Program for the Study of Germany and Europe
Working Paper No. 00.2

Falling Labor Share and Rising Unemployment: Long-Run Consequences of Institutional Shocks?

Norbert Berhold(*)
Rainer Fehn(*)(+)
Eric Thode(*)

Abstract

The literature on unemployment has mostly focused on labor market issues while the impact of capital formation is largely neglected. Job-creation is often thought to be a matter of encouraging more employment on a given capital stock. In contrast, this paper explicitly deals with the long-run consequences of institutional shocks on capital formation and employment. It is shown that the usual trade off between employment and wages disappears in the long run. In line with an appropriation model, the estimated values for the long-run elasticities of substitution between capital and labor for Germany and France are substantially greater than one.

(*)University of Wuerzburg, Dept. VWL 4, Sanderring 2,97070 Wuerzburg, Germany. (+)Center for European Studies at Harvard University, 27 Kirkland Street at Cabot Way, Cambridge, MA, 02138, USA.

I. Introduction

The dismal development on continental European labor markets along with the lack of serious efforts to fight unemployment continues to be puzzling. While the U.S. is enjoying the fruits of its longest post World War II expansion with record low unemployment rates and almost price level stability, continental Europe and in particular its two flagship countries, France and Germany, seem to be stuck in an inexorable upward trend in unemployment rates. Although this European unemployment phenomenon has been widely disussed in the literature, it remains far from being resolved.

In fact, additional puzzles keep popping up. It has recently been noted that labor shares in Germany and France have been falling almost continuously since the early eighties after having risen sharply in the wake of the two oil price shocks in the seventies.[1] Although there is widespread agreement that rising unemployment was largely due to classical reasons, these falling labor shares put classical explanations of rising unemployment based on wages growing faster than productivity into doubt. However, Keynesian explanations, which have recently enjoyed a rebound in popularity[2], even fare worse upon closer inspection. The strong growth of capital intensities, capital coefficients and profit rates are evidence against the importance of high real interest rates and the associated alleged lack of aggregate demand in explaining rising unemployment. Furthermore, the outward shifts of the Beveridge curve and of the Okun curve along with the rise in the NAIRU (NAWRU)[3] over time indicate that demand policy is not the adequate policy instrument for fighting continental European unemployment.[4]

This lack of explanatory power of the two standard theories of unemployment has surely contributed to the current fashion of tracing rising unemployment in Europe back to changes in the structure of labor demand.[5] It is argued that globalization and technological progress biased in favor of qualified workers lead to fundamental changes in the structure of labor demand. The service sector grows while the industrial sector shrinks and labor demand of firms

[1] See e.g. Blanchard (1997), Bentilola and Saint-Paul (1998), Rowthorn (1999) and Caballero and Hammour (1997).
[2] See e.g. Modigliani et al. (1998).
[3] Non-Accelerating (Wage-) Inflation Rate of Unemployment.
[4] See Fehn (1997). The OECD estimates that at most 15% of German unemployment is due to cyclical factors; see OECD (1998, 173-174).
[5] See Krugman (1994), Alogoskoufis et al. (1995) and Jackman (1995).

concentrates on qualified workers, whereas their need for low qualified workers declines rapidly. These developments clash head-on with labor market institutions in continental Europe, in particular with generous and, as a rule, unlimited unemployment benefits, a high level of welfare assistance, a close to 100% marginal tax rate when moving from receiving government transfer payments to regular employment, centralized wage negotiations and strong unions. Hence, the superior performance of the American labor market is according to this view essentially due to more flexible wage structures and more mobile workers. However, despite of the intuitive appeal of this approach some questions remain. It is e.g. somewhat incompatible with this view that unemployment has in fact also risen among qualified workers across OECD countries and that the rate of unemployment among low qualified workers in the U.S. is very much comparable to the one in continental Europe. It is furthermore puzzling in this respect that the rate of vacancies has increased far less than the rate of unemployment in continental Europe. Finally, it is not clear how this approach can explain the strikingly different developments of labor shares between continental Europe and the U.S.[6]

These deficiencies of the three best-known explanations of the European unemployment phenomenon have recently sparked a new set of papers which aim at explaining simultaneously the rise of unemployment rates and the humped-shaped path of labor shares in continental Europe in stark contrast to the U.S.[7] Two strands can be distinguished among these papers. Either a combination of a more or less standard labor market model with several shocks is offered, or it is a parsimonious explanation based only on the long-run consequences of a massive institutional shock which strongly raises the potential of labor to appropriate capital. It is a key feature of the latter approach that the possibilities of capital to withdraw from the production process or to substitute capital for labor are much greater in the long run than in the short run. We will put in this paper this latter approach under closer scrutiny. To this end, the paper is organized as follows. The second section gives a brief overview of the relevant stylized empirical facts. The third section presents the structure of the dynamic model and intuitively describes the main predictions of the model. The fourth section checks these predictions empirically, it offers in particular for Germany, France and the U.S. impulse-response functions concerning wage shocks and estimations of the long-run elasticity of substitution between labor and capital. The fifth section concludes.

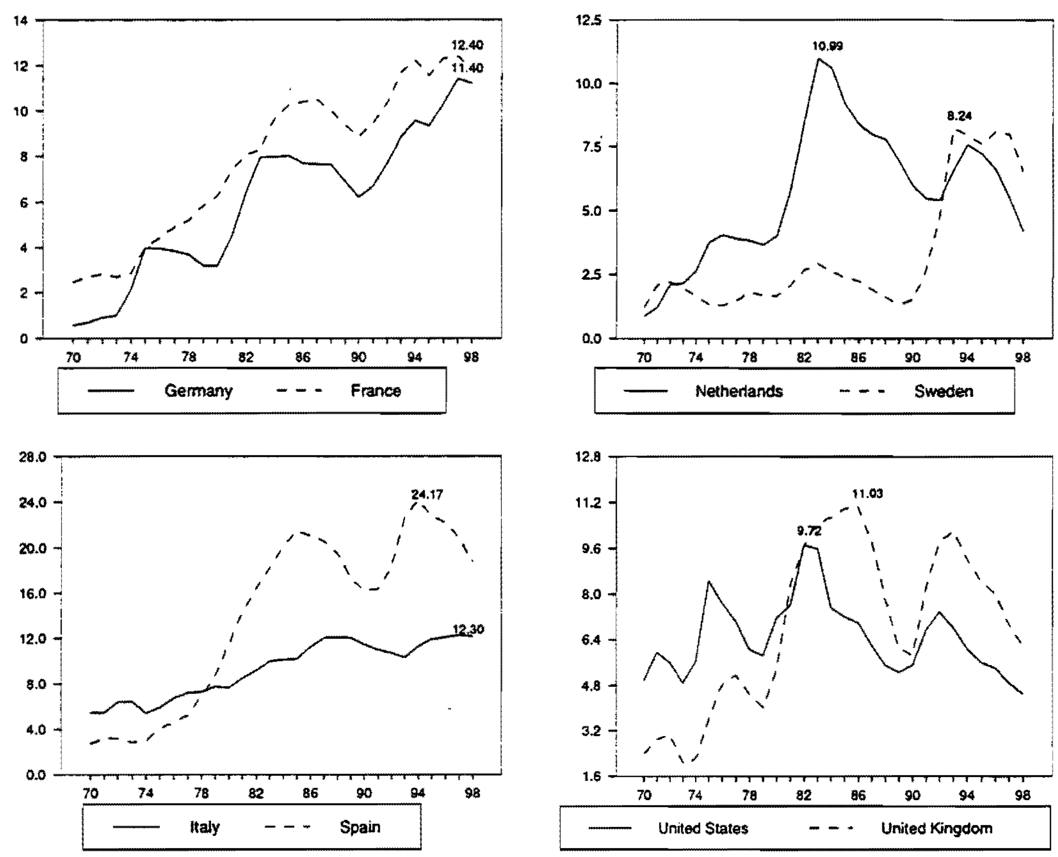
[6] See Blanchard (1995), Nickell and Bell (1995) and Fehn (1997).
[7] See Blanchard (1998) and (1999), Caballero and Hammour (1997) and (1998) and Rowthorn (1999).

II. The Relevant Stylized Facts

Fig. 1 depicts the well-known fact that standardized unemployment rates have developed quite differently in the large continental European countries Germany, France, Italy and Spain compared to the anglo-saxon countries U.S. and UK since the early seventies. Unemployment rates in continental Europe, with the exception of the Netherlands, have ratcheted upwards, thus displaying a high degree of persistence if not even hysteresis, whereas the anglo-saxon countries show more cyclical variations in their unemployment rates but no upward trend. To the contrary, at least in the U.S. the unemployment rate has followed a downward trend since the early eighties. Considering that all of these highly developed OECD-countries have been hit more or less by the same shocks like the oil-price shocks and globalization[8], these differences must mainly stem from variations in institutions across these countries and/or within countries. The focus of the paper will be to show that not only differences especially in labor market institutions across countries matter, a fact which is almost universally accepted by now, but that changes in institutions within countries over this time period are also crucial for a coherent explanation of unemployment rates and of labor shares.

[8] The German reunification is of course an exception.

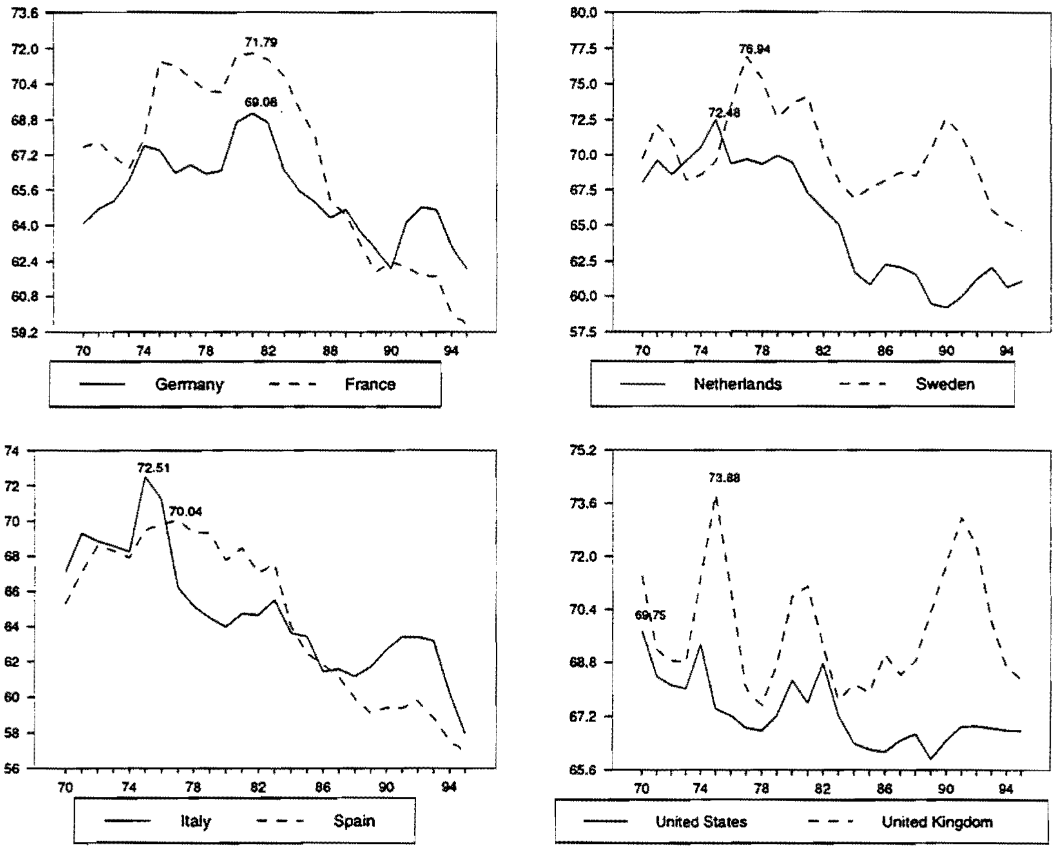
Fig. 1: Standardized Unemployment Rates (1970 – 1998)



Source: OECD Statistical Compendium, 1996, and OECD Economic Outlook, June 1999

This alludes to the next stylized fact, namely that the development of labor shares is also significantly different across these countries (fig. 2). Similar to the unemployment rate, the labor shares in the U.S. and the UK display no trend, but rather mainly cyclical variations. Hence, both of these two countries come somewhat close to having something like a "natural rate" concerning both unemployment and labor share. This is clearly not the case in the continental European countries. Essentially all of these countries display a hump-shaped time path of the labor share with a peak somewhere in the mid seventies to early eighties and a strong and almost continuous fall in their respective labor shares since then. So, contrary to what standard neoclassical economic theory would suggest based on Cobb-Douglas production functions, there appears to be no constant value for the labor share in continental Europe in the long run. This difference compared to the anglo-saxon countries calls for an explanation.

Fig. 2: Labor Shares (1970 – 1995)

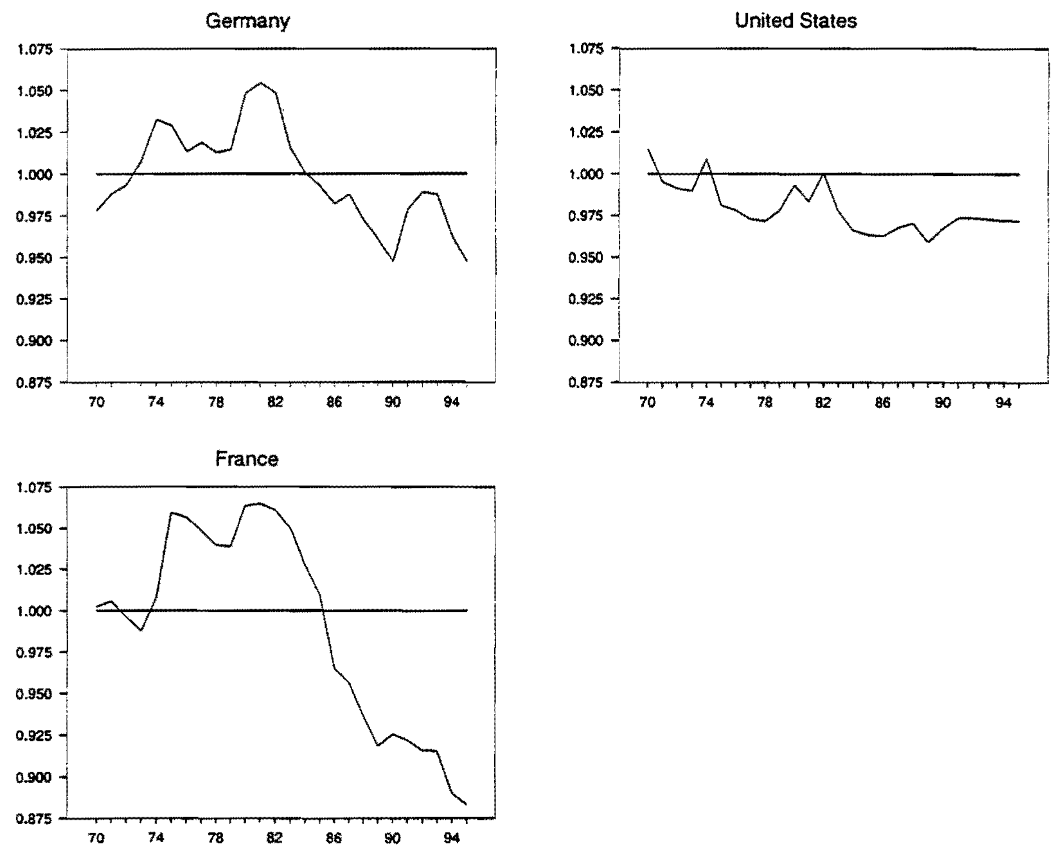


Source: OECD Statistical Compendium, 1996, and OECD Economic Outlook, December 1998

There is in fact further evidence that simple Cobb-Douglas production functions are not suitable for describing the evolution of unemployment rates and of labor shares since the early seventies. The implied unit-elasticity of substitution between labor and capital appears to be too restrictive. The dynamic response to shocks in particular of the continental European countries is richer than suggested by the Cobb-Douglas assumption. Fig. 3 shows the development of the ratios of wages and of the marginal products of labor for Germany, France and the U.S. based on Cobb-Douglas production functions.[9] Only the U.S. shows a very close relationship between wages and the marginal product of labor, while wage rises in Germany and France substantially exceeded the growth of the marginal product of labor in the seventies and has fallen short of it since the early eighties. Obviously, this rough assessment is more evident for France than for Germany.

[9] The partial elasticities of production are set equal to their average national values for the time 1970 to 1973 on the premise that countries were essentially in steady states at that time.

Fig. 3: Wages Compared to the Marginal Productivity of Labor (1970 – 1995)



We take fig. 3 as a benchmark and as an intuitive starting point for our economic analysis.[10] While it is for Germany and France in clear conflict with a simple neoclassical approach, according to which wages and the marginal productivity of labor should track each other closely in all countries at all times, it fits on first sight an alternative set of assumptions. Namely, the picture conveys the impression of a putty-clay production technology in the short run with a very low elasticity of substition and a technological menu in the long run with a much higher elasticity of substitution between labor and capital. In short, in the seventies workers in Germany and France managed to achieve wage growth substantially in excess of labor productivity growth, but they have been paying for this afterwards with wage growth falling short of labor productivity growth. This suggests that capital in continental Europe responded to the appropriation push by labor in the seventies by steadily excluding labor from the production process, thus not only massively raising the capital intensity of production but also not letting labor fully share the fruits of output growth since then. Hence, the astonishing fact that coun-

[10] See also Berthold, Fehn and Thode (1998).

tries at a highly similar stage of economic development display such vastly different capital intensities is largely due to political interferences into the functioning of labor markets in continental Europe. The gist of this theory is also backed up by the following cross-country comparison.

Fig. 4: Cumulative Change in Labor Shares versus Rise in Unemployment (1974 - 1995)

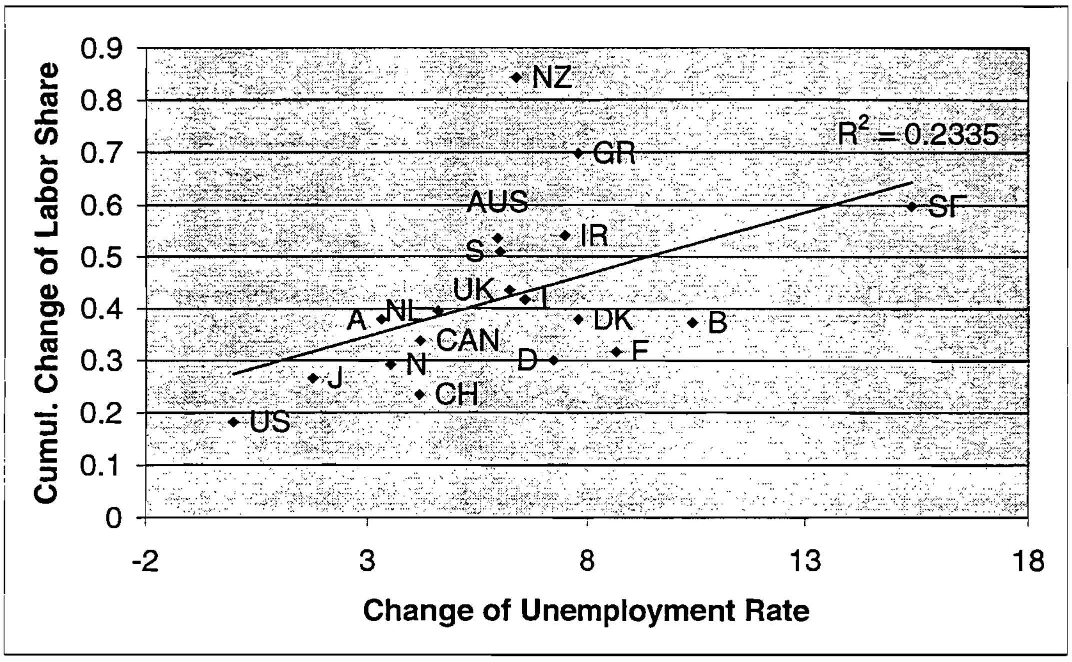


Fig. 4 shows that the asserted hump-shaped time path of the labor share in countries with strongly rising unemployment is not just an artifact for France and Germany. Rather, across OECD countries unemployment rose more where the cumulative changes of the labor share were also large. In order to exclude a U-shaped time path and in order to avoid obtaining the sum of only large cyclical variations in labor shares, the changes in the filtered labor shares were added up from trough to peak and then back to trough. [11] Hence, these two developments, rising unemployment and hump-shaped time path of labor shares, may indeed be related. Starting from an essentially very good employment situation in all OECD countries, unemployment rates have risen most in countries where labor shares increased markedly during the seventies and have dropped substantially from their top somewhere in the late seventies to early eighties. While the seventies fit well with classical explanations of unemployment, de-

[11] A Hodrick-Prescott filter was applied for obtaining clear peaks for all time series. The use of the original time series yielded similar results.

velopments since the early eighties would at first sight point to Keynesian-type problems.[12] The aim of the next section is to present an integrated approach, where the developments since the early eighties are at least to a large extent a natural consequence of what occurred in the seventies.

III. Modeling Rising Unemployment as a Consequence of Appropriation

1. The Gist of the Story

In contrast to the U.S., continental European economies witnessed substantial institutional changes in favor of labor in the late sixties and early seventies. The deep transformation of the capital-labor relations in continental Europe during that time period is well documented and generally recognized.[13] The bargaining power of unions grew substantially during this period. In France and Germany, this is in particular due to the fact that employment protection increased markedly in the late 1960s and early 1970s and has been roughly stable since then. Furthermore, welfare state activities along with active labor market policies expanded. Governments assumed to a much larger degree than before responsibility for the employment situation largely due to overly optimistic expectations about the effectiveness of aggregate demand policies in guaranteeing full employment. Thus, wage-setters were systematically exonerated from their responsibilitiy for the situation on the labor market. Unions and employers readily seized this opportunity by agreeing on wage settlements which mainly served their interests but contributed very little or nothing to preventing or to fighting unemployment. Wage setters externalized the arising costs of unemployment on the rest of society and in particular on future generations.

From a political economy perspective, this institutional response can in hindsight be regarded as an almost natural development considering the excellent economic development in the fifties and sixties. Just taking Germany as a leading example, productivity growth exceeded wage growth on an almost regular basis during this catch-up phase, resulting in labor shortages and in a large number of guest workers flowing in. However, the greater potential of labor to appropriate capital came at a very unfortunate time, namely when the oil price shocks and the general slowdown of productivity growth would have required strong and lasting wage restraint. Labor appropriates capital whenever it uses its ex-post bargaining strength for pushing

[12] Lehment (1999) shows empirically for Germany that the falling labor share is not the result of a too moderate wage policy.
[13] See Blanchard (1999), Blanchard and Wolfers (1999), Siebert (1997) and Caballero and Hammour (1997).

down the ex post return to capital just above the opt-out margin so that capital does not yet abandon joint production. Capital has then very little incentive to open new joint production units, though. Hence, this approach fits nicely with the often lamented slowdown of capital formation in continental Europe since the mid seventies.[14] It has furthermore the advantage of offering an explanation for the differences between countries in the development of capital formation since that time.

Now, the challenging question is how to explain the further rise in unemployment in continental Europe since this time period considering that the institutional build-up in favor of labor in continental Europe came to a halt somewhere around the mid-seventies. Labor market institutions have remained more or less the same since then.[15] Standard theory about employment determination would suggest that these institutional changes in favor of labor resulted in an upward shift of the wage-setting curve in the wage-employment plane. However, the total negative employment effects of such a shift should be borne out after a few years when the intersection point between the new wage-setting curve and the horizontal long-run labor demand curve is reached via a downsizing of the aggregate capital stock relative to trend. The following model is designed to argue that the long-run negative employment effects of increasing the appropriation potential of labor are even larger and take a much longer time to completely materialize than is usually assumed because the full dynamic adjustment in technology and in capital intensity is a protracted process.[16]

2. The Structure of the Dynamic Model

The model is a slightly simplified version of Caballero and Hammour (1997).[17] It is intended to capture the dynamic interaction between capital and labor in an institutional environment where there is an increasing potential of labor to appropriate capital. It is assumed that the appropriation problem cannot be precontracted away, i.e. the necessary contracts such as workers giving a deposit to firms before joining firms or credibly committing themselves to working with full effort at a predetermined wage, are not feasible and/or illegal. Such appropriation attempts by insiders are, however, only successful in the short run where the supply of

[14] See Blanchard (1998) and Rowthorn (1999).
[15] See Blanchard and Wolfers (1999).
[16] For an early, albeit informal, interpretation of the developments on continental European labor markets in the 1980s along these lines, see Hellwig and Neumann (1987).
[17] For comparative static variants of this model, see Caballero and Hammour (1998) and Berthold and Fehn (1999).

capital is highly inelastic due to a putty-clay production technology of already invested vintages of capital. In contrast, firms face in the long run a technological menu allowing them to choose between very different technologies, which are reflected in varying capital intensities of production. Hence, the elasticity of substitution between capital and labor is low only in the short run, but high in the long run. Adjusting the production technology by raising the capital intensity of production can therefore in the long run be a powerful instrument of capital to thwart appropriation attempts of labor. The resulting rise in the aggregate unemployment rate reduces the value of the exit option of insiders and thus also their bargaining strength. The institutional bias in favor of labor is thus in the long run balanced by higher unemployment which serves to guarantee capital its internationally required rate of return $r > 0$. This is of course a highly inefficient macroeconomic response to a distorted institutional framework.

There are only two factors of production in the model, capital and labor, and one consumption good which is used as the numeraire. It is a continuous time model with an infinite horizon. Agents have perfect foresight. Aggregate capital and employment at time t are $K(t)$ and $N(t)$. Aggregate labor supply is assumed to be fully inelastic and normalized to one, whereas uncommitted capital is taken to be fully elastic. Concerning technology, the ex-ante technological menu at time t is given by a CES production function with constant returns to scale and with σ being the elasticity of substitution between capital and labor:

$$y = F\left(k, A(t)n\right) = z\left[\alpha k^{\frac{\sigma-1}{\sigma}} + (1-\alpha)\left(A(t)n\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

with $z, \sigma > 0, 0 < \alpha < 1$. k and n represent capital and labor inputs, respectively, in a specific production unit. $A(t)$ is a measure of labor-augmenting technical progress, which takes place at rate $\chi > 0$:

$$A(t) = A(0)e^{\chi t}. \tag{2}$$

Once the technology is chosen and the investment is undertaken at time t_0, the ex-post production funtion is assumed to be putty clay. It incorporates a fixed level of technical progress $A(t_0)$ and a fixed ex-post capital intensity:

$$\kappa(t_0) \equiv \frac{k}{A(t_0)n}. \tag{3}$$

Hence, capital is inelastic in the short run where a large part of the total supply of capital is already committed, but highly elastic in the long run. Firms can choose ex ante from the technological menu $F(k, A(t)n)$ which constitutes de facto an envelope of available Leontieff production functions with fixed factor proportions. Moving ex post from one specific Leontieff production function to another is, however, not possible instantaneously but rather takes time. Such a move is denoted by a change in $\kappa(t)$, in which the chosen technology is embodied. As all investors are facing the same conditions at a given point in time, all production units of a specific vintage are identical. A production unit created at time t_0 is the combination of one unit of labor and $\kappa(t_0)\ A(t_0)$ units of capital. The structure of production at any given point in time t is characterized by the number of production units of different ages a, denoted by $n(a,t)$, and the capital intensity of such units $\kappa(t-a)$, where a can vary between 0 and the maximum age of any unit $\bar{a}(t)$.

Aggregate capital stock, employment and output at time t are obtained by taking the appropriate integrals over all the operational vintages of capital which differ in age and therefore also production technology:

$$K(t) = \int_0^{\bar{a}(t)} \kappa(t-a)A(t-a)n(a,t)\ da\,, \tag{4}$$

$$N(t) = \int_0^{\bar{a}(t)} n(a,t)\ da\,, \tag{5}$$

$$Y(t) = \int_0^{\bar{a}(t)} A(t-a)F(\kappa(t-a),1)n(a,t)\ da\,. \tag{6}$$

Technical progress causes old production units with obsolete technologies to be continuously replaced by new production units with the latest technology, which is embodied in a larger value of $\kappa(t)$. Such creative destruction comes via $(dA/dt) > 0$, and it is either planned or due to surprises. Planned creative destruction takes place after the expected lifetime of a unit $T(t)$ has expired. Due to the perfect foresight assumption, $T(t)$ is equal to $\bar{a}(t+T(t))$. Unplanned creative destruction happens at the exogenous rate δ.

The driving force of the results of the model are the assumptions that there exist specific quasi-rents and that due to incomplete contracting factors may appropriate each other. Technological as well as institutional variables can make capital appropriable in the sense that a fraction $\phi(t)$ of the invested capital becomes relationship-specific and is lost if capital separates from labor. Technological appropriability can e.g. arise due to firms financing the training of their workers. While technological causes for appropriability are surely not to be neglected and appear to become more important due to the rising skill requirements of firms, politically induced appropriability problems still seem to prevail in continental European welfare states. Two important and straightforward such factors are firing costs and unemployment benefits. Both government interventions into the functioning of labor markets strengthen the bargaining position of insiders in wage negotiations and thus raise their power to appropriate capital. In what follows, it is assumed that a loss of $x^f(t)A(t)$ is incurred by firms in case of a separation decision. It is furthermore assumed that workers receive in case of unemployment the fraction $x^b(t)$ of their shadow wage $\tilde{w}(t)A(t)$.

The shadow wage is by definition equal to the worker's outside opportunities, which consist of a stock and a flow component. The former is equal to the increase in human wealth once he finds again a job and therefore has to be multiplied by the probability of this event, whereas the latter is simply equal to the level of unemployment benefits:

$$\tilde{w}(t)\,A(t)=\frac{H(t)}{U(t)}\beta S(t)+x^{b}(t)\tilde{w}(t)A(t),\ \text{with}\ 0<\beta<1. \qquad (7)$$

To keep matters as simple as possible, the probability of finding a job is just taken to be gross hiring $H(t)$ divided by the aggregate unemployment pool $U(t)=1-N(t)$, out of which hiring only takes place. Hence, it is assumed that all the unemployed have an equal chance of becoming reemployed at time *t*. β is the relative bargaining power of workers vis-à-vis firms. Wages are determined by continuous and generalized Nash-bargaining between workers and firms. *S(t)* are the specific quasi-rents of a production unit that has just been created at time *t*. *S(t)* is equal to the value-added in a new production unit, which is given by the first two expressions on the RHS of the following equation 8, minus the outside opportunities, i.e. the shadow wages of capital and labor:[18]

$$\begin{aligned} S(t)= & \int_t^{t+T(t)} F(\kappa(t),1)A(t)e^{-(r+\delta)(s-t)}ds-x^{f}(t+T(t))A(t+T(t))e^{-(r+\delta)T(t)} \\ & -\Big[(\kappa(t)-\phi(t))c(i(t))-x^{f}(t)\Big]A(t)-\int_t^{t+T(t)}\tilde{w}(s)A(s)e^{-(r+\delta)(s-t)}ds, \end{aligned} \qquad (8)$$

[18] A detailed derivation of equation 8 is provided in the appendix.

where $c(i(t))$ is the unit cost of investment at time t. Actual wage payments are equal to shadow wages plus a quasi-specific rent premium, which depends negatively on the age of a production unit. Hence, some form of implicit profit sharing takes place in this model. The reasons for this form of rent-sharing in actual wage payments are inter alia that firms have to incur firing costs when laying off workers, and that the relationship-specific component of capital $\phi(t)$ is also lost in that case. Yet, such relationship-specific capital is assumed to be financed mainly by firms because workers often face binding credit constraints. It is furthermore assumed that there are no precontracting possibilities so that the ex-post appropriation problem occurs with full force. Once a worker has been hired, he becomes an insider thus gaining substantially in market power. His terms of trade are better ex post compared to ex ante and being an insider he can no longer be denied the quasi-specific rent component. A production unit is scrapped once the quasi-specific rent premium becomes negative because workers then prefer to abandon the firm and to seek work elsewhere. Their expected income is in such a case equal to the shadow wage.

It is assumed that there is free entry of firms in creating new production units, so that the specific investments, which the firm is sinking into the production unit, must be equal to the firm's share of quasi-rents:

$$\phi(t)\, c(i(t))\, A(t) + x^f(t)\, A(t) = (1-\beta)\, S(t)\,. \tag{9}$$

Since firms maximize profits, a production unit will be dissolved once its revenues are just equal to the worker's shadow wage minus the benefits of delaying the separation decision. These benefits are possibly twofold, namely the inevitably arising firing costs are borne at a later date and firing costs may in addition be reduced meanwhile. Hence, the exit condition of firms reads as follows:

$$F(\kappa(t-\bar{a}(t)),1)\, A(t-\bar{a}(t)) = \tilde{w}(t)\, A(t) - \left[(r+\delta-\chi)x^f(t) - \frac{dx^f(t)}{dt} \right] A(t)\,. \tag{10}$$

The size of the shadow wage, not of actual wage payments, is relevant for the firm's decision whether to dissolve a production unit or not, because workers must at least receive the shadow wage so that they do not withdraw from the joint production unit. Profit maximization of firms also implies that firms choose the capital intensity $\kappa(t)$ such that the marginal revenue product of labor is equal to the total marginal cost of labor, i.e. actual wage payments plus future firing costs:

$$\int_{t}^{t+T(t)} \frac{\partial F}{\partial n}(\kappa(t),1)A(t)e^{-(r+\delta)(s-t)}ds =$$

$$\int_{t}^{t+T(t)} w(s,t)A(s)e^{-(r+\delta)(s-t)}ds + x^{f}(t+T(t))A(t+T(t))e^{-(r+\delta)T(t)} . \qquad (11)$$

Firms, not workers, choose the capital intensity of production because it is assumed that institutional conditions are such that workers appropriate capital and not vice versa. Otherwise, there should be labor shortages instead of mass unemployment. Since the appropriating factor labor is always rationed, i.e. involuntarily unemployed, the ex-ante distribution of relative bargaining power is such that the appropriated factor capital can determine factor proportions in return for its willingness to enter into new joint production units despite of the appropriation threat. It is therefore in the long run very costly to try to appropriate an ex-ante elastic factor like capital.[19]

Equation 11 reveals that capital intensities depend on actual wage payments and not only on private shadow wages. Hence, there is excessive capital-labor substitution in the long-run equilibrium compared to the neoclassical benchmark in response to an appropriation push triggered by a change in the institutional setup to the detriment of capital. Actual wage payments include a rent component due to the assumption that the institutional framework enables insiders to appropriate capital. Yet, this excessive capital-labor substitution gives rise to additional aggregate unemployment. Given this rise in aggregate unemployment, even capital intensities based on workers' shadow wages instead of actual wage payments would be too large. There would still be excessive capital-labor substitution from a social point of view because the social shadow wage of labor is zero in the presence of aggregate unemployment. Such aggregate unemployment drives a wedge between the private and the social shadow wage. However, only the social shadow wage should be relevant for determining socially optimal factor proportions.

3. Predictions of the Model

The presented model produces a number of predictions concerning the long-run effects of an institutional shock which raises the power of labor to appropriate capital. While the putty-clay nature of technology severely restricts capital-labor substitution in the short run, the induced

[19] See Caballero and Hammour (1998).

process of substituting capital for labor is in contrast excessively high in the long run. The long-run elasticity of substitution implied by the model is greater than one due to the appropriation problem. Capital will only get its international rate of return if it excessively excludes labor from the production process. This exclusion process has the direct consequence that unemployment will strongly and steadily rise after the appropriation push. The rise in unemployment will be much more protracted than implied by standard models of employment determination based on simple neoclassical production functions, because it will continue until the appropriation push is fully reflected in the production technology. Yet, the induced change in technology takes a long time as it happens gradually via the installation of new production units. Interestingly, the model unambiguously indicates that rising firing costs will lead to higher unemployment in the long run because the appropriation potential of insiders grows. Models which exclusively deal with the effects of higher firing costs on labor demand usually reach either a negligible effect or even the opposite result.[20]

The rise in unemployment is necessary in the model for the profit share to recover after its initial reduction in the wake of the institutional shock. A corrolary of this is the endogenous reduction of bargaining power of workers because shadow wages of workers fall with lower chances of encountering a new job after possibly being laid off or leaving the firm. As the shadow wage determines the fall-back position of insiders, a long time of wage stagnation or even wage reductions follows the initial wage push period. Furthermore, lower shadow wages lead to less pressure on firms to dissolve old production units. Hence, the expected lifetime of production units rises, the speed of creative destruction and with it productivity growth slow down. The greater expected lifetime of newly created production units is necessary to make investments profitable again despite of the appropriation problem. Hence, a specific form of technological sclerosis occurs which has an additional dampening effect on feasible wage growth. It is important to keep in mind in this respect that the choice of capital intensity by firms is based on the discounted value of future labor costs over the total expected lifetime of a vintage of capital that is about to be installed. In contrast, current compensation per worker averages payments for a cross-section of existing vintages of capital. Firms must furthermore take expected future firing costs into account, which is a dead-weight loss to firms and not part of the direct payments to employees. In sum, wages and labor shares can be expected to

[20] See e.g. Bentilola and Bertola (1990); our prediction that rising firing costs lead to greater unemployment is empirically confirmed by Blanchard and Wolfers (1999) and DiTella and MacCulloch (1998) in cross-country studies.

follow the hump-shaped time path after the initial appropriation push, which can be observed in continental European countries.

IV. Testing the Model Empirically

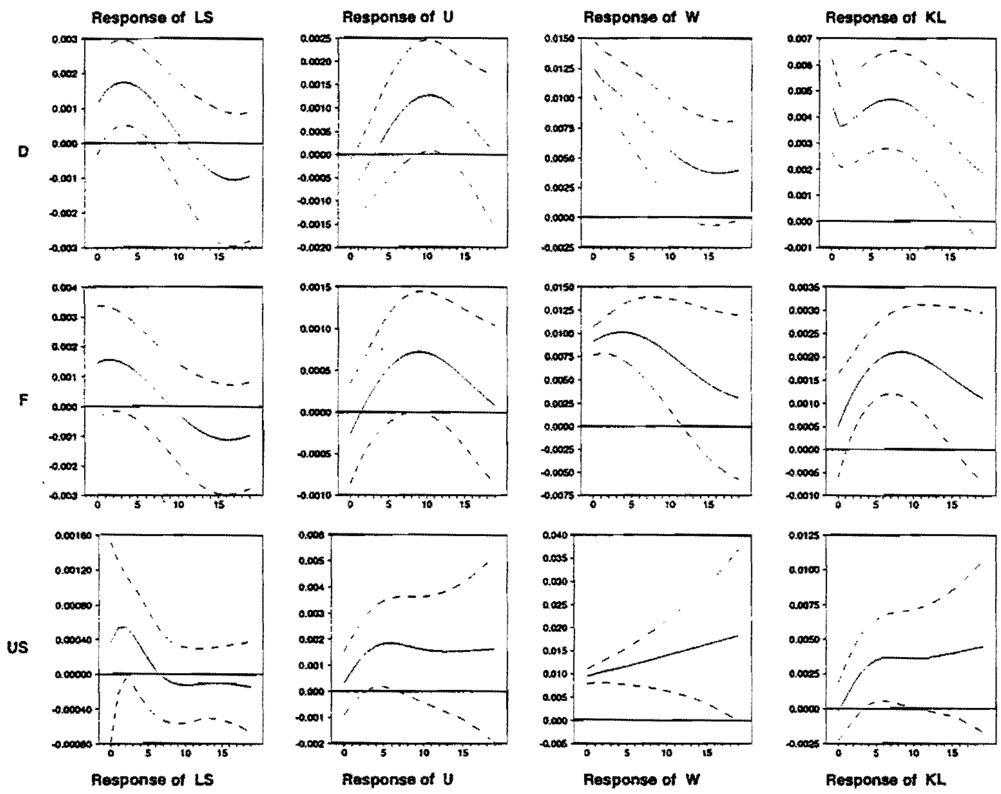
Two approaches are followed for empirically testing the model. First, generalized impulse-response functions to wage shocks are calculated. Wage shocks are taken to proxy institutional shocks such as a rise in firing costs that should actually be the main focus of the analysis. However, even if there existed internationally standardized time series concerning the development of institutional rigidities, they would hardly exhibit a considerable degree of variance neccessary for a proper VAR analysis. Second, the long-run elasticity of substitution between capital and labor is estimated using the seemingly unrelated regressions (SUR-) method. Both exercises are carried out for Germany, France and the U.S.

Recently, the concept of generalized impulse response function has been brought up. Contrary to the traditional approach advocated by Sims (1980) there is no need to impose restrictions on the covariances of the errors. Herein lies a new possibility for overcoming the problem of "incredible" identifying restrictions inherent in both econometrics and time series modeling. A VAR with four variables is estimated consisting of labor share, LS, unemployment, U, nominal wages, W, and capital-labor ratio, KL. Generalized impulse responses are computed over a ten-year period.[21] The results for the impulse-response functions depicted in fig. 5 are rather mixed, though. A wage-push shock does indeed lead to a hump-shaped path for the labor share in all three countries.[22] Wages also display as expected a humped-shaped pattern after a wage shock in Germany and France, but not in the U.S. where wages actually keep rising after a wage shock. Concerning the reaction of unemployment, there is only a long-run increase in unemployment in the U.S. in reaction to a wage-push shock, whereas the unemployment rates in Germany and France appear to be very close to its initial level after about nine years. The best results are clearly obtained for the substitution of labor by capital. A wage-push shock does indeed lead to a lasting and substantial substitution of labor by capital, and, interestingly, this result is valid most for the U.S. Hence, the analysis based on impulse-response functions confirms that wage shocks tend to trigger a long-run substitution process of labor by capital. Yet, the tentative character of all these results should be noted, as the common problem of

[21] For details on the data see the appendix.
[22] Bentilola and Saint-Paul (1998) also find this result.

low significance in impulse-response functions also arises in most of these twelve cases after a few years. This is the case whenever the bands depicting the double standard deviation of the impulse responses include the x-axis and thus the value zero.[23]

Fig. 5: Impulse Responses to a Wage Shock



Hence, a more promising avenue for empirically testing the model might be directly estimating the long-run elasticity of substitution between labor and capital σ. A key prediction of the appropriation model is $\sigma > 1$, once the size of the aggregate capital stock is taken to be endogenous. Such a result would indeed be intriguing because most earlier studies reached the result that $\sigma < 1$, while Blanchard (1999) reads the empirical evidence such that this value is very close to one.[24] Yet, these earlier studies have two important drawbacks. First, they are mostly already outdated, as they were generally published in the eighties or even before, and do therefore only include a small amount of datapoints for which the appropriation hypothesis applies. Second, these studies in general estimate long-run elasticities of substitution between

[23] The error bands were computed using Monte Carlo techniques.
[24] For a survey of such studies, see Rowthorn (1996).

capital and labor without explicitly allowing the size of the aggregate capital stock to vary, e.g. they often estimate a wage-gap type of equation. Neglecting capital adjustment can produce serious distortions concernig the estimations. It should therefore not be surprising that our approach reaches quite different results.

Differentiating our production function (1) with respect to k and n yields

$$\frac{\partial y}{\partial n} = (1-\alpha) z^{\frac{\sigma-1}{\sigma}} \left(\frac{y}{n}\right)^{\frac{1}{\sigma}} \left[A(t)\right]^{\frac{\sigma-1}{\sigma}}, \text{ and} \tag{12a}$$

$$\frac{\partial y}{\partial k} = \alpha z^{\frac{\sigma-1}{\sigma}} \left(\frac{y}{k}\right)^{\frac{1}{\sigma}}. \tag{12b}$$

Firms are assumed to set real labor and capital compensation equal to their respective marginal products. Recalling that $A(t) = A(0)e^{\chi t}$ and taking natural logarithms the following equations are obtained

$$\log \frac{w}{p} = \Gamma_1 + \beta_{11} \log \frac{n}{y} + \beta_{12} t \tag{13a}$$

with $\Gamma_1 = \log(1-\alpha) + [(\sigma-1)/\sigma][\log z - \log A(0)]$, and

$$\log uc = \Gamma_2 + \beta_{21} \log \frac{k}{y} \tag{13b}$$

with $\Gamma_2 = \log \alpha + [(\sigma-1)/\sigma] \log z$.

The real wage is denoted by (w/p), uc_t denotes the real user costs of capital.[25] The β coefficients correspond to the parameters of the production function in the following way: $\beta_{11} = \beta_{21} = -(1/\sigma)$ and $\beta_{12} = \chi(\sigma-1)/\sigma$.

Since the integration tests shown in the appendix indicate that all relevant variables are integrated of order 1 and that there exists a cointegrating relationship between $(w/p)_t$ and $(n/y)_t$ as well as between uc_t and $(k/y)_t$, the adoption of an error-correction-model is ap-

[25] For a detailed data description, see the appendix.

propiate for estimating the long-term elasticity of substitution contained in β_{11} and β_{21}.[26] Hence, the corresponding ECM-equations are[27]

$$\Delta \log\left(\frac{w}{p}\right)_t = \alpha_1\left[\log\left(\frac{w}{p}\right)_{t-1} - \beta_1 \log\left(\frac{n}{y}\right)_{t-1}\right] - \sum_{j=1}^{q-1} b_{1j} \Delta \log\left(\frac{w}{p}\right)_{t-j} - \sum_{j=0}^{p-1} a_{1j} \Delta \log\left(\frac{n}{y}\right)_{t-j} + \varepsilon_{1t}, \quad (14a)$$

$$\Delta \log uc_t = \alpha_2\left[\log uc_{t-1} - \beta_2 \log\left(\frac{k}{y}\right)_{t-1}\right] - \sum_{j=1}^{q-1} b_{2j} \Delta \log uc_{t-j} - \sum_{j=0}^{p-1} a_{2j} \Delta \log\left(\frac{k}{y}\right)_{t-j} + \varepsilon_{2t} \quad (14b)$$

with $\beta_1 = \beta_2 = -(1/\sigma)$, i.e. the long-run elasticity of substitution. One possible approach to estimating the above equations is the two-step procedure proposed by Engle and Granger (1987). However, the estimates of the cointegrating relation in the first step rely on their superconsistency property when used with I(1) variables. As is well known these estimates may have substantial finite-sample biases.[28] Regarding the rather small degrees of freedom usually available in such analyses this could be a serious problem. Estimating the error-correction model directly usually results in less biased estimates with small samples.[29]

The standard error of the long-run estimate can in principle be computed by applying non-linear least squares or by calculating the linear combination of the standard errors of both coefficients involved in the long-run relation obtained by OLS. However, there is a simpler way for achieving this goal. In a reparametrization of the ECM combined with instrumental variable estimation the standard error is readily available.[30] The appropriate Bewley-transformation of the labor and the capital equation would then be

$$\log\left(\frac{w}{p}\right)_t = \beta \log\left(\frac{n}{y}\right)_{t-1} + \frac{1}{\alpha}\sum_{j=0}^{q-1} b_{1j} \Delta \log\left(\frac{w}{p}\right)_{t-j} + \frac{1}{\alpha}\sum_{j=0}^{p-1} a_{1j} \Delta \log\left(\frac{n}{y}\right)_{t-j} + \varepsilon_{1t}, \text{ and} \quad (15a)$$

$$\log uc_t = \beta \log\left(\frac{k}{y}\right)_{t-1} + \frac{1}{\alpha}\sum_{j=0}^{q-1} b_{2j} \Delta \log uc_{t-j} + \frac{1}{\alpha}\sum_{j=0}^{p-1} a_{2j} \Delta \log\left(\frac{k}{y}\right)_{t-j} + \varepsilon_{2t}. \quad (15b)$$

Clearly, the regressors $\Delta \log(w/p)_t$ and $\Delta \log uc_t$ are contemporaneously correlated with the respective dependent variables, so the use of instrumental variable estimation is required. Choosing $\log(w/p)_{t-1}$ and $\log uc_{t-1}$ as instruments produces exactly the same numerical re-

[26] See Engle and Granger (1987).
[27] Labor saving technical progress is omitted to maintain clarity of presentation. It is of course included in actual estimations.
[28] See Banerjee et al. (1993, Chap. 7)
[29] See Johnston and DiNardo (1997, 264)
[30] See Bewley (1979).

sult as the ECM.[31] Since both formulations stem from the production function of the representative firm, it is very likely that the errors of the two equations are not uncorrelated, so they are actually seemingly unrelated regressions. Hence, the SUR method is appropriate for estimating the long-run elasticity of substitution between capital and labor.

For all three countries the data period for the estimation comprises semi-annual data from 1970 to 1995.[32] The estimation results for Germany are shown in table 1. The time coefficient estimating the effect of proxied labor augmenting technical progress was insignificant at any conventional significance level, so it has been dropped out of the final regression. The unrestricted SUR produces significant values for both β_1 and β_2. Column two of table 1 reveals that the coefficients are also significantly greater than -1 although for β_2 only at the 5% level. From these coefficients the long-run elasticity of substitution can be computed as 1.431 and 1.727, respectively. In turn, both values are significantly greater than unity. Of course, economic theory demands that these two values are equal, so a restricted SUR is additionally estimated. The result can be seen in the lower half of table 1. Marginally at the 5% level and clearly at the 1% level the restriction that $\beta_1 = \beta_2$ cannot be rejected. Via a highly significant β-value of –0.691 a long-run elasticity of substitution of 1.447 is obtained.

[31] See Wickens and Breusch (1988).
[32] See the appendix for a detailed description of the data.

Table 1: SUR Results for Germany (1970 – 1995)[a]

Equation	Estimate of β; t-statistic in parenthesis	Test of H_0: $\beta=-1$ vs. H_1: $\beta>-1$; p-value for $\chi^2(1)$-statistic in parenthesis	Computed value for σ	R^2 DW-stat.
w/p	-0.699 (-20.486)	77.982 (0.000)	1.431	0.967 1.963
uc	-0.579 (-2.786)	4.088 (0.043)	1.727	0.856 1.724
Restriction that both coefficients are equal				
		Likelihood-Ratio test for equality; $\chi^2(1)$		
w/p	-0.691 (-16.120)	3.778 (0.052)	1.447	0.965 1.995
uc				0.844 1.713

[a] A dummy was included to control for German reunification. Up to 1990:1 it takes the value 0 and after that the value 1.

The French case, which is given in table 2, is even more pronounced than the German case. Two highly significant β-values yield numerical results for σ of 1.942 and 2.212. Contrary to Germany, the restriction that the two computed elasticities are the same, must be clearly rejected. Again, the coefficient for time was not significant and it was therefore omitted from the regression.

Table 2: SUR Results for France (1970 – 1995)

Equation	Estimate of β; t-statistic in parenthesis	Test of H_0: $\beta=-1$ vs. H_1: $\beta>-1$; p-value for $\chi^2(1)$-statistic in parenthesis	Computed value for σ	R^2 DW-stat.
w/p	-0.515 (-6.522)	37.700 (0.000)	1.942	0.903 1.801
uc	-0.452 (-4.798)	33.750 (0.000)	2.212	0.813 1.750
Restriction that both coefficients are equal				
		Likelihood-Ratio test for equality; $\chi^2(1)$		
w/p	-0.486 (-7.630)	351.355 (0.000)	2.058	0.892 1.785
uc				0.798 1.679

Looking at the U.S. case in table 3, a markedly different picture is revealed. First of all, the coefficient for technical progress is significant even at the 1% level. The estimates of β are much larger than in the other two countries resulting in values for σ of 1.112 and 1.181. Consequently, although they are still significantly different from zero, it cannot be rejected at any conventional level that the long-run elasticity of substitution equals unity. Therefore, a Cobb-Douglas framework for describing the U.S. production structure seems to be appropriate. This should not be too much of a surprise recalling the relatively stable ratio between wages and the marginal product of labor depicted in fig. 3. The result holds for the restricted SUR as well. It cannot be rejected that the imposed restriction does in fact hold yielding an elasticity of 1.147.

Table 3: SUR Results for the United States (1970 – 1995)

Equation	Estimate of β; t-statistic in parenthesis	Test of H_0: β=1 vs. H_1: β>1; p-value for $\chi^2(1)$-statistic in parenthesis	Computed value for σ	R^2 DW-stat.
w/p	-0.899 (-4.515)	0.258 (0.611)	1.112	0.912 1.858
uc	-0.847 (-3.627)	0.429 (0.513)	1.181	0.854 1.751
Restriction that both coefficients are equal				
		Likelihood-Ratio test for equality; $\chi^2(1)$		
w/p	-0.872 (-5.804)	0.821 (0.365)	1.147	0.907 1.835
uc				0.848 1.745

In sum, the estimated values of σ for Germany, France and the U.S. are all significantly different form zero. Whereas the results for the U.S. point to a more Cobb-Douglas-like production structure, the two European countries exhibit long-run elasticities of substitution which are substantially and significantly greater than one. Hence, these results indicate that the appropriation model is empirically relevant for both European countries in deriving much greater harmful effects of institutional shocks on employment than is usually assumed in the simple neoclassical case. The substitution process is not only more protracted but it is also stronger leading to greater negative long-run consequences for employment.

In fact, these results have another important implication. They indicate that the shape of labor demand depends decisively on the time horizon so that standard neoclassical labor demand functions have to be substantially modified in order to take the long-run reaction of firms to wage push/appropriation shocks into account. Labor demand is usually taken to depend negatively on real wages in efficiency units in the short run, where the capital stock is given, and to be infinitely elastic with respect to the real wage in efficiency units in the long run. However, a long-run elasticity of substitution between capital and labor exceeding one implies that long-run labor demand is positively related to the real wage in efficiency units. This does of course not mean that an aggressive wage policy will lead to a larger demand for labor in the long run. Quite the opposite, once the full adjustment in the capital stock and in the production function is taken into account, appropriation shocks lead to both declining employment and falling real wages in efficiency units in the long run, thus also unambiguously producing a falling labor share. Pursuing an aggressive wage policy is therefore a completely self-defeating strategy because real wages measured in efficiency units will actually decline in the long run.

Or looking at the other side of the same coin, countries, which manage to improve the functioning of labor markets by resolving appropriation problems, earn a double dividend: They not only achieve a reduction of their respective unemployment rates, but due to the ensuing adjustments in the complementary production factor capital, their workers will only have to cope with lower real wages measured in efficiency units in the short run immediately after reforms have been implemented. In contrast, those workers will enjoy the benefits of reforms in the long run via higher real wages in efficiency units. Less severe appropriation problems due to a better functioning labor market might therefore be part of the explanation for the by now widely acknowledged fact that employment growth in the U.S. is not solely based on stagnating real wages and growing wage dispersion. Rather, high-paid jobs are produced at almost the same rate by now as low-paid jobs, which is difficult to explain in the standard neoclassical framework of the labor market.

This result for the aggregate level is reinforced once workers are distinguished according to qualifications. Krusell et al. (1997) have shown that the elasticity of substitution between capital and labor is much higher for low-qualified workers than for highly qualified workers, who can be viewed to a larger extent as being complementary to capital. Using U.S. data, their estimated value for the elasticity of substitution between less skilled workers and capital is 1.67, while the one between skilled labor and capital is only 0.67. Machines tend to make low-qualified workers superfluous, but they usually require a staff qualified enough to handle the capital stock in place. Thus, incrasing firing costs and raising in particular wages at the lower end of the wage spectrum, which is often praised as being an especially "fair" wage policy, are particularly grave errors from the long-run employment perspective. Large rises in the unemployment rates at the lower end of the qualification spectrum are to be expected as a result over time. Moreover, it is very difficult to reverse such a process of substitution of labor by capital once firms have invested in a less labor intensive production technique. Firms in labor intensive sectors may then have already moved production to countries where labor is cheaper, and the remaining firms may have already borne significant sunk costs in order to raise their capital intensity of production. A lot of patience by policymakers as well as by wage setters is therefore required if such a process of marked rises in labor costs, an ongoing substitution between capital and labor, and strongly rising unemployment is to be stopped or even reversed.

V. Concluding Remarks

The vast literature on unemployment has mostly focused on labor market issues, such as the institutional setup of wage bargaining and welfare benefits. In contrast, the impact of capital formation and of the incentives to install new firms have been largely neglected. This is the case because job-creation is often thought to be a matter of encouraging more employment on a given capital stock thus facing a permanent trade-off between employment growth and higher real wages. This paper takes a different approach by explicitly dealing with the long-run consequences on labor demand and employment of institutional shocks. It is theoretically as well as empirically shown that this trade off between employment growth and higher real wages measured in efficiency units disappears in the long run. In line with the theoretical results of the appropriation model, the estimated values for the long-run elasticities of substitution between capital and labor for Germany and France are significantly and substantially greater than one.

Hence, appropriation shocks have greater negative repercussions on employment than implied by Cobb-Douglas production functions and improvements in the functioning of labor markets may raise employment and real wages in the long run. Institutional differences can therefore at least partially account for rising unemployment in continental Europe in combination with a humped-shaped path of the labor share. As is well known, this development is in stark contrast to the U.S., where the labor share has remained roughly constant and where the unemployment rate is at its lowest point in the last thirty years. It is also very well compatible with the fact that the employment performance has deteriorated most since the early seventies in those OECD countries which have experienced the greatest decline in their investment rate.[33] The institutional environment especially in Germany and France since that time is such that capital has a relatively small incentive to enter into new joint production units, thus explaining the lackluster investment performance, and such that capital wants to exclude labor from the production process, resulting in an excessively high capital-labor ratio considering the size of the unemployment problem.

The much discussed process of globalization appears to be closely related to these results. Globalization not only raises the potential for specialization, but it also broadens the technological menu which is available to firms by facilitating international technology transfers. Both factors enhance the scope for substituting labor by capital. Globalization may therefore lead to higher overall investments and growth, but countries with a badly functioning labor market may be largely excluded from reaping the fruits of globalization. Especially the less qualified workers in these countries face a bleak future concerning employment prospects and earning possibilities. Labor market reforms must therefore remain high up on the agenda for economic policy in continental European countries such as Germany and France. It is often asserted that it is politically close to impossible to actually implement the necessary employment-enhancing labor market reforms. However, the results of the present paper imply that this political infeasibility is not a natural constant but rather the outcome of policymakers basing their decisions on a too short time horizon.

[33] See Rowthorn (1996).

Appendix

A.1 Derivation of the present value of specific quasi-rents

The appendix provides a detailed derivation of the present value of specific quasi-rents in a given production unit, i.e. of equation 8 in the main text. A specific production unit created at t_0 is considered and n is normalized to 1, so that $n_0 \equiv 1$. First, the following additional variables need to be defined:

$W^e(t,t_0)$ is the human wealth of a worker at time t employed in this production unit;

$W^u(t)$ is the human wealth of an unemployed worker;

$\Pi(t,t_0)$ is the present value of profits from this production unit;

$V(t,t_0)$ is the present value of this unit's non-specific capital.

By definition, the following three arbitrage conditions must hold:

$$rW^e(t,t_0) = w(t,t_0)A(t) - \delta\left[W^e(t,t_0) - W^u(t,t_0)\right] + \frac{dW^e(t,t_0)}{dt}, \tag{A.1}$$

with $W^e(t_0 + T(t_0), t_0) = W^u(t_0 + T(t_0))$.

$$rW^u(t) = \tilde{w}(t)A(t) + \frac{dW^u(t)}{dt}. \tag{A.2}$$

$$r\Pi(t,t_0) = F(k(t_0), A(t)) - w(t,t_0)A(t) - \delta\,\Pi(t,t_0) + \frac{d\,\Pi(t,t_0)}{dt}, \tag{A.3}$$

with $\Pi(t_0 + T(t_0), t_0) = V(t_0 + T(t_0), t_0) - x^f(t_0 + T(t_0))A(t_0 + T(t_0))$.

Specific quasi-rents in this production unit are by definition equal to

$$S(t) = \left[\Pi(t,t_0) + W^e(t,t_0)\right] - \left[V(t,t_0) - x^f(t)A(t)\right] - W^u(t). \tag{A.4}$$

Assuming continuous-time Nash bargaining, labor and capital obtain at any t their outside opportunity cost plus their respective share of quasi-rents:

$$W^e(t,t_0) = W^u(t) + \beta S(t,t_0), \tag{A.5}$$

$$\Pi(t,t_0) = \left[V(t,t_0) - x^f(t)A(t)\right] + (1-\beta)S(t,t_0). \tag{A.6}$$

Assuming free entry, the present value of profits must equal:

$$\Pi(t_0,t_0) = c(i(t_0))A(t_0)\kappa(t_0). \tag{A.7}$$

Assuming free disposal, whenever a firm lays off its present workforce, it must reinvest $\phi(t)$ units of specific capital to replace each worker. Hence, the value of a unit's non-specific capital is equal to:

$$V(t,t_0) = \max\{0, \Pi(t,t_0) - c(i(t))A(t)\phi(t)\}. \tag{A.8}$$

The equilibrium conditions can now be derived. First, add (A.1) and (A.3):

$$r(W^e(t,t_0) + \Pi(t,t_0)) = w(t,t_0)A(t) - \delta[W^e(t,t_0) - W^u(t,t_0)] + \frac{dW^e(t,t_0)}{dt}$$
$$+F(k(t_0),A(t)) - w(t,t_0)A(t) - \delta\Pi(t,t_0) + \frac{d\Pi(t,t_0)}{dt}. \tag{A.9}$$

Solving (A.4) for $W^e(t,t_0) + \Pi(t,t_0)$ and inserting into (A.9) yields:

$$r\left[S(t) + V(t,t_0) - x^f A(t) + W^u(t)\right] = -\delta\left[W^e(t,t_0) - W^u(t)\right] + \frac{dW^e(t,t_0)}{dt}$$
$$+F(k(t_0),A(t)) - \delta\Pi(t,t_0) + \frac{d\Pi(t,t_0)}{dt}. \tag{A.10}$$

Inserting (A.2) gives:

$$r\left[S(t)+V(t,t_0)-x^f A(t)\right] = -\delta\left[W^e(t,t_0) - W^u(t)\right] + \frac{dW^e(t,t_0)}{dt} + F(k(t_0),A(t))$$
$$-\delta\Pi(t,t_0) + \frac{d\Pi(t,t_0)}{dt} - \tilde{w}(t)A(t) - \frac{dW^U(t)}{dt}. \tag{A.11}$$

Solving (A.4) for $W^u(t)$ and again for $W^e(t,t_0) - W^u(t)$, inserting both results into (A.11) and rearranging terms gives:

$$(r+\delta)[S(t)+V(t,t_0) - x^f A(t)] = F(k(t_0),A(t)) - \tilde{w}(t)A(t)$$
$$+\frac{d}{dt}[W^e(t,t_0) + \Pi(t,t_0) - W^u(t)]. \tag{A.12}$$

In order to obtain the present value of specific quasi-rents in the given production unit, this expression needs to be integrated forward:

$$\int_{t_0}^{t_0+T(t_0)} (r+\delta)[S(t) + V(t,t_0) - x^f A(t)] - F(k(t_0),A(t)) + \tilde{w}(t)A(t)\,ds$$

$$= \int_{t_0}^{t_0+T(t_0)} \frac{d}{dt}[W^e(t,t_0) + \Pi(t,t_0) - W^u(t)]\, ds. \tag{A.13}$$

With the aid of (A.4), this can can rewritten to be:

$$\int_{t_0}^{t_0+T(t_0)} (r+\delta)[S(t)+V(t,t_0) - x^f A(t)] - F(k(t_0), A(t)) + \tilde{w}(t)A(t)\, ds$$

$$= \int_{t_0}^{t_0+T(t_0)} \frac{d}{dt}[S(t)+V(t,t_0) - x^f A(t)]\, ds. \tag{A.14}$$

This integration problem can be solved by partial integration. For this, both sides need to be multiplied by $e^{-(r+\delta)t}$. Collecting in addition terms appropriately yields:

$$\int_{t_0}^{t_0+T(t_0)} e^{-(r+\delta)s}\tilde{w}(t)A(t) - F(k(t_0), A(t))\, ds$$

$$= \int_{t_0}^{t_0+T(t_0)} \frac{d}{dt}\left[e^{-(r+\delta)s}(S(t)+V(t,t_0) - x^f A(t)\right] ds$$

$$= \left[e^{-(r+\delta)s}[S(t)+V(t,t_0) - x^f A(t)]\right]_{t_0}^{t_0+T(t_0)}$$

$$= -e^{-(r+\delta)(t_0+T(t_0))} x^f A(t_0+T(t_0)) - e^{-(r+\delta)t}\left[S(t)+V(t,t_0) - x^f A(t)\right]. \tag{A.15}$$

The last step used the following boundary conditions: $S(t_0+T(t_0)) = V(t_0+T(t_0), t_0) = 0$.

Solving (A.15) for $S(t)$ yields:

$$S(t) = \int_{t_0}^{t_0+T(t_0)} \left[F(k(t_0), A(t)) - \tilde{w}(t)A(t)\right] e^{-(r+\delta)(s-t)} ds$$

$$-e^{-(r+\delta)(t_0+T(t_0)-t)} x^f A(t_0+T(t_0)) - [V(t,t_0) - x^f A(t)]. \tag{A.16}$$

(A.16) is equivalent to equation 8 in the main text, considering that (A.7) and (A.8) can be combined to obtain: $V(t,t_0) = c(i(t_0))A(t_0)[\kappa(t_0) - \phi(t_0)]$. (A.17)

Free-entry condition, i.e. equation 9 in the main text, is obtained directly by combining equations (A.6), (A.7) and (A.17), whereas the exit condition and the determination of optimal capital intensity, i.e. equations 10 and 11 in the main text, follow from profit maximization. A detailed derivation of equations 10 and 11 as well as of the wage path can be found in the mathematical appendix of Caballero and Hammour (1997).

A.2 Generalized impulse response functions

Consider the VAR in standard form

$$\mathbf{x}_t = \sum_{i=1}^{p} \Phi_i \mathbf{x}_{t-i} + \Psi \mathbf{w}_t + \varepsilon_t \,,\ t = 1,2,\dots,T \tag{A.18}$$

where $\mathbf{x}_t$ is a $m \times 1$ vector of endogenous variables, $\mathbf{w}_t$ is a $q \times 1$ vector of deterministic and/or exogenous variables and ε_t is a vector of shocks with $E[\varepsilon_t] = 0$, $E[\varepsilon_t \varepsilon_t'] = \Sigma$ for all t, where $\Sigma = \{\sigma_{ij}, i, j = 1,2,\dots,m\}$.

Focussing on the impulse responses a reformulation of the VAR in terms of the MA-representation is useful:

$$\mathbf{x}_t = \sum_{i=0}^{\infty} \mathbf{A}_i \varepsilon_{t-i} + \sum_{i=0}^{\infty} \mathbf{G}_i \mathbf{w}_{t-i} \,.^{34} \tag{A.19}$$

The purpose of an impulse response analysis is to measure the time profile of the effect of shocks at a given point in time on the expected future value of variables in a dynamic system. Usually the researcher is interested in tracing the effect of a shock to one specific variable on itself and all other variables in the system. Since, in general, all elements of the ε_t vector are correlated, it would be misleading just to set one element, say ε_{jt}, to a certain value and all other elements to zero. Hence, the main problem with impulse response analysis is to choose the appropriate vector of hypothesized shocks, δ. The traditional approach[35] is to use the Cholesky decomposition of the covariance matrix Σ, implying

$$\mathbf{PP}' = \Sigma \,, \tag{A.20}$$

where $\mathbf{P}$ is an $m \times m$ lower triangular matrix resulting in the MA-representation

---

[34] The matrices $\mathbf{A}_i$ and $\mathbf{G}_i$ are obtained from Φ_i and Ψ_i using recursive formulae. See e.g. Lütkepohl (1993, 18).
[35] See Sims (1980).

$$\mathbf{x}_t = \sum_{i=0}^{\infty}(\mathbf{A}_i\mathbf{P})\xi_{t-i} + \sum_{i=0}^{\infty}\mathbf{G}_i\mathbf{w}_{t-i}, \tag{A.21}$$

such that $\xi_t = \mathbf{P}^{-1}\varepsilon_t$ are orthogonalized, i.e. $E[\xi_t\xi_t'] = \mathbf{I}_m$. Having constructed the shocks in such a way the impulse responses may easily be obtained. The $m\times 1$ vector of orthogonalized impulse response functions of a unit shock to the *j*th equation on $\mathbf{x}_{t+n}$ is given by

$$\psi_j^o(n) = \mathbf{A}_n\mathbf{P}\mathbf{e}_j,\ n = 0,1,2,..., \tag{A.22}$$

where $\mathbf{e}_j$ is an $m\times 1$ selection vector with unity as its *j*th element and zeros elsewhere.

The problems with this approach are well known. There is no unique P that satisfies (A.20). The Cholesky decomposition is not the only way to compute P and, once having resorted to using the decomposition, the ordering of the equations in the VAR system affects the implicit restrictions imposed by the decomposition. In fact, the Cholesky decomposition imposes a recursive structure on the VAR model, meaning that the variable x_{st} in the $\mathbf{x}_t$ vector cannot have an instantaneous impact on variables x_{kt} for $k<s$. That specific structure of restrictions is seldomly justified on economic reasoning. One way to circumvent this issue is to think of economically meaningful restrictions that are sufficient to identify a set of independent shocks. This approach is taken in the so called structural VAR models.[36] Another way is to use generalized impulse response functions. Instead of shocking all the elements of ε_t, one can consider fixing the *j*th shock from the vector of all shocks and then integrating out the effects of other shocks using an assumed or the historically observed distribution of the errors.[37] In this case we have

$$\mathbf{GI}_x(n,\delta_j,\Omega_{t-1}) = E[\mathbf{x}_{t+n}\,|\,\varepsilon_{jt} = \delta_j,\Omega_{t-1}] - E[\mathbf{x}_{t+n}\,|\,\Omega_{t-1}]. \tag{A.23}$$

The difference on the LHS means one is taking the expectation conditional on the observed history Ω_{t-1} and on the fixed value of the *j*th shock at time t while integrating out all other contemporaneous and future shocks. Subtracting from this the expectation only conditional on the history produces the sole effect of the fixed shock which is called the generalized impulse response function.

[36] See e.g. Enders (1995, 320-338) or Giannini (1992) for an overview of structural VAR modeling.
[37] See Pesaran and Shin (1997).

Assuming that ε_t has a multivariate normal distribution the conditional expectation becomes

$$E\left[\varepsilon_t \mid \varepsilon_{jt} = \delta_j\right] = \left(\sigma_{1j}, \sigma_{2j}, \ldots, \sigma_{mj}\right)' \sigma_{jj}^{-1} \delta_j = \Sigma \mathbf{e}_j \sigma_{jj}^{-1} \delta_j . \qquad \text{(A.24)}$$

The unscaled generalized impulse response function of a shock to the jth equation at time t on $\mathbf{x}_{t+n}$ ist then given by

$$\psi_j^{gu}(n) = \frac{\mathbf{A}_n \Sigma \mathbf{e}_j}{\sqrt{\sigma_{jj}}} \frac{\delta_j}{\sqrt{\sigma_{jj}}} . \qquad \text{(A.25)}$$

Normalizing the size of a shock to one standard deviation, i.e. setting $\delta_j \equiv \sqrt{\sigma_{jj}}$ the scaled generalized impulse response function is finally given by

$$\psi_j^{g}(n) = \sigma_{jj}^{-\frac{1}{2}} \mathbf{A}_n \Sigma \mathbf{e}_j . \qquad \text{(A.26)}$$

The scaled generalized impulse response function measures the effect of one standard error shock to the jth equation at time t on expected values of $\mathbf{x}$ at time $t+n$. Note that this generalized impulse response function only reduces to the traditional one generated by the Cholesky decomposition if the covariance matrix of the errors is diagonal, i.e. the variables are uncorrelated.

3. Data Sources

All the data were taken from the OECD Statistical Compendium. For sources and detailed definitions see OECD (1996). The data for the generalized impulse response analysis range from 1970 to 1995 with semi-annual frequency. LS is the labor share in the business sector, U refers to the standardized unemployment rates. W refers to the nominal wage rate, whereas KL corresponds to the capital-labor-ratio in the business sector.

The data for the SUR estimation of the elasticity of substitution range from 1970 to 1995 with semi-annual frequency as well. To compute real wages, denoted by (w/p), the deflator for GDP, p, was used. Private employment, n, was constructed using the difference of total dependent employees and employment by the government. The GDP is denoted by y. The price for capital is proxied by the user costs of capital constructed by $uc_t = \left[p_t^I \left(i_t^L + d - \hat{p}_t^I\right)\right] / p_t$ with p^I: deflator for investment goods and i^L: long-term interest rate. Finally, the capital stock is denoted by k. Unit root test where carries out using the augmented Dickey-Fuller procedure. The Cointegration tests have been conducted using the t-statistic of the adjustment parameter of the error-correction term.[38] The results are shown in table A1.

Table A1- Unit Root (ADF)- and Cointegration Tests

	Germany	France	U.S.
Integration			
(w/p)	-2.783*	-2.506	--0.855
Δ(w/p)	-6.392***	-4.040***	-8.266***
(n/y)	-1.836	-1.658	-0.797
Δ(n/y)	-6.974***	-6.697***	-4.513***
uc	-2.741*	-2.612*	-2.555
Δuc	-7.938***(N)	-7.521(N)***	-8.665(N)***
(k/y)	-2.560(T)	-2.784*	-2.749*
Δ(k/y)	-5.126***	-2.908**	-4.283***
Cointegration			
(w/p) and (n/y)	-5.232***	-3.019**	-1.975**
uc and (k/y)	-2.745***	-4.925***	-4.323***

Note: *, ** and *** denote significance at the 10, 5 and 1 per cent level, respectively. In general, a constant was included in the test equation. Inclusion of a significant time trend is denoted by (T), whereas removing the constant on statistical grounds is denoted by (N). All variables in natural logs.

[38] This test has a greater power than the ADF test on the residuals of the first step of the Engle-Granger procedure. The distribution of the adjustment parameter is approximately standard normal. See Kremers, Ericsson and Dolado (1992).

References

Alogoskoufis, G. et al. (1995), Unemployment: Choices for Europe, CEPR Report: Monitoring European Integration 5, London.

Banerjee, A., J. Dolado, W. Galbraith and D. Hendry (1993), Co-Integration, Error-Correction, and the Econometric Analysis of Non-Stationary Data, Oxford.

Bentilola, S. and G. Bertola (1990), Firing Costs and Labour Demand: How Bad is Eurosclerosis? Review of Economic Studies 57, 381 - 402.

Bentilola, S. and G. Saint-Paul (1998), Explaining Movements in the Labour Share, CEPR Discussion Paper 1958.

Berthold, N. and R. Fehn (1999), Aggressive Lohnpolitik, überschießende Kapitalintensität und steigende Arbeitslosigkeit: Können Investivlöhne für Abhilfe sorgen? Forthcoming in: Berg, H. (ed.), Arbeitsmarkt und Beschäftigung, Schriften des Vereins für Socialpolitik, Berlin.

Berthold, N., Fehn, R. and E. Thode (1998), Fallende Lohnquote und steigende Arbeitslosigkeit: Ist das „Ende der Bescheidenheit" die Lösung? Wirtschaftsdienst 78, 736 - 742.

Bewley, T. (1979), The Direct Estimation of the Equilibrium Response in a Linear Dynamic Model, Economics Letters, 357 – 361.

Blanchard, O. (1995), Macroeconomic Implications of Shifts in the Relative Demand for Skills, Economic Policy Review of the Federal Reserve Bank of New York 1, 48 - 60.

Blanchard, O. (1997), The Medium Run, Brookings Papers on Economic Activity, 89 - 158.

Blanchard, O. (1998), Revisiting European Unemployment: Unemployment, Capital Accumulation and Factor Prices, NBER Working Paper 6566.

Blanchard, O. (1999), European Unemployment: The Role of Shocks and Institutions, mimeo.

Blanchard, O. and J. Wolfers (1999), The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence, mimeo.

Caballero, R. and M. Hammour (1997), Jobless Growth: Appropriability, Factor Substitution, and Unemployment, NBER Working Paper 6221.

Caballero, R. and M. Hammour (1998), The Macroeconomics of Specificity, Journal of Political Economy 106, 724 - 767.

Di Tella, R. and R. MacCulloch (1998), The Consequences of Labour Market Flexibility: Panel Evidence Based on Survey Data, mimeo.

Enders, W. (1995), Applied Econometric Time Series, New York.

Engle, R. and C. Granger (1987), Cointegration and Error-Correction: Representation, Estimation, and Testing, Econometrica 55, 251 – 276.

Fehn, R. (1997), Der strukturell bedingte Anstieg der Arbeitslosigkeit in Europa: Ursachen und Lösungsansätze, Baden-Baden.

Giannini, C. (1992), Topics in Structural VAR Econometrics, Berlin.

Hellwig, M and M.J. Neumann (1987), Economic Policy in Germany: Was there a Turnaround?, Economic Policy 2, 103 – 145.

Jackman, R. (1995), Unemployment and Wage Inequality in OECD Countries, Centre for Economic Performance, Discussion Paper 235, LSE, London.

Johnston, J. and J. DiNardo (1997), Econometric Methods, New York.

Koop, G., M. Pesaran and S. Potter (1996), Impulse Response Analysis in Nonlinear Multivariate Models, Journal of Econometrics 74, 119 - 147.

Kremers, J., N. Ericsson and J. Dolado (1992), The Power of Cointegration Tests, Oxford Bulletin of Economics and Statistics 54, 325 – 348.

Krugman, P. (1994), Past and Prospective Causes of High Unemployment, in: Federal Reserve Bank of Kansas City (ed.), Reducing Unemployment: Current Issues and Policy Options, Jackson Hole, Wyoming, 49 - 80.

Krusell, P. et al. (1997), Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis, Staff Report 239, Research Department, Federal Reserve Bank of Minneapolis.

Lehment, H. (1999), Zur Bestimmung des beschäftigungsneutralen Lohnerhöhungsspielraumes, Die Weltwirtschaft 1, 79 - 89.

Lütkepohl, H. (1993), Introduction to Multiple Time Series Analysis, Berlin.

Modigliani, F. u. a. (1998), An Economists' Manifesto on Unemployment, Quarterly Review, Banca Nazionale del Lavoro 51 (206), 327 - 361.

Nickell, S. and B. Bell (1995), The Collapse in Demand for the Unskilled and Unemployment Across OECD Countries, Oxford Review of Economic Policy 11, 40 - 62.

OECD (1998), Economic Outlook 63, Paris.

Pesaran, M. and Y. Shin (1998), Generalized Impulse Response Analysis in Linear Multivariate Models, Economics Letters 58, 17 - 29.

Rowthorn, R. (1996), Unemployment, Wage Bargaining and Capital-Labour Substitution, ESRC Centre for Business Research Working Paper 38, University of Cambridge.

Rowthorn, R. (1999), Unemployment, Capital-Labor Substitution, and Economic Growth, IMF Working Paper WP/99/43, Washington D.C.

Siebert, H. (1997), Labor Market Rigidities - At the Root of Unemployment in Europe, Journal of Economic Perspectives 11, 37 - 54.

Sims, C. (1980), Macroeconomics and Reality, Econometrica 48, 1 – 48.

Wickens, M and T. Breusch (1988), Dynamic Specification, the Long-Run and the Estimation of Transformed Regression Models, Economic Journal 98, 189 – 205.

The Minda de Gunzburg Center for European Studies

The Minda de Gunzburg Center for European Studies is an interdisciplinary program organized within the Harvard Faculty of Arts and Sciences and designed to promote the study of Europe. The Center's governing committees represent the major social science departments at Harvard and the Massachusetts Institute of Technology.

Since its establishment in 1969, the Center has tried to orient students towards questions that have been neglected both about past developments in eighteenth- and nineteenth-century European societies and about the present. The Center's approach is comparative and interdisciplinary, with a strong emphasis on the historical and cultural sources which shape a country's political and economic policies and social structures. Major interests of Center members include elements common to industrial societies: the role of the state in the political economy of each country, political behavior, social movements, parties and elections, trade unions, intellectuals, labor markets and the crisis of industrialization, science policy, and the interconnections between a country's culture and politics.

For a complete list of Center publications (CES Working Paper Series, Program for the Study of Germany and Europe Working Paper Series, Program on Central and Eastern Europe Working Paper Series), please contact the Working Papers Series, CES, 27 Kirkland St, Cambridge MA 02138, (E-mail jabrown@fas.harvard.edu). Additional copies can be purchased for $5 (plus postage for overseas orders).
A monthly calendar of events at the Center is also available on the World Wide Web at http://www.fas.harvard.edu/~ces.