Chapter 2

Factor shares and adjustment costs

2.1 Introduction

Factor shares are usually regarded as being constant, at least in the long run. On a theoretical level, such constancy is suggested not only by growth theory in the Solow-Cass-Koopmans tradition but is also compatible with more recent models of endogenous growth.[1] However, in many countries factor shares do not appear to be constant and pronounced cross-country differences exist. Figure (2.1) shows the labor shares of the US and the four major continental European Countries, France, Germany, Italy and Spain.[2] While the US labor share fluctuates around a downward trend, the European

[1] For the discussion of factor shares in neoclassical growth theory see Dixit (1976) and, in models of endogenous growth, Bertola (1993).

[2] The labor shares are calculated by multiplying employment (the number of employed workers plus the self employed minus unpaid family members) with average employee compensation, and dividing over nominal domestic product at factor cost. All data are from the OECD business sector data base and refer to the private sector only.

labor shares typically have a hump-shaped pattern.[3]

The labor share as a key socio-economic variable often attracts attention in its own right. Furthermore, as it equals the ratio of wages to labor productivity, it has been widely used as the basis for calculating wage gaps in order to distinguish between "classical" and "Keynesian" unemployment, see Artus (1984) for a major example. More recently, Blanchard (1997, 1998) and Caballero and Hammour (1998a) have reconsidered labor share movements and stressed their importance for understanding how changes and differences in labor market institutions affect the macroeconomic outcome. Labor market institutions typically differ across countries and over time. They therefore provide a natural explanation for factor share movements. The analysis in this chapter focusses on one particularly important institutional feature in this context, the size of hiring and firing costs.

In order to explain labor share movements by adjustment costs, I consider a representative firm facing linear hiring and firing costs and uncertainty about business conditions and wages. Its optimal dynamic labor demand policy allows insights to be acquired about the relationship between the size of hiring and firing costs and the direction and magnitude of labor share changes in response to shocks in business conditions or wages. The labor share is found to fluctuate counter-cyclically with business conditions and pro-cyclically with wages. Higher adjustment costs imply bigger swings in factor shares. Two invariance results are derived for the benchmark case of Cobb-Douglas technology. An increase in business cycle fluctuations will not affect the size of factor share movements. Similarly, if adjustment costs are proportional to wages, increased wage fluctuations will leave factor share

[3]For earlier criticism of the notion of factor share constancy see Solow (1958) and Atkinson (1983).

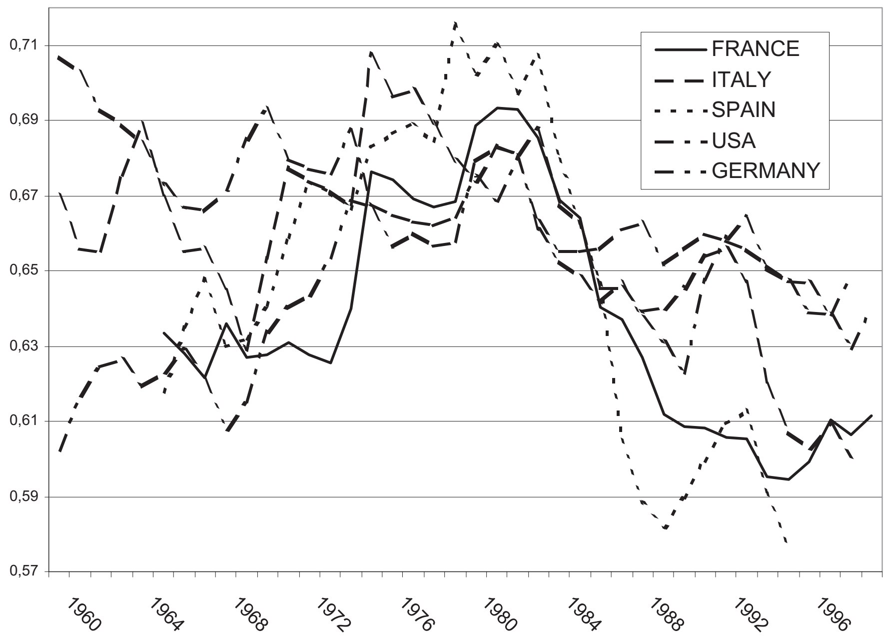

Figure 2.1: *Labor Shares of the USA and the four major continental European countries*

movements unchanged. Therefore, the size of adjustment costs rather than the size of wage shocks or shocks to business conditions is the key magnitude which determines the size of labor share fluctuations.

The results are tested quantitatively by considering labor share fluctuations for a group of 20 OECD countries. The labor share is found to move counter-cyclically with respect to economic activity and pro-cyclically with wages. Using institutional data on the strength of employment protection legislation, it is shown that the labor share will deviate more in response to changes in economic activity in countries with stronger EPL. No clear relationship between the strength of EPL and wage induced labor share movements is found for wage fluctuations.

Of the recent literature that has readdressed the question of labor share movements, my approach is most closely related to the contribution by Bentolila and Saint-Paul (1999), in the sense that factor share movements are not seen as the result of out-of-steady-state transitions, but the aim is to explore the scope for such movements without resorting to these transitions. They provide a comprehensive analysis of a variety of factors affecting the labor share and demonstrate that, with constant returns and labor-augmenting technological progress, a one-to-one relation between the capital-output ratio and the labor share exists. This relationship may be altered if the workforce is heterogeneous or if there are further production inputs. Factors such as efficient bargaining or labor adjustment costs can cause this relation to break down.

Blanchard (1997) identifies two groups of countries whose experiences seem to be similar. The "Anglo-Saxon" countries exhibit more or less stable labor shares whereas the "Continental" labor shares have a hump-shaped pattern.[4] Blanchard explains the latter by an adverse labor supply shock in the seventies and an adverse labor demand shock in the eighties. He simulates these shocks using a macro model. Caballero and Hammour (1998a), on the other hand, explicitly model the evolution of particular labor market institutions, such as taxes, firing costs, and the level of unemployment benefits. Their model makes use of the concept of factor specificity, see Caballero and Hammour (1998b), and its interaction with putty-clay technology. In this account, pro-labor reforms in the late 1960s and 1970s increased capital's specificity with respect to labor and allowed labor to successfully appropri-

[4] His Anglo-Saxon countries are the US, the UK and Canada, the Continental countries are France, Germany, Italy and Spain.

ate a greater fraction of the joint surplus. Over time, however, in order to lower its per unit specificity, capital responded by increasing the capital-labor ratio in new production units, thereby regaining and even overcompensating the lost share. Although initially used to explain the French data, the appropriation mechanism and the response it triggered formalizes an argument that is potentially valid for other European countries.

A further aspect of labor share dynamics is the changing sectoral composition of an economy. This issue is addressed in de Serres et al. (2002) and Giammaroli et al. (2001). Their work shows that for some European countries such sectoral changes do indeed play a role in explaining the decrease in the labor share in the 1980s and 1990s.

The chapter is organized as follows. Section two reconstructs series for the evolution of capital-labor ratios for the US and the major continental European economies in order to assess the explanatory power of deviations from Cobb-Douglas production. As a by-product, the plausibility of the appropriation hypothesis of Caballero and Hammour (1998a) for other European countries is revisited. Non-unit elasticity is found not to be a plausible explanation for observed differences in labor share movements. Section three develops the theoretical model in order to analyze the effects of adjustment costs under fluctuations in business conditions. The model is then applied to wage fluctuations in section four. Section five addresses joint fluctuations. Section six focusses on the case of labor demand inaction. The empirical implications of the model are tested in section seven and section eight concludes.

2.2 Non-unit elasticity of substitution

If the elasticity of substitution between labor and capital is not one, factor shares will be changed when the ratio of factor inputs changes over time. The aim of this section is to assess the explanatory power of such deviations from the Cobb-Douglas assumption to account for both the time series and the cross-country differences in labor share movements. While this is a natural starting point, such an explanation is subject to certain restrictions. In particular, it is not plausible to assume that the main OECD economies are technologically different. Different labor share movements can therefore not be explained by substantially different elasticities of substitution in the individual countries. Any potential explanation requires the non-unit elasticity of substitution to be similar across countries. The differences in labor share movements must then be explained by the interaction of cross country differences in the development of the factor input ratios with a common non-unit elasticity of substitution.

Consider the standard constant elasticity of substitution production function

$$Y_t = \left[a\left[A_t L_t\right]^{-\rho} + (1-a){K_t}^{-\rho}\right]^{-\frac{1}{\rho}}, \tag{2.1}$$

where Y_t is aggregate output, L_t and K_t are labor and capital inputs, a is the distribution parameter and A_t labor-augmenting technological progress. The elasticity of substitution is given by $\sigma = \frac{1}{1+\rho}$. Including capital-augmenting technological progress can also open up interesting explanations for factor share movements, as in Acemoglu (2000). However, as Diamond et al. (1978) have shown, doing this gives rise to a fundamental identification problem, so that explanations involving technological bias can empirically never be refuted. Given this restriction, only labor-augmenting technological progress

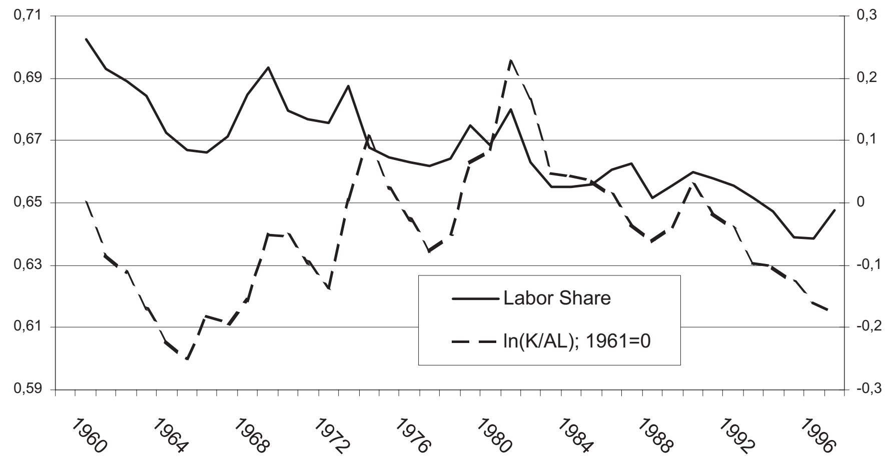

Figure 2.2: *Labor share (left scale) and capital-labor ratio, USA*

is the natural benchmark, since assuming this is compatible with balanced growth.

As first proposed by Kmenta (1967), the CES production function can be approximated using a Taylor expansion as

$$\ln Y_t = a \ln A_t + a \ln L_t + (1-a)\ln(K_t) - \frac{1}{2}\rho a(1-a)\left[\ln\left(\frac{K_t}{A_t L_t}\right)\right]^2.$$

Under constant returns and labor being paid its marginal product the labor share, LS_t, equals the output elasticity with respect to labor input. Thus,

$$LS_t = \frac{\partial Y_t}{\partial L_t}\frac{L_t}{Y_t} = \frac{\partial \ln Y_t}{\partial \ln L_t} = a + \rho a(1-a)\ln\left(\frac{K_t}{A_t L_t}\right). \tag{2.2}$$

It will change over time according to

$$\frac{dLS_t}{dt} = \rho a(1-a)\left[\overset{o}{K}_t - \left(\overset{o}{A}_t + \overset{o}{L}_t\right)\right], \tag{2.3}$$

where the circle above a variable denotes its growth rate. Hence, if capital grows faster than labor in efficiency units, the labor share will rise if the

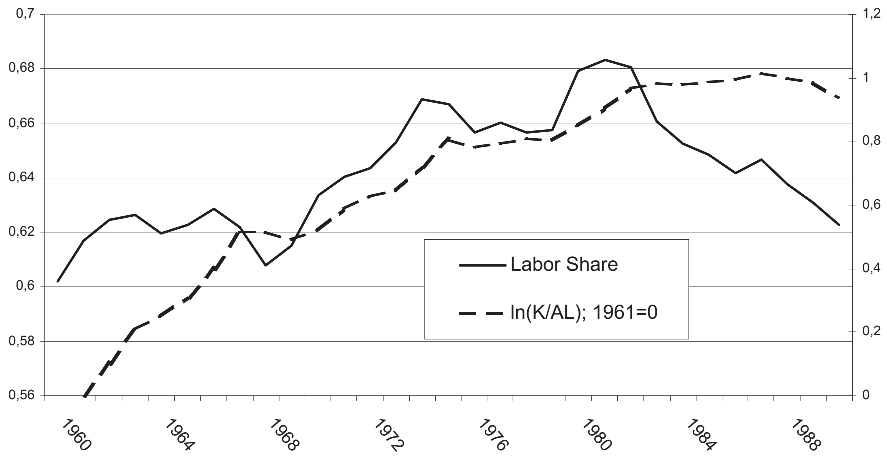

Figure 2.3: *Labor share (left scale) and capital-labor ratio, Germany*

elasticity of substitution is low ($\sigma < 1 <=> \rho > 0$), or fall if the elasticity of substitution is high ($\sigma > 1 <=> \rho < 0$). Conversely, if capital grows more slowly than labor in efficiency units, then the labor share will rise if the elasticity is high ($\sigma > 1 <=> \rho < 0$) or fall, if the elasticity is low ($\sigma < 1 <=> \rho > 0$). Intuitively, if the elasticity is high and one of the factors grows faster than the other, only a small change in prices is needed for adjustment and the quantity effect dominates the price effect. On the other hand, if the elasticity is low, a large change in prices is needed and the price effect dominates the quantity effect. Note that, for a given elasticity, explaining the typical European hump-shaped labor share requires a reversal in the capital-labor ratio. Similarly, if a reversal in the capital-labor ratio can be observed, it cannot be compatible with a roughly constant labor share unless $\sigma = 1$.

In order to analyze relationship (2.2), series of the log of the ratio of

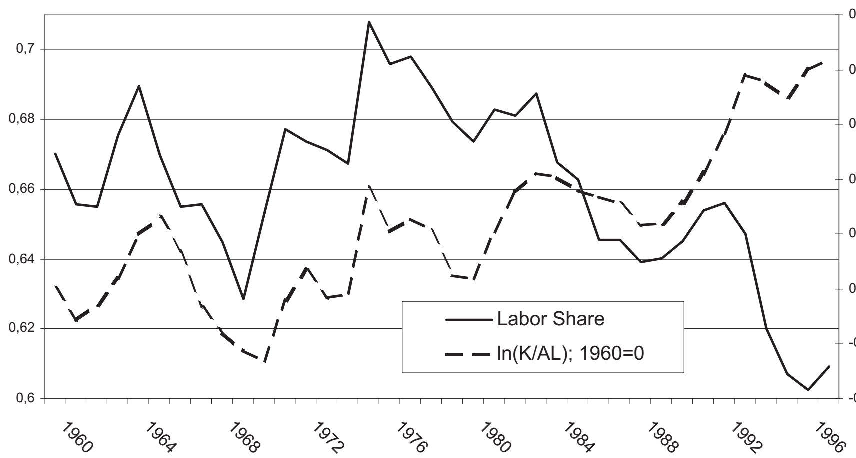

Figure 2.4: *Labor share (left scale) and capital-labor ratio, Italy*

capital to labor in efficiency units were calculated for the US and the major continental European economies, France, Germany, Italy and Spain.[5] The data that is used is from the OECD business sector data base 2001 and refers to the private sector.[6] The UK was left out, since UK data is reported only from 1987 onwards. For all countries the log capital-labor ratio was normalized to zero for the first year of available data. They are shown in

[5]To do so first recover Solow residuals according to

$$\frac{dA_t}{A_t} = \frac{1}{LS_t}\frac{d\left(\frac{Y_t}{K_t}\right)}{\frac{Y_t}{K_t}} - \frac{d\left(\frac{L_t}{K_t}\right)}{\frac{L_t}{K_t}}. \tag{2.4}$$

Choosing $A_0 = 1$ and integrating, gives series for A_t. The series found by this procedure usually exhibit a pro-cyclical fluctuations which may be caused by adjustment costs or thick market effects during booms. For the medium run development these cyclical effects are of secondary importance.

[6]Note that this database has been revised. For France, using the 1999 edition, gives somewhat different results

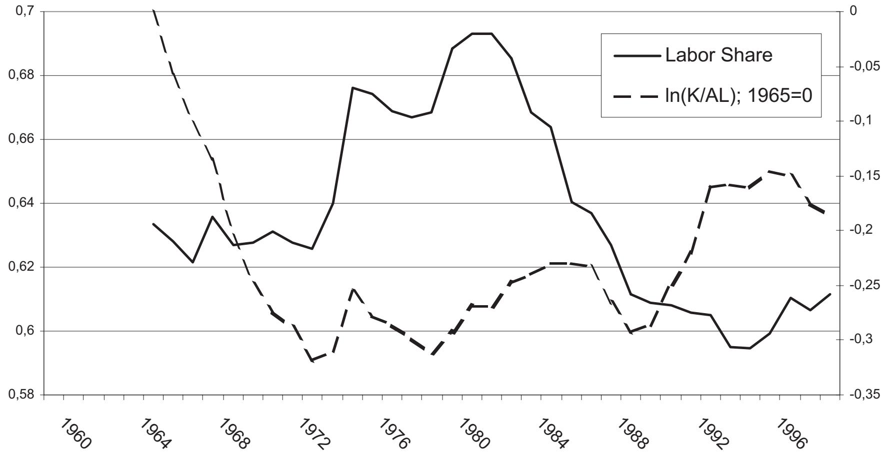

Figure 2.5: *Labor share (left scale) and capital-labor ratio, France*

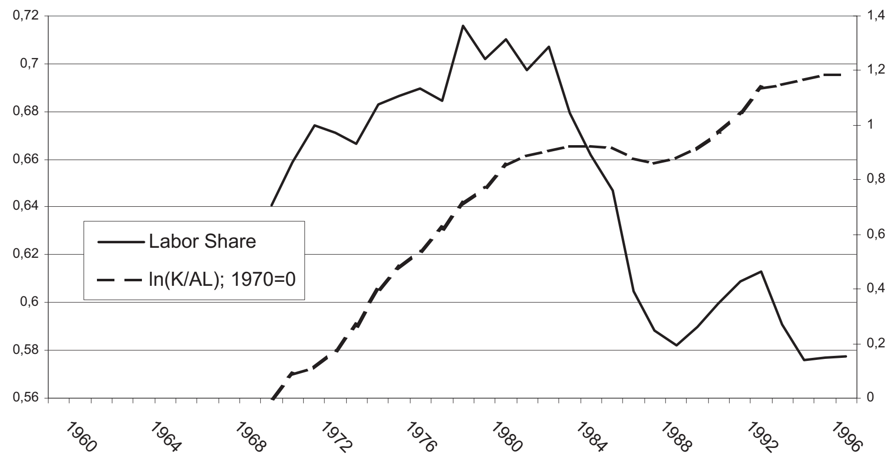

Figure 2.6: *Labor share (left scale) and capital-labor ratio, Spain*

figures (2.2)-(2.6) together with the respective labor shares.

The main results are the striking differences between the pictures that appear for the different countries. For the US and Italy there is some evidence that the labor share and the capital-labor ratio move together, indicating some evidence for $\sigma < 1$. However, the Italian capital labor ratio shows an upward trend, while the US ratio fluctuates around some stable level. For Germany and Spain, the capital-labor ratio is rising almost steadily. This cannot be harmonized with either $\sigma < 1$ or $\sigma > 1$ and their hump-shaped labor shares. For France the capital-labor ratio has a clear U shape, quite in line with the appropriation push argument of Caballero and Hammour, who correspondingly claim $\sigma > 1$. However, the development of the German and Spanish capital-labor ratios shows, that such an explanation is not valid for these countries, since the capital deepening was not increasing in the seventies. Thus, there is no evidence for an appropriation push by labor in these countries. For Italy, however, there is some evidence that the capital-labor ratio started to increase in the seventies.

Summing up, for some individual countries, deviations from unit elasticity of substitution may seem to be an element that contributes to the explanation of labor share movements, whereas for others this seems not to be the case. Even for those countries where there is a consistent relationship between the capital-labor ratio and the labor share, the implications for the elasticity of substitution differ between countries. Thus, non-unit elasticity does not provide an encompassing explanation for the observed differences in labor share movements. These findings parallel the results of Blanchard (1997) who studies a number of OECD countries and does not find any indication of deviations from unit elasticity.

2.3 Factor shares in a Markov chain model

Labor market institutions have differed substantially across time and across countries. They therefore represent an obvious alternative explanation. An essential feature of many of the typical European labor market institutions is to increase hiring, and particularly, firing costs directly or indirectly. Adjustment costs cause labor demand to be off the demand curve, implying the possibility of labor share changes even under Cobb-Douglas technology. In order to study the relationship between adjustment costs and the labor share, the simple stochastic model of Bertola (1990), which he used to analyze the effects of adjustment costs on dynamic labor demand, is reconsidered. Let a representative risk-neutral firm's dynamic labor demand problem be given by

$$\underset{\{L_i\}}{Max}\ E_t \left\{ \sum_{k=0}^{\infty} \left(\frac{1}{1+r} \right)^k [R(Z_{t+k}, L_{t+k}) - w_{t+k}L_{t+k} - C(L_{t+k} - L_{t+k-1}] \right\}.$$

$R(Z_i, L_i)$ denotes the firm's one period revenue as a function of the amount of labor employed L_i and the prevailing business conditions Z_i. The business conditions are assumed to follow a two state Markov chain, i.e. $i \in \{g, b\}$, so that in good times $Z_i = Z_g$ and in bad times $Z_i = Z_b$ and $Z_g > Z_b$. The probabilities p_g and p_b are the probabilities of the good state remaining good and the bad state remaining bad, so that $1 - p_g$ and $1 - p_b$ are the respective switching probabilities. The wage rate is given exogenously and may follow a similar process. The firm faces asymmetric linear costs of adjusting its labor force,

$$C(L_i - L_{i-1}) = \begin{cases} H(L_i - L_{i-1}) & if \quad L_i - L_{i-1} > 0 \\ -F(L_i - L_{i-1}) & if \quad L_i - L_{i-1} < 0, \end{cases}$$

where H and F represent the given costs per hired and fired worker respectively. Define the shadow product of labor V as,

$$V_t \equiv E_t \left\{ \sum_{k=0}^{\infty} \left(\frac{1}{1+r} \right)^k M(Z_{t+k}, L_{t+k}) - w_{t+k} \right\},$$

where $M(Z, L) \equiv \frac{\partial R(Z,L)}{\partial L}$ is the marginal revenue product of labor (MRPL) function. The first order conditions of the firm's problem are given as,

$$-F \leq V_t \leq H \text{ always,} \tag{2.5}$$

$$V_t = H, \text{ if } L_t - L_{t-1} > 0 \tag{2.6}$$

$$V_t = -F, \text{ if } L_t - L_{t-1} < 0. \tag{2.7}$$

The firm's optimal policy is to hire when business conditions become good and to fire when they become bad. When conditions stay the same inaction is optimal, since there are no voluntary quits in the model. Hence, employment itself follows a Markov chain $\{L_i\}$ whose state coincides with the driving chain $\{Z_i\}$. It may even be the case that it is optimal not to change employment at all, if hiring and firing costs are prohibitively high.

While in the latter case the oscillations of employment are obviously reduced to the minimum, they are always attenuated relative to the no adjustment cost case, since labor demand will be increased relatively in the bad state but reduced in the good state. According to the first order conditions it must be that

$$V_t = M(Z_g, L_g) - W_g + \frac{1}{1+r} E\left[V_{t+1}\right] = H$$

when the firm is hiring. Substituting $E\left[V_{t+1}\right] = p_g H + (1 - p_g)(-F)$ gives

$$w_g = M(Z_g, L_g) - \frac{1}{1+r}(1 - p_g)(H + F) - \frac{r}{1+r}H. \tag{2.8}$$

Similar derivation for bad times yields

$$w_b = M(Z_b, L_b) + \frac{1}{1+r}(1 - p_b)(F + H) + \frac{r}{1+r}F. \tag{2.9}$$

Equations (2.8) and (2.9) show the wedges that are driven between wages and the MRPL when there are adjustment costs. In good times the wage is below the MRPL, in bad times it is above it. This causes the labor share to vary. Implicitly (2.8) and (2.9) define the optimum labor demands as $L_g = L_g(Z_g, W_g, H, F, p_g, r)$ and $L_b = L_b(Z_b, w_b, H, F, p_b, r)$, depending on the functional form of the revenue function. Comparative statics show that $\frac{\partial L_g}{\partial F}, \frac{\partial L_g}{\partial H} < 0$, $\frac{\partial L_g}{\partial p_g}, \frac{\partial L_g}{\partial r} > 0$ and $\frac{\partial L_b}{\partial F}, \frac{\partial L_b}{\partial H} > 0$, $\frac{\partial L_b}{\partial r}, \frac{\partial L_b}{\partial F} < 0$. Consequently, everything that makes the wedge, $Q_g \equiv \frac{1}{1+r}(1-p_g)(H+F) - \frac{r}{1+r}H$, bigger in good times reduces labor demand and everything that makes the wedge, $Q_b \equiv \frac{1}{1+r}(1-p_b)(F+H) + \frac{r}{1+r}F$, bigger in the bad state increases labor demand. The labor share in state i, LS_i, is therefore given by

$$LS_i = \frac{w_i L_i(Z_i, w_i, H(w_i), F(w_i), p_i, r)}{R_i(Z_i, L_i(Z_i, w_i, H(w_i), F(w_i), p_i, r))}, i = g, b \tag{2.10}$$

This general formulation allows the different causes of labor share fluctuations and their relationship to the size of adjustment costs to be analyzed. More particularly, labor share movements may be mainly due to output fluctuations with relatively stable wages, or due to changing wages with relatively stable output.

For analytical clarity consider first the case of fluctuations in Z only, assuming a constant wage $w_g = w_b = w$. This is consistent with the empirical findings of a-cyclical behavior of real wages, see Abraham and Haltiwanger (1995). Note, that the discrete jumps in Z require a direct comparison of the labor share in the different states, while expression (2.10) can be used to derive comparative static properties of the labor share within a given state. The labor share will be higher in bad times than in good times if $\frac{L_b}{R_b} > \frac{L_g}{R_g}$. This condition is met for all commonly assumed functional forms, such as constant elasticity or linear labor demand, but may break down for some rather unlikely functional forms.[7] Thus, with adjustment costs the labor share will fluctuate counter-cyclically. The relationship within a given state between the labor shares with, and without, adjustment costs is given in the following proposition:

Proposition 1 *The labor share is unambiguously increased during bad times and reduced in good times by the presence of adjustment costs.*

Proof: The effect of an increase in employment for fixed Z and w equals

$$\frac{\partial \frac{wL_i}{R(L_i,Z_i)}}{\partial L_i} = \frac{w(R_i - \frac{\partial R_i}{\partial L_i} L_i)}{R_i^2} > 0. \tag{2.11}$$

Consequently, since adjustment costs increase labor demand in bad times but reduce it in good ones, the labor share will be increased in bad times and reduced in good times.□

By the same reasoning, opposite results can be derived for increases in $p_i, i = g, b$ and r. Thus, everything that makes the wedges Q_g and Q_b bigger also increases labor share fluctuations. Since plausible parameters will imply a bigger wedge during bad times, the deviations from a benchmark no adjustment cost case will be larger in bad times.

Consider now an increase in fluctuations of Z. From (2.10) it follows

$$\frac{\partial \frac{wL_i}{R_i}}{\partial Z_i} = \frac{wL_i}{R_i Z_i}\left(\frac{\partial L_i}{\partial Z_i}\frac{Z_i}{L_i} - \frac{\partial R_i}{\partial Z_i}\frac{Z_i}{R_i}\right). \tag{2.12}$$

The sign of this expression depends on the relationship between the elasticities of labor demand and revenue with respect to business conditions. If

[7] To see this reformulate the condition in terms of the MRPL function as

$$\frac{L_g}{L_b}\int_0^{L_b} M(Z_b, L)dL < \int_0^{L_g} M(Z_g, L)dL.$$

This shows that the condition mainly hinges on the behavior of the two marginal revenue functions on the interval $[0, L_b]$.

labor demand reacts relatively less than output to an increase in Z, the labor share will fall and its fluctuations will therefore be increased. The following invariance result holds for the natural Cobb-Douglas benchmark .

Proposition 2 *With Cobb-Douglas revenue and multiplicative shocks, the size of labor share fluctuations is invariant with respect to the size of these shocks, as long as adjustment costs are not prohibitively high.*

Proof: From (2.12) it follows that in general $\frac{\partial \frac{wL_i}{R_i}}{\partial Z_i} = 0$, if $\frac{\partial L_i}{\partial Z_i}\frac{Z_i}{L_i} = \frac{\partial R_i}{\partial Z_i}\frac{Z_i}{R_i}$. Optimal labor demands with adjustment costs equal $L_g = [W + Q_g]^{-\frac{1}{\beta}} Z_g^{\frac{1}{\beta}}$ and $L_b = [W - Q_b]^{-\frac{1}{\beta}} Z_b^{\frac{1}{\beta}}$. Revenues are $R_b = \frac{1}{1-\beta} Z_b \left([W - Q_b]^{-\frac{1}{\beta}} Z_b^{\frac{1}{\beta}} \right)^{1-\beta}$ and $R_g = \frac{1}{1-\beta} Z_g \left([W + Q_g]^{-\frac{1}{\beta}} Z_g^{\frac{1}{\beta}} \right)^{1-\beta}$. Taking logs and differentiating yields $\frac{\partial L_i}{\partial Z_i}\frac{Z_i}{L_i} = \frac{1}{\beta}, i = g, b$ and $\frac{\partial R_i}{\partial Z_i}\frac{Z_i}{R_i} = \frac{1}{\beta}, i = g, b$. Thus, $\frac{\partial \frac{wL_i}{R_i}}{\partial Z_i} = 0$, $i = g, b$.□

In the case of Cobb-Douglas, the relative importance of labour demand and revenue elasticity exactly balance. This is particularly interesting since many changes in labor market institutions of the continental European countries coincided with considerable deterioration in the economic environment during the 1970s. At the same time there were large increases in these countries' labor shares. The result points to the surprising possibility that the size of adjustment costs is much more important than the size of slumps and booms.

2.4 Wage fluctuations

Consider now the labor share dynamics implied by changing wages with stable business conditions. Such wage changes may arise from changes in labor supply or, in a non-competitive framework, from movements of the wage-setting curve. They may be identified with changes in union militancy or with individual labor leisure substitution and changing participation rates. Furthermore, if the labor supply/wage-setting curve is upward sloping, fluctuations in the labor demand curve, such as the ones induced by changes in Z, will endogenously cause wages to be higher in good times.

Let Z stay fixed (and set to unity for convenience) and assume that wages are subject to stochastic variations, following a two state Markov process with the potential states h when wages are high, and l when wages are low, so that $w \in \{w_h, w_l\}$, $w_h > w_l$. The optimality conditions describing the firm's labor demand policy (2.5), (2.6) and (2.7) remain valid. When the wage switches from low to high, the firm is firing, when it does the reverse, the firm is hiring. Similarly, equations (2.8) and (2.9) still show the wedge between the wage and the marginal product, with the modifications that p_g is replaced by p_l, the probability of the low wage remaining low, and p_b is substituted by p_h, the probability of the high wage remaining high, and that Z is dropped. Again, the fluctuations in labor demand are dampened by the presence of adjustment costs. The main difference between the two cases is that, with changing Z, optimal labor demand jumps between two different labor demand curves, whereas, with changing wages, labor demand moves along a single labor demand curve.

Furthermore, two cases can be distinguished. Hiring costs and firing costs are either considered to be fixed or dependent on wages as already allowed for in (2.10). The latter case can be justified by either the high labor content of red tape adjustment costs or the direct relationship that often exists between wages and severance payments.

It cannot generally be expected that $LS_h > LS_l$, since a high elasticity of substitution may well cause the quantity effect to dominate the price effect, as discussed in section two. However, in this case too, the logic of proposition

1 is still valid. The labor share will be unambiguously bigger in the high wage state and smaller in the low wage state with respect to the no adjustment cost benchmark, since employment falls in the low wage state and rises in the high wage state and (2.11) holds again. Moreover, just as before, everything that increases the wedge will also increase the fluctuations in the labor share.

The effect of an increase in wage fluctuations can be evaluated within each state j, $j = h, l$, by

$$\frac{\partial LS_j}{\partial w_j} = \frac{L_j}{R_j}\left[1 + \left(\frac{\partial L_j}{\partial w_j}\frac{w_j}{L_j} + \frac{\partial L_j}{\partial F}\frac{F}{L_j}\frac{\partial F}{\partial w_j}\frac{w_j}{F} + \frac{\partial L_j}{\partial H}\frac{H}{L_j}\frac{\partial H}{\partial w_j}\frac{w_j}{H}\right)\left(1 - \frac{\partial R_j}{\partial L_j}\frac{L_j}{R_j}\right)\right].$$

In order to evaluate this within a given state note that the wage elasticity of labor demand is systematically reduced in the high wage state and increased in the low wage state by the presence of adjustment costs, as long as labor demand is convex.[8] Consider again the Cobb-Douglas benchmark case, where without adjustment costs $\frac{\partial LS_j}{\partial w_j} = 0$. Now, if hiring and firing costs do not depend on wages, i.e. $\frac{\partial H}{\partial w} = \frac{\partial F}{\partial w} = 0$, the systematic change of the labor demand elasticity implies $\frac{\partial LS_l}{\partial w_l} > 0$ and $\frac{\partial LS_h}{\partial w_h} < 0$. Hence, further increases in the wage will reduce the deviation from the no adjustment cost benchmark, whereas further decreases of the wage in the low wage state will increase the deviation. However, if hiring and firing costs depend on the wage, the additional effects will work in the opposite direction. For the Cobb-Douglas benchmark with adjustment costs proportional to the wage, with $H = cw$ and $F = bw$, the following invariance result holds.

Proposition 3 *If hiring and firing costs are proportional to wages and technology is Cobb-Douglas, the size of labor share fluctuations caused by wage*

[8]To see this, note that with adjustment costs employment increases in the high wage state, so that $\frac{w}{L}$ falls. Moreover, if $M'' \geq 0$, $\frac{\partial L}{\partial w}$ will fall or remain constant as employment increases. The reverse applies for the low wage state.

fluctuations is invariant to the size of these fluctuations, as long as adjustment costs are not prohibitively high.

Proof: With proportional adjustment costs $H = cw$ and $F = bw$ the wedges between the MRPL and the wage become

$$Q_l = \frac{1-p_l}{1+r}(cw+bw) + \frac{r}{1+r}cw = w\left(\frac{1-p_l}{1+r}(c+b) + \frac{rc}{1+r}\right),$$

$$Q_h = \frac{1-p_h}{1+r}(bw+cw) + \frac{r}{1+r}bw = w\left(\frac{1-p_h}{1+r}(b+c) + \frac{rb}{1+r}\right).$$

Therefore labor shares are given by

$$\frac{w_l L_l}{R_l} = \frac{w_l\left[w_l + Q_l\right]^{-\frac{1}{\beta}}}{\frac{1}{1-\beta}\left[w_l + Q_l\right]^{1-\beta}} = \frac{(1-\beta)}{(1 + \frac{(1-p_l)(c+b)}{1+r} + \frac{rc}{1+r})},$$

$$\frac{w_h L_h}{R_h} = \frac{w_h\left[w_h - Q_h\right]^{-\frac{1}{\beta}}}{\frac{1}{1-\beta}\left[w_h - Q_h\right]^{1-\beta}} = \frac{(1-\beta)}{(1 - \frac{(1-p_h)(c+b)}{1+r} - \frac{rb}{1+r})}.$$

Obviously, the labor share does not depend on wages in both states, such that $\frac{\partial LS_j}{\partial w_j} = 0$, $j = h, l$.$\square$

The intuition behind this result is straightforward. If adjustment costs are fixed, the higher the wage the less important they become for the labor demand decision, and the lower the wage the more important they become. If adjustment costs are proportional, their relative importance remains constant.

2.5 Joint fluctuations in business conditions and wages

The mechanism described above can be extended to the situation where both Z and w fluctuate. In this case, there are four possible states, which will be indicated with subscripts ij, $i = g, b$, $j = h, l$. Obviously, business conditions and wages have opposite effects on labor demand. In general, this makes inaction more likely and, for the theoretical analysis, requires an assumption about which effect dominates the other in terms of labor demand. While labor demand will be highest when Z is high and w is low, and lowest if Z is low and w high, labor demand in the mixed states depends on the dominant of the two effects. Furthermore, the extreme states can be reached by hiring or firing only, but the intermediate states can be reached by hiring or firing in relation to the previous state. Therefore, for these intermediate states, there are two distinct shadow values of labor, depending on whether labor demand was previously higher or lower. To distinguish these cases, I will denote the labor demand variables corresponding to these states with superscript f if the state was reached by firing, or with superscript h if the state was reached by hiring. Accordingly, there will be now six wedge equations analogous to (2.8) and (2.9). The labor share will again be given in the general form by (2.10). As before, this share will be unambiguously higher when the firm is firing, and lower when it is hiring compared to the no-adjustment-cost case. Furthermore, $\frac{w_h L_{gh}^f}{R_{gh}^f} > \frac{w_h L_{gh}^h}{R_{gh}^h}$ and $\frac{w_l L_{bl}^f}{R_{bl}^f} > \frac{w_l L_{bl}^h}{R_{bl}^h}$, since (2.11) still holds. Otherwise the relationship between the labor shares in the various situations depends on functional forms and the nature of the transition matrix. Consider again the Cobb-Douglas case as a useful benchmark.

$$\frac{w_m L_m^h}{R_m^h} = (1-\beta)\left(\frac{w_m}{w_m + \frac{1}{1+r}p_f(H+F) + \frac{r}{1+r}H}\right), m = gl, gh, bl$$

$$\frac{w_n L_n^f}{R_n^f} = (1-\beta)\left(\frac{w_n}{w_n - \frac{1}{1+r}p_h(H+F) - \frac{r}{1+r}F}\right), n = gh, bl, bh.$$

Here, p_f and p_h denote the probabilities of firing and hiring in the next period. If the firm is hiring, the labor share is below the benchmark level, if it is firing, it is above this level. This shows that the labor share can be higher in state gh than in state bl, although the former are better times than the latter in terms of labor demand. Thus, somewhat contrary to the argument so far that in "good times" the labor share is low and in bad times it is high, in the intermediate range it is possible that the converse might occur. Of course, for the really good and bad times, the original argument still holds.

Furthermore, if the parameters are such that states bh and gl will give the highest and lowest values of the labor share respectively, we would expect to see sharp turnaround in the labor share after these extremes are reached, since the very good state can only be left by firing and the very bad state only by hiring. More generally, the assumption that parameters mean that action is always optimal will cause a lot of volatility in the labor share, since hiring and firing will be quite commonplace. However, in the aggregate, these effects are likely to be weakened, if firms are allowed to be heterogenous in their exposure to wage and business condition fluctuations.

2.6 Inaction in labor demand

So far the role of hiring and firing for factor share movements has been stressed. However, the larger adjustment costs the more likely inaction becomes, since (2.5) is more likely to hold as a strict inequality. Because adjustment costs are large in countries that have the traditional European labor market institutions, this may be important here. Finally, offsetting effects of fluctuations in wages and business conditions also make inaction more likely.

Consider inaction in the two state case, with only Z or w fluctuating. The labor share still changes, since either revenues or wages change and the other components remain constant. Increasing fluctuations in Z or w continuously increases labor share fluctuations as long as inaction remains optimal. As action eventually takes place, the fluctuations tend to remain at that level because of the invariance results derived. Thus, the size of fluctuations with inaction are bounded by the size of fluctuations with action. This holds for any given level of adjustment costs. Consequently, the fact that increases in H and F cause larger fluctuations in the labor share and that bigger H and F cause a larger range of inaction are just two facets of the same phenomenon.

Turn now to the general case, but assume that parameters are such that it will only be optimal to adjust if one of the extreme states gl or bh is reached. Thus labor demand will switch only between two values as in the two state world. However, the labor share will also change if one of the intermediate states is reached, since revenue or wages change. Consider first the two extreme states gl and bh, which cause the firm to hire or to fire. In state gl $LS_{gl} = \frac{w_l L_{gl}}{R_g}$, and in state bh $LS_{bh} = \frac{w_h L_{bh}}{R_b}$, and assume that functional forms are such that $LS_{bh} > LS_{gl}$. Now, if the economy is moving from state bh to state bl or state gh inaction causes employment to stay at L_{bh}, so that labor share will be given as $LS_{bl} = \frac{w_l L_{bh}}{R_b}$ or $LS_{gh} = \frac{w_h L_{bh}}{R_g}$, respectively, and therefore be lowered in both cases. Similarly, if the economy is moving from state gl to state bl or to state gh the labor share changes to $LS_{bl} = \frac{w_l L_{gl}}{R_b}$ and $LS_{gh} = \frac{w_h L_{gl}}{R_g}$, respectively, so that it is increased. Therefore, the labor share in the states bh and gl give the upper and lower bounds of the labor share. Comparing the possible labor shares within state bl shows that $\frac{w_h L_{bh}}{R_g} < \frac{w_h L_{gl}}{R_g}$ Thus, if we arrive at gh from gl, where the labor share was low, the labor share is higher than in the case where we arrive at gh from bh, where the labor share was high. Similarly, $\frac{W_l L_{bh}}{R_b} < \frac{W_l L_{gl}}{R_b}$. If we arrive at bl from gl, where the labor share was low, the labor share will be higher than if we arrive at bl from

bh, where the labor share was high. This implies that fluctuations in factor shares are still substantial and that intermediate states are compatible with both relatively high and relatively low labor shares, even if inaction prevails over certain ranges. Thus, while the original analysis suggested that changes in the labor share are always accompanied by changes in employment, either in the form of hiring or in the form of firing, the possibility of inaction demonstrates that factor shares can change in response to wage and business condition fluctuations, even if no change in employment occurs.

2.7 Empirical evidence

This section presents some simple empirical evidence for the significance of firing costs for the direction and size of labor share movements. It builds on, and extends, the work of Giammaroli at al. (2001). In contrast to these authors, who use Eurostat aggregate economy data, I use data from the OECD business sector data base for the private sector only. As is argued by these authors, focussing on the private sector only is more appropriate, since public sector labor demand is typically not principally driven by business conditions or wages.

While wage fluctuations are directly observable, business conditions are typically unobservable. A potential proxy for them may be found in subjective business climate survey data. Figure (2.7) uses one such series, the ifo business climate index for Germany and plots it against the German labor share. The two appear to be inversely related as predicted and labor share movements are surprisingly well explained by the single variable business conditions. Regressing the labor share on a constant and the business climate index is highly significant and results in an R^2 of 0.75., quite high for

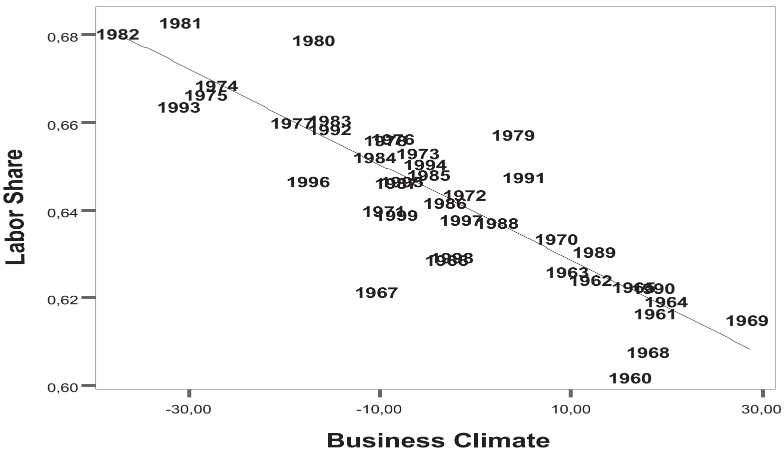

Figure 2.7: *Labor Share and Business climate, Germany*

a simple cross-correlation. This is particularly remarkable, since the labor share is not corrected for its level. This points to the possibility that even the medium term, hump-shaped movements may be explainable by adjustment costs. It also shows that the size invariance of labor share fluctuations due to changes in business conditions appears not to hold at the aggregate level. Firms are actually heterogeneous, and for aggregate labor share fluctuations the number of firms experiencing positive or negative shocks is decisive.

Unfortunately, such business climate data is not readily available for a larger group of OECD countries and where they are, the methodological differences in the construction of these indices make them unsuitable for cross-country comparisons. Therefore, following Giammaroli et al. (2001), changes in economic activity, which are consistently comparable across countries, are taken as a proxy for business conditions. Furthermore, in order to control

	Strength of EPL			single x-corr.		joint est.	
country	90	98	av.	coeff. Δy	coeff. Δw	coeff. Δy	coeff. Δw
AUS	1.1	1.1	1.1	-0.44 (***)	0.52 (**)	-0.47 (***)	0.55 (***)
AUT	2.4	2.4	2.4	-0.37 (***)	-0.04	-0.55 (***)	0.34 (**)
BEL	3	2.1	2.55	-0.78 (***)	0.18	-0.82 (***)	0.31
CAN	0.6	0.6	0.6	-0.41 (***)	0.52 (***)	-0.34 (***)	0.44 (***)
GER	3.6	2.8	3.2	-0.36 (***)	-0.10	-0.53 (***)	0.30 (***)
DEK	2.4	1.5	1.95	-0.50 (***)	0.3	-0.60 (***)	0.49 (***)
FIN	2.2	2.1	2.15	-0.72 (***)	0.35 (*)	-0.73 (***)	0.39 (***)
FRA	2.7	3.1	2.9	-0.30 (***)	0.09	-0.45 (***)	0.34 (**)
GRE	3.6	3.5	3.55	0.06	0.43 (**)	-0.42	0.53 (***)
IRL	1	1	1	-0.46 (***)	0.23	-0.47 (***)	0.25
ITA	4.2	3.3	3.75	-0.39 (***)	0.01	-0.61 (***)	0.34 (***)
JAP	2.6	2.6	2.6	-0.34 (***)	-0.26 (*)	-0.38 (***)	0.07
NLD	3.1	2.4	2,75	-0.52 (***)	0.13	-0.68 (***)	0.33 (**)
NOR	3.1	2.9	3	-0.06	0.08	-0.16	0.16
NZL	1	1	1	0.2	0.64 (***)	-0.03	0.64 (***)
POR	4.2	3.7	3.95	-1.01 (***)	0.32	-1.14 (***)	0.46 (**)
ESP	3.7	3.2	3.45	-0.42 (***)	0.28 (**)	-0.65 (***)	0.45 (***)
SWE	3.4	2.4	2.9	-0.72 (***)	0.16	-0.99 (***)	0.52 (***)
CHE	1.3	1.3	1.3	-0.29 (***)	0.22	-0.38 (***)	0.54 (**)
USA	0.2	0.2	0.2	-0.26 (***)	-0.07	-0.34 (***)	0.29 (**)

Table 2.1: *EPL strength and individual country regression results. Dependent variable: Labor share's cyclical component. One, two or three stars imply significance at 10 %, 5% and 1% level, respectively. High values of the EPL index imply strong EPL.*

for aspects that may affect the level of the labor share and potentially differ across countries, such as changing sectoral composition, the labor shares of all countries looked at were de-trended using a Hodrick-Prescott filter with smoothing parameter 100.[9]

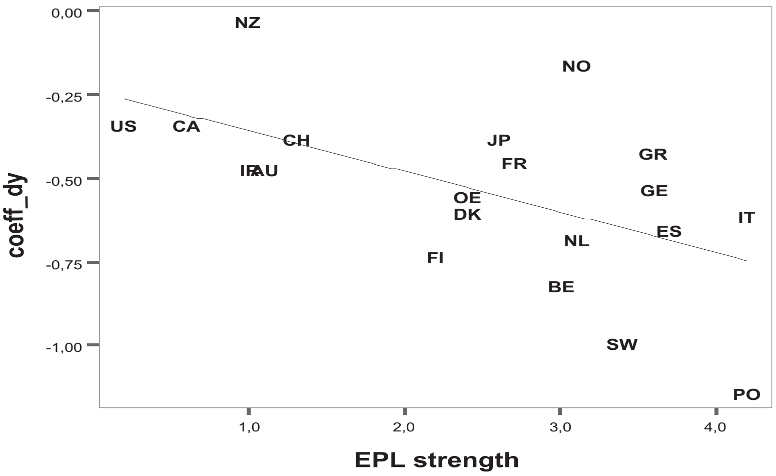

Figure 2.8: *The strength of EPL according to the Nicoletti et al. (1999) Index for 1990 is given on the horizontal axis. The vertical axis gives the coefficient of the growth rate of gdp in the joint static regression. A significant negative relationship emerges.*

[9]This value is frequently used for annual data. However, as Ravn and Uhlig (2002) demonstrate, a smoothing value of 6.25 for annual data corresponds to the value of 1600 used for quarterly data for filtering out the business cycle. Thus, the cyclical component generated here will contain fluctuations at lower frequencies than the typical business cycle frequencies. Giammaroli et al. (2001) use a value of 1200, which produces long run fluctuations.

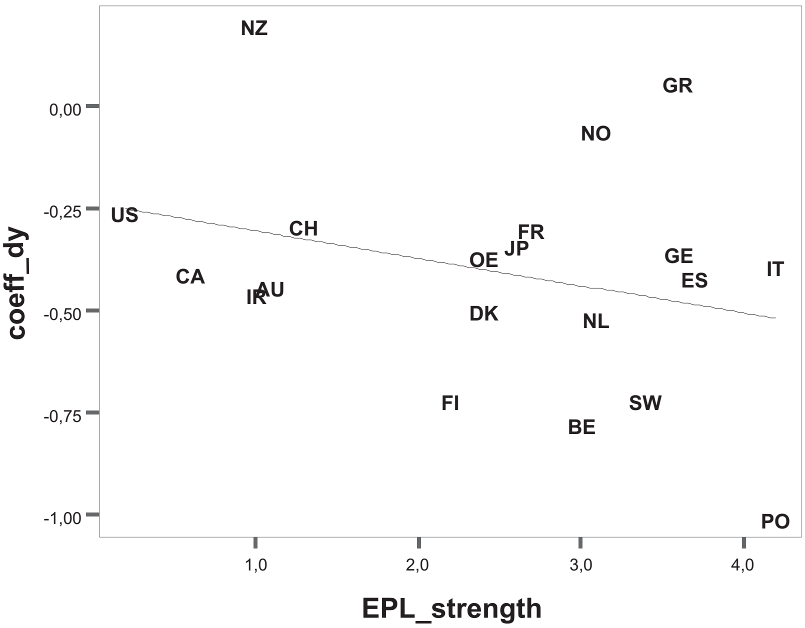

Figure 2.9: *The strength of EPL according to the Nicoletti et al. (1999) Index for 1990 is given on the horizontal axis. The vertical axis gives the cross-correlation of the growth rate of gdp with labor share's cyclical component. The negative relationship is not significant at the 5%level.*

The correlation coefficients of the resulting cyclical labor share fluctuations with the growth rate of wages and gdp were calculated for each country. Furthermore, a static OLS regression with labor share fluctuations as the dependent variable and the two growth rates (and a constant) as explanatory variables was run for each country. The results are shown in table (2.1).

For changes in economic activity, both the single cross correlations as well as the coefficients of the static joint regressions confirm the negative relationship between economic activity and the labor share. In the case of wage fluctuations, the positive relationship with labor share movements is evident from the coefficients of the joint estimations. Thus, the model's implications for the directions of labor share movements are confirmed.

Consider now the second claim of my theoretical propositions, the direct correlation between the size of hiring and firing costs and the size of labor share fluctuations. In order to test this relationship, the variations in the strength of labor share movements in response to changes in economic activity and wages are related to differences in the strength of EP regulations. The necessary institutional data on the strength of EPL across countries are taken from Nicoletti et. al (1999), who construct indices of the strength of EPL for 1990 and 1998. These, as well as their averages, are also reported in table (2.1). Figure (2.8) shows the relationship between the estimated influence of a change in economic activity in the joint estimation on the labor share and the 1990 index of EPL strength in the respective county. A clear relationship emerges: The stronger the EPL, the more pronounced the changes in the labor share. The coefficient of EPL strength is negative and clearly significant at the 5% level.[10] The picture is not very different if an average of the 1990 and 1998 EPL indices or the 1998 EPL index is used. The coefficient of EPL strength is always significant at the 5% level, although significance is somewhat reduced. These findings support the tentative conclusions derived

[10]The relationship is probably even less noisy than suggested by the picture. Norway and New Zealand are small economies which were strongly affected by large changes in their terms of trade. Not surprisingly, these two countries (and Greece) don't even show a statistically significant directional movement of the labor share. In the case of Portugal the estimated coefficient is negatively influenced by the large changes in the labor share following the revolution in 1974.

by Giammaroli et al. (2001) from their empirical results with respect to the existence of such a relationship.

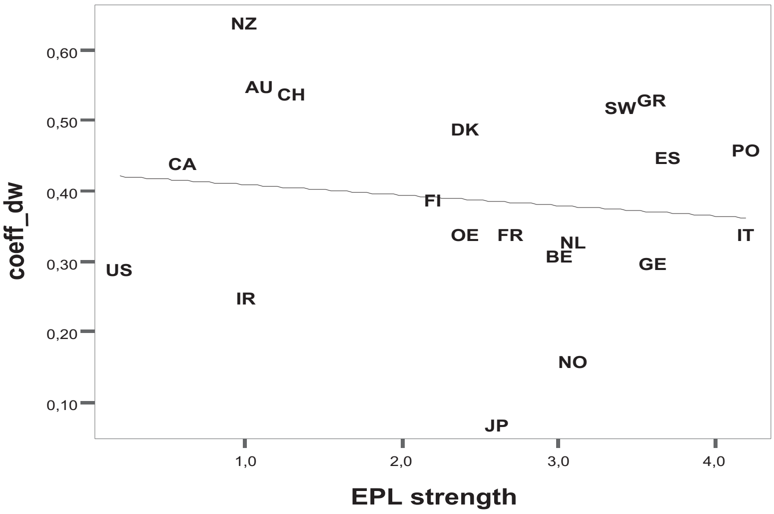

Figure 2.10: *The strength of EPL according to the Nicoletti et al. (1999) Index for 1990 is given on the horizontal axis. The vertical axis gives the coefficient of the growth rate of wages in the joint static regression. No significant relationship emerges.*

Figure (2.9) shows the same relationship, but using the coefficients from the single cross-correlations. The resulting negative relationship is not statistically significant, however. If the countries for which the individual cross-correlations were not significant, Greece, Norway, and New Zealand are dropped, the coefficient of EPL strength becomes significant, but only at the 10% level.

For wage fluctuations, however, no clear relationship emerges between

EPL strength and labor share reactions to wage fluctuations, see figure (2.10). There are three potential explanations for this failure to pick up a positive relationship between EPL strength and wage induced labor share movements. First, the comparative statics for an increase in the size of wage fluctuations revealed a non-monotonicity in this relationship. If the size of wage fluctuations differs across countries, the coefficients found for the various countries should be biased to different extents. Second, the wage growth variable may not pick up the wage fluctuations responsible for labor share fluctuations completely. It may well be that wage fluctuations at lower frequencies play an important role. Finally, the theoretical model's assumption of exogenous wage fluctuations may be too simplistic. The relationship between wages and the labor share may depend in a more complex way on union behavior and the way wages and employment are determined. However, considering the ranking of labor share sensibility to wage fluctuations, it seems that there is no obvious explanation along the lines of some other labor market institution.

2.8 Conclusion

The chapter has analyzed the importance of adjustment costs for factor share movements. It first reconsidered the alternative explanation of non-unit elasticity and this was found not to be a convincing alternative. While for some individual countries, deviations from Cobb-Douglas technology may seem to have some explanatory power, no case can be made for technology being different from Cobb-Douglas for the largest OECD economies in general.

It was analyzed in a dynamic Markov chain model how linear hiring and firing costs cause factor shares to vary in response to changes in business conditions or wages. For the case of business conditions, the labor share movements will be counter-cyclical, in the case of wage fluctuations they will be pro-cyclical. These fluctuations should be increasing in the size of the adjustment costs. Two invariance results were derived for the benchmark of Cobb-Douglas technology. First, in this case, the size of labor share fluctuations does not depend on the size of fluctuations in business conditions. Second, if hiring and firing costs are proportional to wages, the size of labor share movements does not depend on the size of wage fluctuations.

The cross-country evidence supports the implications of the theoretical model with respect to the implied direction of labor share changes. It moves counter-cyclically with respect to business conditions or economic activity and is positively related to wage fluctuations. The cross-country evidence indicates that the size of labor share movements due to changes in economic activity depends positively on the strength of EPL. Thus higher EPL implies larger movements in factor shares. No such effect could be detected for wage fluctuations. This may be due to problems with the empirical set-up or to a more complex relationship between wages, employment, and the labor share, that is potentially affected by a number of other labor market institutions.