | (5.73) | -0.08 | (2.36) |
| Chemicals | 0.40 | (4.76) | -0.21 | (2.83) |
| Non-met. minerals | 0.49 | (5.66) | -0.21 | (3.16) |
| Basic metal | 0.94 | (4.50) | -0.51 | (3.34) |
| Machinery | 0.19 | (4.90) | -0.07 | (2.41) |
| Elec., Gas & Water | 0.03 | (4.53) | -0.20 | (2.95) |
| Construction | 0.13 | (4.88) | -0.04 | (2.17) |
| Trade | 0.49 | (5.62) | -0.10 | (2.53) |
| Transport & Comm. | -0.08 | (4.74) | -0.03 | (2.16) |
| Social services | 0.06 | (4.83) | -0.10 | (2.58) |
| Govt. services | -0.14 | (4.31) | 0.12 | (1.20) |
| Joint significance ($p$): | 47.49 | (0.00) | 101.59 | (0.00) |
| Constant | -0.24 | (2.00) | | |
| Employment change ($\Delta\ln n_{ijt}$) | -0.60 | (4.58) | | |
| Output volatility ($\tilde{\sigma}_{ijt}$) | -0.46 | (3.76) | | |
| Labor conflict rate ($\widetilde{lcr}_{jt}$) | -0.72 | (2.47) | | |
| Sargan: $p$ and d.f. | 0.11 | (65) | | |
| Diff. Sargan: $p$ and d.f. | 0.05 | (48) | | |
| $m_2$ | -1.09 | | | |

NOTE.– No. of observations: 3272, no. of industry-country units: 179, Period: 1973-93. Method: Instrumental variables, system estimator. Two-step estimates robust to residual heteroskedasticity and autocorrelation. Diagnostic statistics: p-value of the Sargan test (with degrees of freedom beside), p-value of the Difference Sargan test (with d.f. beside), and coefficient of second-order correlation of the residuals. Except for the first one, $t$-ratios on $\ln k_{ijt}$ and $\ln (q_{jt}/p_{jt})$ refer to significance vis-a-vis Agriculture. p-values of Wald test statistics of joint significance of all interactions reported next to them. Instruments. (a) Differences: $d_i\times \ln K_{ij,t-2}$, $(\ln K_{ij,t-2})^2$, $\Delta\ln n_{ij,t-2}$, $\tilde{\sigma}_{ijt}$, $\tilde{\sigma}_{ijt-1}$, $\tilde{\sigma}_{ijt-2}$, $d_i \times \widetilde{lcr}_{jt}$, and $d_i \times \Delta\ln y_{j,t-2}$. (b) Levels: $d_i\times \Delta\ln k_{ij,t-2}$, $\Delta(\ln k_{ij,t-2})^2$, $\Delta\tilde{\sigma}_{ijt}$, $\Delta\tilde{\sigma}_{ijt-1}$, $\Delta\tilde{\sigma}_{ijt-2}$, $d_i \times \Delta\widetilde{lcr}_{jt}$, and $d_i \times \Delta^2\ln y_{j,t-2}$.

TABLE 5
ESTIMATION OF LABOR SHARE EQUATION
WITH $\widetilde{\sigma}$ POTENTIALLY NON-PREDETERMINED
Dependent Variable: $\ln s_{L,ijt}$

| | Capital-output ratio $\ln k_{ijt}$ | $t$-ratio | Real oil price $\ln(q_{jt}/p_{jt})$ | $t$-ratio |
|---|---|---|---|---|
| *Industry:* | | | | |
| Agriculture | -1.61 | (3.77) | 0.37 | (2.23) |
| Mining | -0.20 | (2.89) | -0.17 | (2.86) |
| Food | 0.02 | (3.84) | -0.09 | (2.59) |
| Textiles | 0.04 | (3.84) | -0.03 | (2.22) |
| Paper | 0.22 | (4.13) | -0.06 | (2.32) |
| Chemicals | 0.59 | (3.97) | -0.26 | (2.93) |
| Non-met. minerals | 0.44 | (4.46) | -0.18 | (2.99) |
| Basic metal | 1.22 | (4.72) | -0.61 | (3.82) |
| Machinery | 0.06 | (3.84) | -0.03 | (2.20) |
| Elec., Gas & Water | -0.02 | (3.47) | -0.18 | (2.72) |
| Construction | 0.12 | (3.79) | -0.02 | (2.18) |
| Trade | 0.46 | (4.35) | -0.08 | (2.49) |
| Transport & Comm. | -0.09 | (3.56) | -0.01 | (2.14) |
| Social services | 0.06 | (3.72) | -0.09 | (2.54) |
| Govt. services | -0.14 | (3.63) | 0.13 | (1.39) |
| Joint significance ($p$): | 50.42 | (0.00) | 116.48 | (0.00) |
| | | | | |
| Constant | -0.30 | (2.55) | | |
| Employment change ($\Delta\ln n_{ijt}$) | -0.55 | (3.97) | | |
| Output volatility ($\widetilde{\sigma}_{ijt}$) | 0.41 | (1.46) | | |
| Labor conflict rate ($\widetilde{lcr}_{jt}$) | -2.35 | (2.95) | | |
| | | | | |
| Sargan: $p$ and d.f. | 0.07 | (61) | | |
| Diff. Sargan: $p$ and d.f. | 0.06 | (46) | | |
| $m_2$ | -1.42 | | | |

NOTE.– See note to Table 4. Method: Instrumental variables, system estimator. Instruments: same as in Table 4, but excluding $\widetilde{\sigma}_{ijt}$, $\widetilde{\sigma}_{ijt-1}$ in differenced equations and excluding $\Delta\widetilde{\sigma}_{ijt}$, $\Delta\widetilde{\sigma}_{ijt-1}$ in levels equations.

FIGURE 1. THE LABOR SHARE IN THE UK

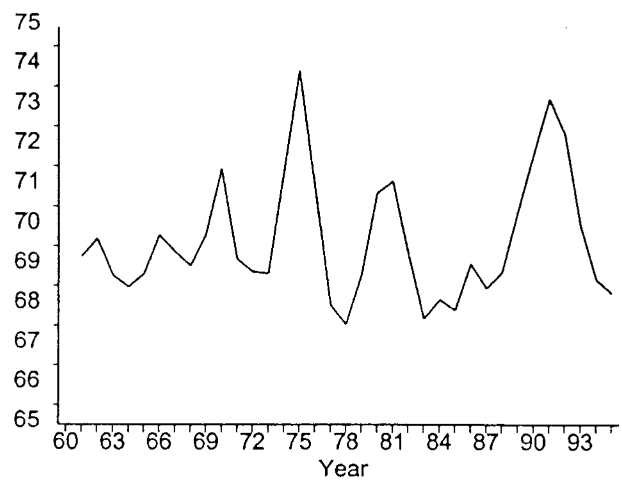


FIGURE 2. THE LABOR SHARE IN THE US

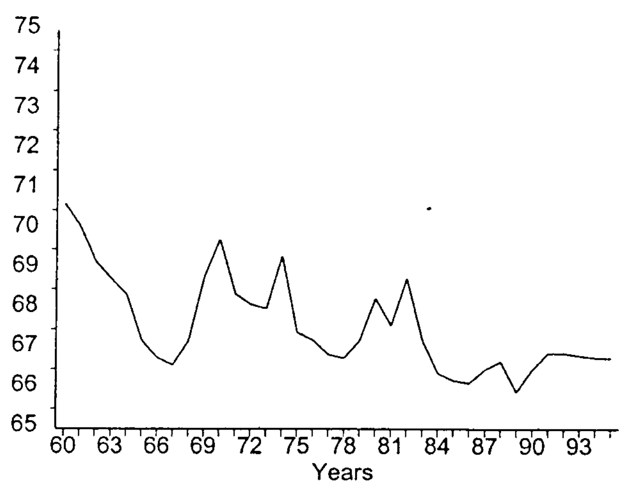

FIGURE 3. THE LABOR SHARE IN JAPAN

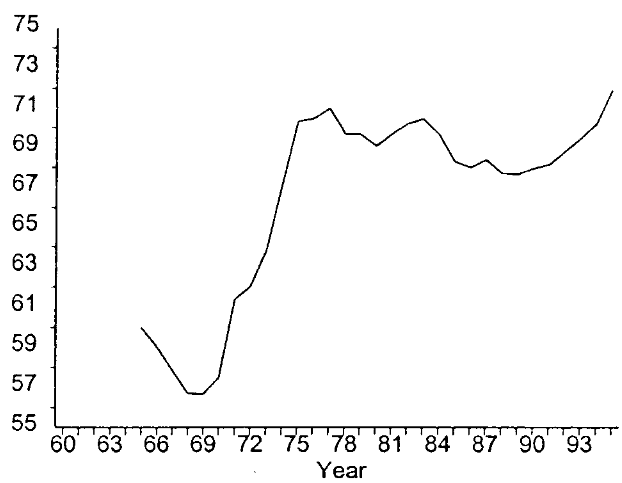


FIGURE 4. THE LABOR SHARE IN FRANCE AND GERMANY

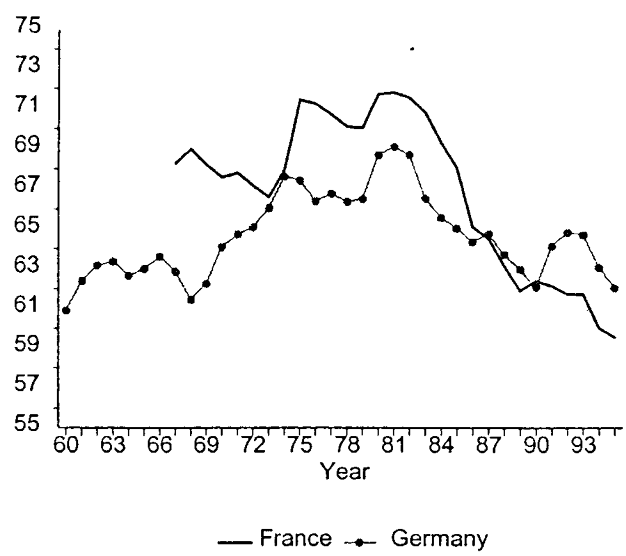

FIGURE 5. WAGE GAPS IN GERMANY AND THE US