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I. Introduction

Mass unemployment is the number one item of economic policy in most continental European countries. There is nonetheless a considerable lack of success stories in the fight against unemployment. This can hardly be attributed to widespread disagreement concerning the principal causes of the unfortunate situation on European labor markets. Rather, most economists argue that unemployment is predominantly of the structural type. Hence, with given imperfections on goods and capital markets the functioning of the labor market has to be improved for achieving lasting employment gains. In particular, real wages as well as wage structures have to become more flexible and the mobility of the labor force has to increase. However, this is much easier said than done. As the literature dealing with the positive economics of rigid labor markets has pointed out, labor markets are not rigid by accident but rather because rigid labor markets serve the interests of employed insiders, which still constitute the majority of society. They therefore also increase the reelection probability of incumbent governments. In other words, tough labor-market reforms are rarely observed due to political difficulties in implementing them.[1]

The growing awareness of the political infeasibility of far-reaching labor-market reforms gives rise to renewed interest in indirect channels for reducing unemployment. Expansionary demand policies have long been the instrument of choice for policymakers as they are relatively easy to implement and because they often lead to quick, albeit only temporary employment gains. However, it is almost common knowledge by now that merely injecting additional goods demand into the economy cannot produce lasting employment growth. Rather, expansionary demand policies left by themselves usually trigger a wage-price spiral, thus causing a permanently higher inflation rate. This option is therefore largely forestalled by now.

Hence, other indirect channels through which the situation on the labor market is influenced must be identified. Especially the relation between capital market imperfections and structural unemployment has not been investigated thoroughly yet. This is the case despite of frequent but mostly informal claims about the lack of venture capital in Europe, and despite mounting empirical evidence that the financial structure of firms along with financial constraints affect real decisions of firms contrary to the neutrality theorem of Modigliani and Miller (1958).[2] As one of their central assumptions, namely perfect information of borrowers and lenders, is in

[1] See Krugman (1994), Lindbeck (1996), Saint-Paul (1996), and Berthold and Fehn (1996).
[2] See e.g. Fazzari, Hubbard, and Petersen (1988), Devereux and Schiantarelli (1990), and Hubbard (1997).

conflict with reality this should not be surprising. Information is typically distributed asymmetrically on capital markets: borrowers (firms) are better informed about their characteristics and actions than lenders (banks). This gives rise to adverse selection and moral hazard problems, which can cause credit and equity rationing of firms, thus reducing investment, innovations, entry of new firms, and in the end employment.

However, it could be argued that the recent trend of more deregulated and globalized capital markets should have reduced rather than magnified distortions on capital markets, so that capital market imperfections can hardly account for rising structural unemployment in Europe. This is only part of the story, though. Rigid real wages, inflexible wage structures, and an immobile labor force reduce the capacity of an economy to adjust to adverse shocks without rising unemployment. Yet, the size with which certain exogenous shocks hit the labor market can be considerably aggravated by malfunctioning capital markets. Hence, the worse capital markets work in certain countries, the greater is the burden of adjustment on the labor market. Capital market imperfections might therefore help labor-market rigidities in explaining the rise of structural unemployment in Europe.

The question is which kind of shocks are in particular magnified in their effects on labor demand by capital market imperfections. Greater volatilities are a key suspect in this respect. There exists sizable evidence that the level of volatilities which firms have to cope with has increased significantly in recent years. This is above all the result of more globalized goods and capital markets, which give rise to the rapid restructuring from manufacturing to the service industry, "footloose" industries, "caleidoscopic" compararative advantages, shorter product life cycles, unstable portfolio choices of foreign investors, and more pronounced fluctuations of stock market prices.[3] The present paper demonstrates that greater volatilities interacting with imperfect capital markets can produce large employment losses even if firms do not act in a risk-averse manner.[4] These employment losses translate into rising structural unemployment if capital and labor-market imperfections are combined. Reducing capital market imperfections can therefore be an important step in fighting unemployment.

[3] See Bhagwati and Dehejia (1994), Bertola and Ichino (1995), Ljungqvist and Sargent (1998), Rodrik (1997), and Calvo and Mendoza (1997). The latter authors show in particular that more globalized capital markets make herd behavior of investors more likely because of fixed information costs concerning the fundementals of countries and firms, and because they widen the band of multiple equilibria due to reputational effects. Gottschalk and Moffitt (1994) provide empirical evidence for the U.S. that not only the dispersion of earnings between individuals but also the volatility of an individual's earnings has increased since the early 1980s.

[4] For the case of risk-averse firms see Greenwald and Stiglitz (1993); their results depend on the rather special assumption that bankruptcy costs increase with firm size. In addition, they did not endogenize wage setting.

To this end the paper is organized as follows. Section II derives how labor demand is affected by rising volatilities under imperfect capital markets. Section III incorporates labor-market imperfections and discusses the interaction between wage setting and rising volatilities. Section IV analyzes whether a better-functioning market for venture capital can help to absorb rising volatilities without increasing unemployment. Section V concludes.

II. Rising Volatilities and Labor Demand with Imperfect Capital Markets

Bertola and Ichino (1995) have shown that rising volatilities can exert large negative employment effects in countries characterized by high firing costs and centralized wage setting. However, this result holds only if the rise in volatility occurs in a certain range and if central wage setters do not react with sufficient wage moderation. Capital market imperfections are not only an alternative to high firing costs for explaining the negative effects of rising volatilities on employment, but they also help to understand how the employment effects of rising volatilities relate to the degree of centralization of wage bargaining. There is a large body of literature pointing out on the microeconomic level why firms face financing contraints under asymmetric information on capital markets. Empirical evidence on the macrolevel shows in addition that equity and credit rationing are not only microeconomic phenomena but that they also help to explain aggregate time series. An example in kind is the prominent role of cash flows in explaining aggregate investment which fits nicely with the notion of financially constrained firms.[5]

The purpose of this section is to present a model which combines capital market imperfections due to costly financial intermediation with the effects of rising volatilities on production and employment in an economy where credit is an input.[6] Capital markets are assumed to be imperfect because of information and enforcement problems. Firms are not only subject to random productivity shocks but they also do not necessarily report their true financial situation to banks when repayment of the loan is due. The temptation for firms to underreport depends crucially on the legal penalties that are associated with such illegal behavior in case it is detected. Furthermore, capture of at least part of the firms' remaining assets by banks in case of

[5] See Fazzari, Hubbard, and Petersen (1988), Nickell and Nicolitsas (1995), and Winker 1996).
[6] See Aizenman and Powell (1997), and Agénor and Aizenman (1997) for similar approaches. These expositions concentrate, though, on the employment effects and welfare losses of rising volatilities in non-OECD countries in Latin America and South East Asia. For an informal survey, see Mishkin (1998).

default is assumed to be costly. Hence, banks have to consider possible state verification and enforcement costs when calculating the interest rates which they charge firms. The greater these costs are, the larger the spread must be between the risky rate of interest for loans to firms and the rate of interest for bank deposits. The provision of collateral can help to reduce this spread and thus to alleviate the above mentioned imperfections. However, the interest rate spread would only be eliminated if loans were completely secured by collaterals and if the capture of collaterals by banks caused no state verification and enforcement costs.

Specifically, the future output *y* of firm *i* is random and shall be determined by

$$y_i = (L_i)^{\alpha}(1+\varepsilon_i); \quad 0<\alpha<1, \quad |\varepsilon_i| \le V < 1, \quad E(\varepsilon) = 0, \tag{1}$$

where L_i denotes the level of the variable input labor which is used by the firm, ε_i is the realized productivity shock, and *E* is the expectation operator.[7] Productivity shocks are allowed to vary between -*V* and +*V* with greater absolute values of *V* describing a greater level of volatilities. It is assumed that firms have to pay variable inputs and in particular their labor force before the revenues of the goods produced are obtained. Due to moral hazard and adverse selection problems this financing problem cannot be solved by issuing equity. It is for simplicity also assumed that a market for venture capital does not exist.[8] Rather, firms, which are assumed to be risk neutral have to turn to banks for receiving loans. The risky interest rate on loans to firms is r_i, while the relative price of labor, i.e. the real wage, is *w*. Hence, the size of the loan is $(1+r_i)L_i w$. Producer i provides the bank with a collateral of C_i, which accrues to the bank in case of default. The bank receives in addition the fraction μ of the value of the firm in case of default, which equals physical output because the output price is for simplicity set equal to one. Firm *i* defaults if the contractual claim of the bank exceeds the bankruptcy payments to the bank, i.e., if

$$\mu(L_i)^{\alpha}(1+\varepsilon_i) + C_i \le (1+r_i)L_i w. \tag{2}$$

Let ε_i^* be the highest productivity shock still leading to default, so that equation (2) becomes

$$\mu(L_i)^{\alpha}(1+\varepsilon_i^*) + C_i = (1+r_i)L_i w. \tag{3}$$

Firm *i* goes bankrupt for $\varepsilon_i \le \varepsilon_i^*$. The bank receives in this case a net income NI_B of the fraction μ of the actual output plus the collateral minus the state verification and enforcement costs K_i:

[7] To focus on the relationship between imperfect capital market and labor demand, it is for simplicity assumed that labor is the only variable input. This assumption is innocuous because changes in the relative price between labor and capital and their long-run effects on the labor intensity of production are not part of the analysis.
[8] Relaxing this assumption later on will be a crucial step in the argument.

$$NI_B = \mu(L_i)^{\alpha}(1+\varepsilon_i) + C_i - K_i\,. \tag{4}$$

Banks shall have unlimited access to funds at the market interest rate $\bar{r}$. As banks are not only assumed to be risk neutral but also competitive, the interest rate for risky loans to firms is determined by the following zero-profit condition:

$$(1+\bar{r})L_i w = \int_{\varepsilon_i^*}^{+V}[(1+r_i)L_i w]f(\varepsilon)\,d\varepsilon \;+\; \int_{-V}^{\varepsilon_i^*}[\mu(L_i)^{\alpha}(1+\varepsilon_i) + C_i - K_i]f(\varepsilon)\,d\varepsilon\,, \tag{5}$$

with *f(ε)* being the density function. The LHS of (5) is the cost of financing the loan for the bank, while the RHS is the expected repayment of the firm to the bank. The first term denotes the expected repayment for the viability case while the second term reflects the expected repayment in case of bankruptcy. With the aid of equations (3) and (5) the equilibrium interest rate spread $r_i - \bar{r}$ can be calculated. Solving (3) for C_i and inserting the result in (5) yields:

$$(1+\bar{r})L_i w = \int_{\varepsilon_i^*}^{+V}[(1+r_i)L_i w]f(\varepsilon)\,d\varepsilon \;+\; \int_{-V}^{\varepsilon_i^*}[\mu(L_i)^{\alpha}(1+\varepsilon)]f(\varepsilon)\,d\varepsilon \;+$$

$$\int_{-V}^{\varepsilon_i^*}[(1+r_i)L_i w - \mu(L_i)^{\alpha}(1+\varepsilon_i^*)]f(\varepsilon)\,d\varepsilon \;-\; \int_{-V}^{\varepsilon_i^*}K_i f(\varepsilon)\,d\varepsilon$$

$$= \int_{-V}^{\varepsilon_i^*}\mu(L_i)^{\alpha}(\varepsilon-\varepsilon_i^*)f(\varepsilon)\,d\varepsilon \;-\; \int_{-V}^{\varepsilon_i^*}K_i f(\varepsilon)\,d\varepsilon \;+\; (1+r_i)L_i w\left[\int_{-V}^{\varepsilon_i^*}f(\varepsilon)\,d\varepsilon \;+\; \int_{\varepsilon_i^*}^{+V}f(\varepsilon)\,d\varepsilon\right]. \tag{6}$$

As the last term in brackets is by definition of the density function equal to one, equation (6) can be solved for the equilibrium interest rate spread:

$$r_i - \bar{r} = \frac{1}{L_i w}\left[\mu(L_i)^{\alpha}\int_{-V}^{\varepsilon_i^*}(\varepsilon_i^* - \varepsilon)f(\varepsilon)\,d\varepsilon \;+\; K_i\int_{-V}^{\varepsilon_i^*}f(\varepsilon)\,d\varepsilon\right]. \tag{7}$$

Hence, the risky interest rate, which firms are charged, follows a mark-up rule on banks' cost of funds. The first term on the RHS of (7) is the expected revenue lost in case of default, while the second term reflects the expected state verification and enforcement costs. The sum of the two terms is normalized by the size of the loan. Firms can reduce the spread by providing higher collaterals, so that the ε_i^* arising from equation (3) is smaller and default occurs less frequently.

The expeced net income of the firm NI_F consists of expected revenues minus expected costs in good and bad states of nature:

$$NI_F = (L_i)^{\alpha} - \int_{\varepsilon_i^*}^{+V} [(1+r_i)L_i w] f(\varepsilon)\, d\varepsilon - \int_{-V}^{\varepsilon_i^*} [\mu (L_i)^{\alpha}(1+\varepsilon) + C_i] f(\varepsilon)\, d\varepsilon . \quad (8)$$

With the aid of equation (5), equation (8) can be simplified to

$$NI_F = (L_i)^{\alpha} - (1+\bar{r})L_i w - K_i \int_{-V}^{\varepsilon_i^*} f(\varepsilon)\, d\varepsilon . \quad (9)$$

In principle, the firm determines the optimal level of employment by maximizing (9) with respect to L_i. To keep the closed-form solution tractable, it is assumed that shocks follow specifically a uniform distribution, so that all possible values of ε are equally likely. With the aid of this assumption a simple explicit solution of (7) can be obtained. The density function is in this case $f(\varepsilon) = \frac{1}{2V}$, and the probability of default, i.e. that $\varepsilon_i \leq \varepsilon_i^*$, is $\Phi_i = \frac{V + \varepsilon_i^*}{2V}$. The second term in brackets on the RHS of (7) is therefore simply equal to $K_i \Phi_i$. The solution to the first term on the RHS of (7) is obtained as follows:

$$\int_{-V}^{\varepsilon_i^*} (\varepsilon_i^* - \varepsilon) \frac{1}{2V} d\varepsilon = \left[\frac{\varepsilon \varepsilon_i^*}{2V} \right]_{-V}^{\varepsilon_i^*} - \left[\frac{\varepsilon^2}{4V} \right]_{-V}^{\varepsilon_i^*} = \frac{(\varepsilon_i^*)^2}{4V} + \frac{\varepsilon_i^*}{2} + \frac{V}{4} = \left(\frac{V + \varepsilon_i^*}{2V} \right)^2 V = (\Phi_i)^2 V . \quad (10)$$

Hence, for a uniform distribution of ε, the equilibrium interest rate spread is simply equal to

$$r_i = \frac{1}{L_i w} \left[\mu (L_i)^{\alpha} (\Phi_i)^2 V + K_i \Phi_i \right] + \bar{r} . \quad (11)$$

Equation (11) allows to determine the partial effects of changes in parameters on the risky rate of interest which firms are charged:

$$r_i = r\left(\overset{+}{K_i}, \overset{-}{C_i}, \overset{-}{\mu}, \overset{+}{V} \right). \quad (12)$$

The economic intuition behind the partial derivatives is straightforward.[9] Greater state verification and enforcement costs reduce the expected net revenue of banks, thus forcing them to charge firms a higher risky rate of interest in order to break even on the basis of expectations. If firms are able to provide banks with more collateral, the risk for banks of making losses in case a firm defaults is reduced. Furthermore, if only a smaller fraction of the actual value of defaulting firms accrues to banks, the risky rate of interest again rises in order to compensate banks for the smaller revenues in case of default by higher revenues in good states of nature.

Finally, a greater volatility of shocks induces banks to charge firms a higher risky rate of interest because a greater portion of the total probability mass falls into the default region. Hence,

[9] The explicit derivations of the results are provided in the appendix.

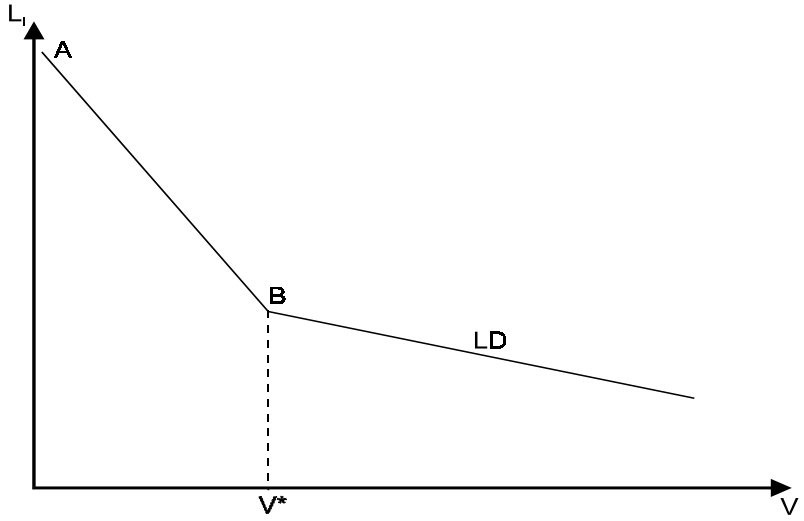
default and the ensuing losses of banks with loans which are not fully secured become more likely. This is obviously not compensated by the fact that a greater volatility of shocks also increases the probability of very high profits for firms because payments by firms to banks never exceed principal plus interest.[10] Greater state verification and enforcement costs worsen the effect of higher volatilities on the equilibrium risky rate of interest, whereas more collateral reduces the effect of higher volatilities on the equilibrium risky rate of interest, i.e. $\frac{\partial^2 r_i}{\partial V \partial K_i} > 0$ and $\frac{\partial^2 r_i}{\partial V \partial C_i} < 0$. Hence, young and still small firms, where state verification costs are high and which usually have little collateral, are particularly affected by rising volatilities.[11]

It is now possible to analyze the effects of rising volatilities on labor demand *LD* under the assumption of imperfect capital markets. As a greater volatility of shocks causes the risky rate of interest which firms are charged by banks to rise, labor demand of firms is in turn reduced. The ensuing higher marginal productivity of employed labor is needed to compensate firms for their higher obligations concerning interest rate payments and for their higher default risk. However, the size of the negative effect of rising volatilities on labor demand of firms is not uniform (Figure 1).

[10] Note that the interest rate/volatility curve is in general backward bending because higher interest rates as such cause a higher risk of default. Any given level of volatility is therefore associated with two possible interest rates. It is assumed throughout the paper that competitive banks choose the efficient lower interest rate where default occurs less frequently.

[11] For an elaborate treatment of the relationship between unemployment and the financial constraints faced by small firms see Jefferson (1997).

Figure 1: The Effects of Rising Volatilities on Labor Demand



Source: Aizenman and Powell (1997, Figure 4).

As long as volatility does not exceed a certain threshold V^*, firms maximize expected profits by keeping the probability of default at zero for a given set of parameter values in order to avoid costly defaults. Evidently, V^* depends positively on the banks' legal position as measured by μ and on the size of the collateral relative to the loan, whereas a rising importance of the variable input labor in the production function α lowers V^*. If volatility increases from *0* to V^*, labor demand and production is therefore rapidly reduced by firms which is the only way for firms to keep the probability of default at zero. Hence, when moving from point A to point B, labor demand is sufficiently cut to exactly offset the positive effect on the probability of default induced by the higher level of volatilities by an increasing marginal productivity of labor. As default therefore never occurs in this region of still relatively low volatilities, $\Phi_i = 0$ and the condition $(L_i)^{\alpha}(1-V) = (1+r_0)L_i w$ is always satisfied, since expected net income of firms must not be smaller than zero even in the worst state of nature.[12] Thus, labor demand is in this region simply determined by

$$L_i = \left[\frac{1-V}{w(1+\bar{r})}\right]^{\frac{1}{1-\alpha}}. \tag{13}$$

The negative effect of rising volatilities on labor demand is in this region given by

$$\frac{\partial L_i}{\partial V} = -\frac{1}{1-\alpha}\cdot\frac{1}{w(1+\bar{r})}\left[\frac{1-V}{w(1+\bar{r})}\right]^{\frac{\alpha}{1-\alpha}} < 0. \tag{14}$$

[12] Recall that expected net income of the firm is given by (7) with the last term on the RHS being $K_i\Phi_i$.

There is a "voluntary" credit squeeze because firms cut employment to prevent costly defaults. If V exceeds the threshold level V^*, it is no longer profitable for firms to cut employment sufficiently as a reaction to further rises in V for keeping the probability of default at zero. Further increases in volatilities let the benefits of default outweigh the costs of state verification. The arising default option mitigates the rise in costs to firms induced by the additional growth of volatilities because the marginal debt only has to be serviced in good states of nature. The potential losses incurred by firms in case volatilities take even greater values than V^* are limited to losing the collateral and the fraction μ of the remaining value of the firm in bad states of nature. To the right of point B employment is therefore reduced at a lower rate than along AB.

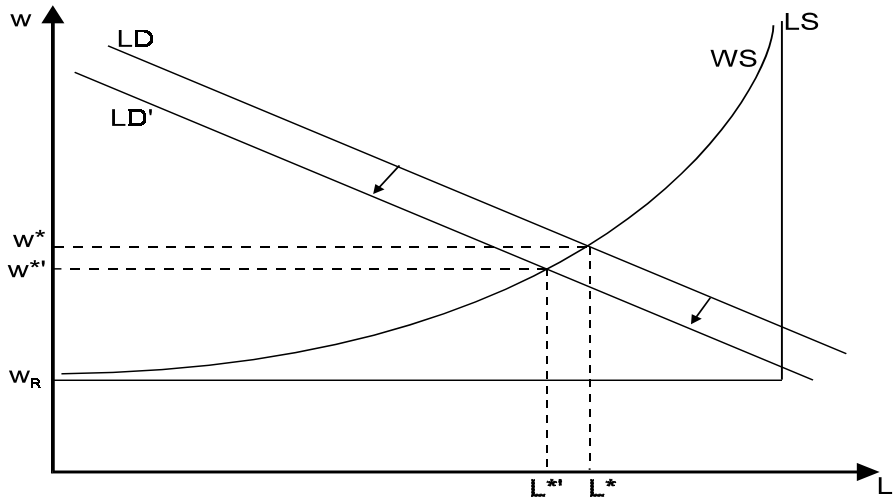
In sum, labor demand is negatively affected by rising volatilities if capital markets are imperfect. This negative effect is particularly pronounced if the costs of state verification and enforcement are high (large K), if firms can only provide a small level of collateral (low C), and if the legal position of banks is weak (small μ). The question which shall be addressed next is whether increasing volatilities can therefore contribute to explaining rising structural unemployment in Europe.

III. Labor-Market Imperfections

It has been shown that rising volatilities reduce labor demand for any given real wage. Yet, as labor demand depends of course negatively on the real wage, as is immediately clear upon closer inspection of equation (13), such a shift in the labor-demand schedule *LD* in the real wage/employment plane to the south-west only leads to higher unemployment if real wages are not perfectly flexible (figure 2). Real-wage rigidities are usually justified by efficiency-wage considerations, union models, and insider-outsider problems (Fehn 1997). The latter two are closely related and they fit especially well with the institutional framework on European labor markets with strong unions, high firing costs, and generous transfer payments to the unemployed. An upward sloped wage-setting curve *WS* can therefore be introduced into the standard model of the labor market to account for these labor-market imperfections. The positive slope of the wage-setting curve can e.g. be justified intuitively by the fact that the bargaining strength of insiders/unions rises with higher employment. The difference between total labor supply *LS*, which is for simplicity assumed to have the stylized form given in figure 2, and the level of employment in the point of intersection between the labor-demand sche-

dule and the wage-setting curve reflects the quasi-equilibrium or structural level of unemployment. The extent to which higher volatilities increase unemployment depends on two factors: First, how much do higher volatilities shift the labor-demand schedule to the southwest due to capital-market imperfections? Second, how rigid are real wages as reflected in a flat wage-setting curve and in possible shifts of the wage-setting curve in reaction to higher volatilities? The issue of real-wage rigidity is addressed next, while the shift of the labor-demand schedule is discussed in section four.

Figure 2: The Employment Effects of Rising Volatilities in the Aggregate Labor Market



Real wages are rigid if unemployment exerts only a small downward effect on equilibrium real wages. Real wage flexibility has been an issue in Europe at least since the late 1980s when persistent unemployment became the number one topic of economic policy in Europe. Empirical estimates as to how rigid real wages are in Europe differ considerably. A promising novel avenue for estimating real-wage rigidities based on a structural VAR approach has recently been proposed by Viñals and Jimeno (1996). The model is composed of a labor demand and a real wage equation according to which real wages depend on current and lagged unemployment. The advantage of this method lies in the fact that not only the effects on current unemployment are taken into account but rather the whole adjustment path to wage-push shocks. The measure for real wage rigidity is then a combination of the initial response of unemployment to a transitory wage-push shock and the mean lag reflecting the adjustment path to such a shock. Hence, in this SVAR framework the impulse response functions of unemployment to wage-push shocks serve as a useful device for computing an index of real wage rigidities.[13]

[13] For more details, see the appendix in Berthold, Fehn, and Thode (1998).

The results of using this approach for the 1970 to 1995 period are found in columns one and two in table 1. While unit root tests for the real wage indicate integration of order 1 and thus secure the suitability of the pursued Blanchard-Quah method, the results for the rate of unemployment are mixed. The fact that the SVAR results in Table 1 are comparable only within each column and not between them renders the interpretation to be difficult. Taking into account, however, that the unemployment rate is bounded from the lower by zero and from the upper by unity, it seems unplausible that, in the long run, the mean and/or the variance of the series can grow beyond all limits, as it would be the case for an integrated process. In view of this ambiguity the exercise has been carried out for both cases. The first case, where real wages react more to the level of current unemployment than to the level of lagged unemployment and where unemployment is therefore treated as a non-integrated variable, is found in column one. The hysteresis case with real wages essentially only reacting to changes in unemployment is given in column two. In the first case, unemployment is viewed as stationary and a bivariate VAR consisting of the growth rate of real wages and the level of unemployment is estimated. In the second case, unemployment is assumed to be integrated of order one and therefore follows a random walk. Thus, a bivariate VAR composed of the growth rate of real wages and changes in unemployment is estimated. Taking a closer look at the results, it is interesting to note that in the standard case the U.S. and Sweden have as expected the greatest degree of real wage flexibility, whereas they are outperformed by Germany and a group of smaller countries consisting of Belgium, Denmark and Finland in the hysteresis case. However, most European countries exhibit in both cases a higher degree of real wage rigidity than the U.S. Yet, the more rigid real wages are, the greater is the increase in unemployment caused by negative shifts of labor demand due to rising volatilities.

Table 1: An International Comparison of Real Wage Rigidities

	SVAR (Δ(w-p),u)	SVAR (Δ(w-p),Δu)
	Real Wage Rigidity	Real Wage Rigidity
Austria	2.518	0.997
Belgium	2.486	0.606
Denmark	1.708	0.626
Finland	1.253	0.116
France	2.055	1.433
Germany	1.730	0.812
Greece	1.902	1.399
Ireland	2.334	1.142
Italy	2.641	1.205
Netherlands	1.581	1.129
Portugal	1.302	0.959
Spain	2.414	1.294
Sweden	1.001	0.865
UK	1.594	0.981
USA	1.208	0.920
Japan	1.960	1.796

Source: Berthold, Fehn, and Thode (1998).

Doubts about the ability of European labor markets to absorb rising volatilities without increasing unemployment are reinforced by taking in addition into account whether centralized or decentralized wage-bargaining systems are more likely to react with wage moderation to a greater volatility of firm-specific shocks. It is a stylized fact that continental EU-countries are characterized by more centralized wage-bargaining systems than the U.S. Wage-bargaining on the industry or sectoral level is still common in Europe, while firm level and individual bargaining dominate in the U.S. This assessment is roughly valid although situations of severe economic distress forced certain European countries to decentralize wage bargaining slightly in recent years, such as e.g. in Sweden, Finland, the UK, and in the eastern part of Germany.

A greater volatility of firm-specific shocks is likely to shift the wage-setting curve to the south-east under decentralized bargaining. Wage setting is in this case not only moderated by the general reduction in labor demand, but the bargaining process itself is also directly affected. To show this, it is assumed that the right-to-manage model applies, i.e., that wages are negotiated on the firm-level and that firms determine unilaterally the level of employment given the wage outcome. Hence, the wage resulting from the Nash-bargaining process maxi-

mizes the weighted sum of the logs of the rewards to the firm-level union and to the firm, namely

$$\max_{w_i} \; \beta \log [S_i(w_i - A)] \; + \; \log [NI_F]. \tag{15}$$

β is the bargaining power of the union relative to the firm, S_i is the survival probability of the representative worker in the firm, which depends negatively on the wage, and A is the expected alternative income if laid off by the firm, which hinges primarily on the level of unemployment benefits and, importantly, on the aggregate unemployment rate.[14] Hence, the term $S_i(w_i - A)$ measures the expected rent to the representative union member which is achieved by the union in the bargaining process. The firm simply gets its expected net income if a solution is reached in the bargaining process. The solution to this maximization problem is a mark-up of the wage over outside opportunities

$$\frac{w_i - A}{w_i} = \left(\eta_{Sw} + \frac{L_i \, w_i}{\beta \, NI_F} \right)^{-1}, \tag{16}$$

with $\eta_{Sw} = -\frac{\partial S_i}{\partial w_i} \frac{w_i}{S_i}$ being the absolute elasticity of survival of the respresentative union member in the firm with respect to the wage. A greater volatility of firm-specific shocks dampens the size of the mark-up of wages over outside opportunities via two channels. First, as firms face a greater threat of bankruptcy they react with larger cuts in employment to rises in wages. The resulting greater value of η_{Sw} leads to a lower wage settlement. Second, a greater volatility of firm-specific shocks causes greater fluctuations in the incumbent work force in the firm. Thus, the heterogeneity of the work force rises which reduces the relative bargaining power β of the firm-level union. The build-up of insider power by firm-level unions depends crucially on the existence of a relatively stable core work force in the firm to which the threat of being laid-off is only very remote. However, as a greater level of firm-specific shocks reduces the scope for establishing such a core work force, the bargaining power of firm-level unions shrinks and, consequently, negotiated wages fall.

The more centralized wage setting takes place, the less will wages be moderated by a greater volatility of firm-specific shocks via these two wage-reducing effects. Centralized unions are primarily moderated in their wage demands by a higher aggregate unemployment rate, which is the effect on equilibrium real wages given by point of intersection between the old wage-setting curve and the new labor-demand schedule which has shifted to the south-west. A lo-

[14] See Layard, Nickell, and Jackman (1994, 38-39).

wer profitability of firms in the aggregate might also shift the wage-setting curve of centralized unions in case they are concerned about the resulting lower rate of capital investments and future lay-offs. However, a greater volatility of firm-specific shocks essentially leaves the aggregate profitability of firms unaffected if negative and positive shocks cancel out on the aggregate level. The centralized union does not worry about the fact that such greater volatilities of firm-specific shocks increase the probability of default for any particular firm. It is furthermore unlikely that centralized unions are as well informed about such an increase in the volatility of firm-specific shocks as firm-level unions, making again wage moderation of centralized unions less probable. In sum, centralized wage bargaining systems reduce the ability of an economy to absorb a greater volatility of firm-specific shocks without rising unemployment.

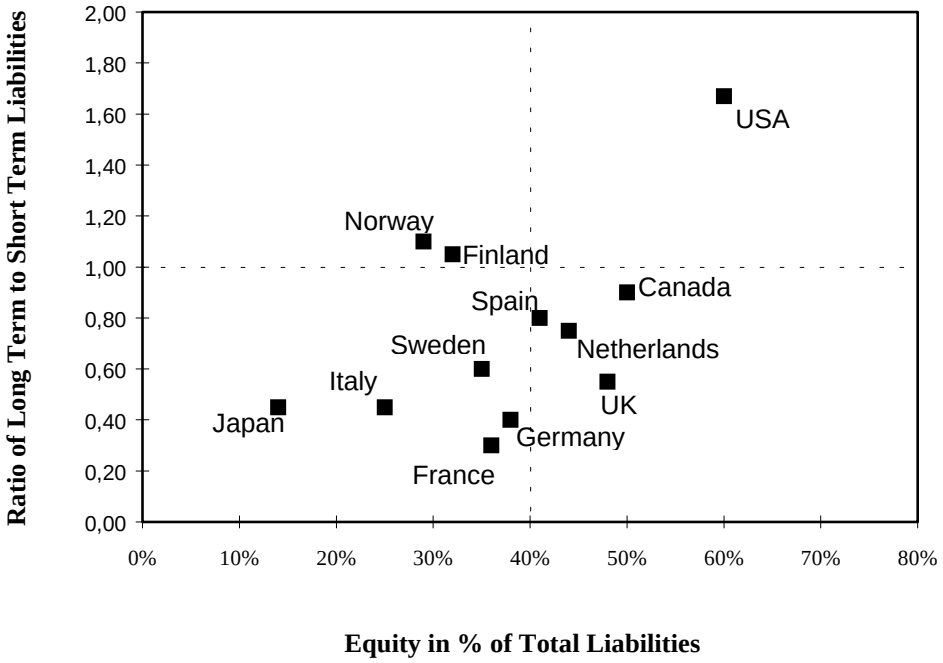
IV. Can Venture Capital Mitigate the Negative Employment Effects?

It has been shown so far that greater volatilities reduce labor demand if capital markets are imperfect and if firms have to rely mostly on credits for financing their activities. However, closer inspection of the degree of real wage rigidity sheds some doubt on the conjecture that the better employment performance of the U.S. can simply be explained by the combination of about the same negative shift in labor demand in Europe and the U.S. and more flexible real wages in the U.S., although more decentralized wage bargaining in the U.S. helps in absorbing rising volatilities. Yet, the by far worse unemployment record of a country such as Germany in the last two decades suggests that additional factors must have been at work. One possibility is that rising volatilities have had a greater adverse effect on labor demand in Europe than in the U.S. The size of the reduction in labor demand depends decisively on the functioning of capital markets. Those countries, which are equipped with well-functioning capital markets, are much better able to absorb such an adverse shock than countries where capital markets are malfunctioning not least because the former allow all agents to diversify risk efficiently. A first indicator of a well-functioning capital market is a high capitalization of the stock market relative to GDP. This value was in 1994 merely 28.3% in Germany, whereas the capitalization of the U.S. stock market amounted to 81.8% of GDP. Closely related to this phenomenon is the larger willingness of households in the U.S. to hold stocks. Comparing again the U.S. and Germany reveals that in 1994 only 6% of German households held stocks while the corresponding value was more than 20% in the U.S.[15] Hence, the U.S. market for

[15] See Gerke (1996), and Wenger (1996).

risk-bearing capital appears to be much further developed. This first impression is reinforced by the financial structure of non-financial firms in the U.S. and in Europe. Figure 3 shows that non-financial firms have a much better equity position and a considerably higher ratio of long-term to short-term debt in the U.S. compared to Europe in general and compared to Germany in particular, thus increasing their ability to absorb the negative effects of higher volatilities on labor demand.

Figure 3: An International Comparison of Balance-Sheet Structures of Non-Financial Firms (1985-1990)



Source: OECD (1995, 40).

However, it is a particularly important property of well-functioning capital markets that they give easy access to risk-bearing capital to small, young, and not yet listed firms. These firms are otherwise highly dependent on credit financing because their cash flows are as a rule, in contrast to large and established firms, insufficient for financing major projects. The main avenue for acquiring risk-bearing capital for young and small firms is the venture-capital market (OECD 1996a, 5). The provision of venture capital does in contrast to ordinary bank lending not entitle to fixed claims. Rather, providers of venture capital fully share the risk of making losses but they also participate without an upper limit in case large profits occur. They furthermore require in general no or very little collateral. This is crucial for all firms investing heavily in intangible assets, which is again particularly the case in young and still small enterprises. Intangible assets such as human capital can usually not serve as collateral. As intangi-

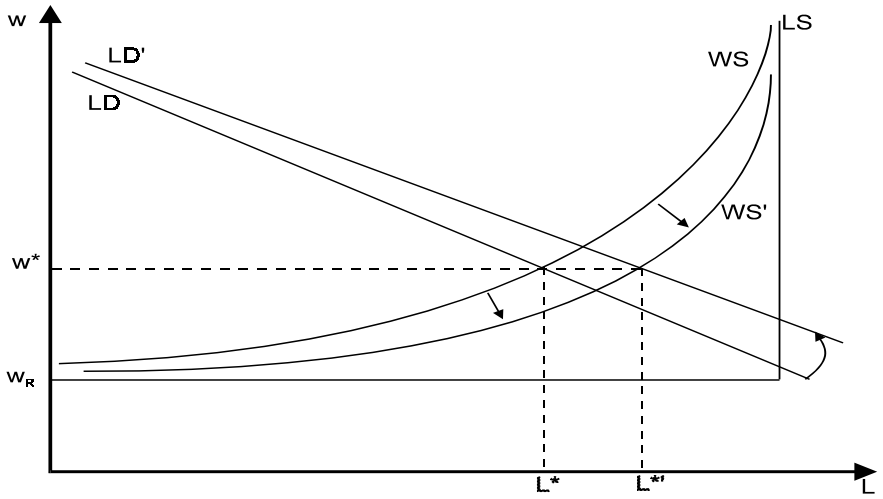
ble assets become more significant throughout the production process, the importance of an efficient venture-capital market relative to an efficient market for bank credits is bound to rise. Providers of venture capital usually not only finance projects but they also advise management and exert closer control over a firm's policy than banks. In addition, the money is generally given to firms successively so that there are several substitute mechanisms for collaterals at work which reduce agency costs and moral-hazard problems and thus also the loss risk of the venture capitalist (Mull 1990, 83). This is important because venture capitalists do as a rule not reap their profits via regular payments during the investment phase but rather only at the very end of a cooperation via an exit, e.g. when a firm goes public or is sold to another firm.

A well-developed market for venture capital reduces the dependency of in particular young and still small firms on credit financing. It not only fosters innovation, structural change, and the creation of new firms, but it can therefore also mitigate the above described negative effects of rising volatilities on labor demand (OECD 1996b, 15). Risk neutral providers of venture capital, such as large institutional investors, are not affected by rising volatilities because the probability of large losses and of large profits rises symmetrically with greater volatilities in stark contrast to the case of credit financing where the lender has only a fixed claim on the borrower. The greater the share of venture capital in a firm's total financing portfolio is, the smaller is the increase in bankruptcy risk induced by a given rise in volatilities and the smaller is therefore also the negative effect on labor demand. The size in the reduction of labor demand caused by rising volatilities in a certain country therefore depends negatively on the functioning of the market for venture capital. A well-developed market for venture capital is able to at least partially absorb rising volatilities and to thus shield the labor market. It can furthermore harness wage setting so that an additional positive effect on employment from the wage-setting side is effectuated. The wage-setting power of insiders depends on the existence of monopoly rents of firms which they can share and which reduce the elasticity of labor demand. It furthermore depends on there being little turnover on the labor market so that a stable core work force with largely homogeneous interests exists. Both conditions are undermined by a well-functioning market for venture capital which facilitates the entry, growth, and exit of new firms. Labor demand not only grows and becomes more elastic as a result, but wage setting therefore becomes less aggressive as well.[16] The resulting aggregate positive employ-

[16] The demand curve for labor becomes in general more elastic if impediments to the supply of capital or to the supply of other factors of production are removed. This result is a manifestation of Marshall's third law of derived demand - the elasticity of demand for labor declines if the supply of capital to firms becomes more inelastic, see Krueger and Pischke (1997).

ment effects of institutional reforms to foster the development of the venture-capital market are summarized in figure 4, which is drawn under the assumption that the opposing effects of a better-functioning market for venture capital via labor demand and wage setting with respect to the real wage just cancel out.

Figure 4: The Positive Aggregate Employment Effects of Venture Capital



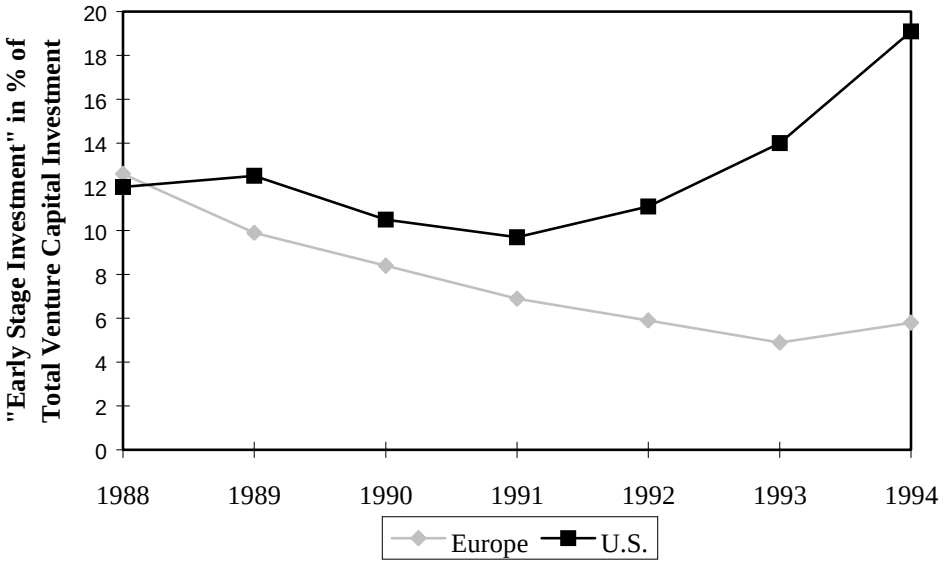
The venture capital market is obviously underdeveloped in Germany in comparison not only to the U.S., but also to the other recently more successful countries with respect to the employment situation like the UK. The total volume of venture capital in 1994 amounted to 55.86% of GDP in the U.S., 2.3% in the UK, and 0.27% in Germany. However, this exceedingly large difference to the U.S. is not only due to the greater activity in the formal market for venture capital which is largely funded by institutional investors such as pension funds, insurance companies, and banks, but it is also due to a much more lively informal market for venture capital. The latter one is dominated by so called "business angels" which are often highly successful and wealthy entrepreneurs with extensive managerial skills. Such business angels are especially able to aid young firms in weathering crisis situations not only by providing risk-bearing capital but also by giving managerial advice.[17]

However, apart from the greater volume of the venture capital market, venture capitalists are in the U.S. evidently also less reluctant to enter into highly risky projects. The establishment of a new firm or project is especially risky in the early stages where an idea is born, conceptualized, and possibly just started. The risk of failure is still very large in this phase and banks therefore rarely provide credits which are not fully collateralized. Venture capital financing is

[17] See Kaufmann and Kokalj (1996), Mc Kinsey (1994), OECD (1996b), and Levy (1995).

appropriate in these early stages since such a high level of collateral can usually not be obtained during this phase. Yet, comparing now the U.S. with all of Europe reveals that the U.S. venture capital market has in the 1990s been much better able to finance early stage investments (figure 5). Whereas this share of all venture capital investments has shrunk in Europe between 1988 and 1994 from 12.6% to 5.8% of all venture capital investments, there has been an increase in the U.S. from 12.0% to 19.1%. Furthermore, in contrast to Germany venture capitalists in the U.S. concentrate their activities on financing high technology projects. 77% of all venture capital investments were used in 1992 for such high technology projects in the U.S. while the corresponding value was only 19% in Germany where venture capitalists mainly finance less risky consumer related activities.[18] The U.S. venture capital market, which is anyway much larger than the one in Europe, is evidently much better able to finance highly risky investment projects which are in particular affected by rising volatilities.

Figure 5: The Development of the Availibility of Venture Capital for "Early Stage Investments" in the U.S. and Europe[19]



Source: OECD (1996b, 21).

The vitality of the U.S. market for venture capital in the 1980s and 1990s, where the formal market for venture capital alone grew by 800% from 1980 to 1990, is inextricably connected to institutional reforms. First, providing venture capital is only attractive if there are convenient exit options available. Going public is the by far most important exit route in the U.S., and

[18] In fact, the number of high-tech start-ups has significantly declined in Germany in the first half of the 1990s, see Franz (1998, 40).
[19] The numbers for Europe are for those 16 European OECD countries which are organized in the European Venture Capital Association; for more details see OECD (1996b, 21-22).

it depends crucially on a functioning market for initial public offerings (IPOs) of young and innovative firms. The "National Association of Securities Dealers Automated Quotation System" (NASDAQ), which was founded in 1971 in the U.S., is such a national second stock market. The importance, which NASDAQ has gained by now in the U.S., is shown by the fact that the total number of listed firms amounted to 4902 firms in 1994, exceeding by far the number of 2570 firms listed in 1994 at the New York Stock Exchange (NYSE). It is furthermore underlined by the reluctancy of firms, which would be allowed to switch to the NYSE, to actually do so. Second, the "Revenue Act" reduced in 1978 the tax rate on capital gains from 49% to 28%, thus increasing the incentive to invest in risk-bearing capital. The further reduction of this tax rate to 20% which was enacted in the early Reagan period was reversed, though, in the "Tax Reform Act" of 1986 where the tax rate on capital gains was again raised to 28%. Third, the restrictions for institutional investors to invest into venture capital were eased at the end of the 1970s. The "ERISA Prudent Man Act" of 1978/79 allowed pension funds for the first time to invest up to 5% of their total investments into venture capital. Fourth, the "ERISA Safe Harbor Regulation" of 1980 ensured a separation in the management of pension funds and of venture capital firms. Hence, venture capital firms could from then on accept pension funds as investors, and table 2 shows that pension funds are indeed the main provider of venture capital in the U.S.[20]

[20] See Bygrave (1995), Santarelli (1995), Solomon (1996), Sidler (1997), Schilit (1992), OECD (1996a and b).

Table 2: Sources of Venture Capital Commitments (in % of Annual Total) in Germany and the USA

Germany				
Capital Provider	**1991**	**1992**	**1993**	**1994**
Banks	60.87	48.51	48.13	51.01
Savings Banks	5.84	3.13	4.12	4.11
Insurances	9.57	11.52	12.12	11.71
Industry	5.75	5.61	9.27	7.84
Private	13.64	5.40	6.66	8.24
State	0.06	3.76	5.62	6.97
Other	4.27	1.46	3.39	3.36
Sum	100.00	79.39	89.29	93.24
no details available		21.61	10.71	6.76
Total Capital in bio. DM	**5.551**	**7.855**	**8.258**	**8.829**
USA				
Corporations	4	3	8	9
Private	12	11	7	12
Pension Funds	42	42	59	46
Foreign	12	11	4	2
Endowments and Foundations	24	19	11	21
Banks and Insurances	6	15	11	9
Total Capital in bio. $	**1,271**	**2,548**	**2,545**	**3,764**

Source: Pfirrmann et al. (1997, pp. 24 and 34).

Hence, the results obtained suggest that fostering a similar development of the venture capital market as in the U.S. would help to achieve a better employment performance as this would improve the supply of risk-bearing capital to firms. It would in particular allow young and still small firms to rely less on credits for financing their activities thus reducing their vulnerability with respect to rising volatilities. It must therefore be asked which obstacles prevent a better functioning market for venture capital in Germany. A first important point is related to tax considerations. An example for the maltreatment of venture capital financing by the tax code is given by venture capital firms having to pay full taxes on profits earned by selling their shares of a company if they exceed 10% of the total capital of the firm concerned. This point is in particular an issue for young and still small firms seeking venture capital financing. A major expansion of the venture capital market requires that this mode of financing the acitivity of firms is not discriminated against by the tax code.[21]

[21] For detailed discussions of the discrimination of venture capital financing by the tax code in Germany, see Albach and Köster (1997), Gerke (1996), and Kaufmann and Kokalj (1996).

A second problem concerns the still underdeveloped market for IPOs in Germany. Going public takes a long time in Germany, i.e. on average about 55 years, whereas an IPO occurs in the U.S. on average after about 14 years. However, as has been mentioned above, venture capital financing of non-listed firms requires a well-developed market for IPOs. The "Neuer Markt" is supposed to reduce this problem. Yet, it has just been established in 1997 and is still by no means comparable to the NASDAQ. Thus, the development of the German capital market lags years behind in this respect. The formal barriers for initiating an IPO at the "Neuer Markt" are furthermore relatively high. The minimum requirement for the emission volume is 10 Mio. DM. At least 50% of the capital issued at the "Neuer Markt" must serve to increase the stock of risk-bearing capital, and ownership of at least 15% of the total capital volume must be scattered. Finally, publication requirements are relatively tough. It is in sum doubtful whether the "Neuer Markt" can ever play a similarly important role for IPOs as NASDAQ. Establishing a market for IPOs which is more targeted toward young and still small firms with lower formal entry barriers should therefore help in developing a better functioning market for venture capital (BMWi 1997).

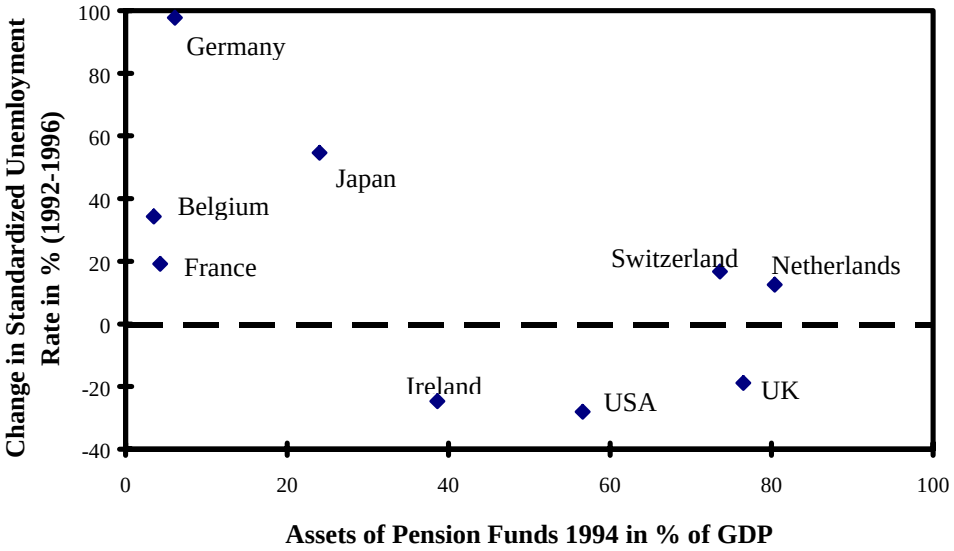
The third important obstacle to a better functioning market for venture capital is the German pension system. True pension funds of the anglosaxon type, which are the by far most important provider of venture capital in the U.S., are still not allowed in Germany. The German pension system is dominated by the government organized pay-as-you-go pillar which does not supply any venture capital because all the contributions of the working age population are not invested but rather handed out directly to the retired part of the population. The second pillar of the German pension system have traditionally been voluntary pension provisions by firms. These provisions reduce balance-sheet profits and thus tax payments and dividends immediately although the actual pension payments occur years later when the employee retires. Hence, the financial position of firms is improved and they become less dependent on credit financing. On first sight, this system should have a similarly favorable effect on labor demand as a well-functioning market for venture capital in times of rising volatilities because it improves the financial position of firms. However, this conjecture turns out to be questionable upon closer inspection. First, voluntary pension provisions are declining in importance throughout the German economy possibly due to the greater risk of guaranteeing ex ante fixed pension payments in retirement age and due to high unemployment reducing the necessity of buying the loyalty of employees via pension provisions. Second, such pension provisions are mainly effectuated in large and established firms. Young and still small firms, which depend heavily on credit financing, can hardly ever resort to this instrument for finan-

cing their activities. It is furthermore highly problematic that the use of these financial means is largely at the discretion of management and not controlled by the capital market. Voluntary pension provisions can therefore not work as a substitute for a well-developed market for venture capital. The German tax preferences given to defined benefit pension provisions which stay in the firm are therefore not justified from the employment perspective.

Hence, reforming the pension system appears to be a key step in fostering the German market for venture capital and to thereby achieve a better employment performance. Figure 6 suggests that there is a negative relation between the change in unemployment in the 1990s and the relative importance of pension funds. In short, the system needs to be more capital funded so that institutional investors such as pension funds can channel at least part of the additional savings into the venture-capital market. The size of the pay-as-you-go system should therefore be cut and the favorable tax treatment of pension provisions should be abolished. Furthermore, the establishment of true pension funds of the anglo-saxon type should be allowed, which is still not the case, but which is at least part of the draft for the fourth law to promote financial markets in Germany ("4. Finanzmarktförderungsgesetz"). Such pension funds should then be allowed to invest a significant share of their funds into the venture-capital market similar to the "prudent man" concept in the U.S.. This change in the financing procudure would inevitably entail a switch from the defined benefit system, which prevails currently in Germany, to the defined contribution system, which is predominant in the U.S. Thus, employees would no longer be guaranteed ex ante fixed pension payments. The actual size of the pension payments would then rather depend on the contributions made to the system and on the ex post profitability of the investments undertaken by pension funds with these contributions. However, certain limitations as to how risky these investments are allowed to be and a close government surveillance of the investment policy of these pension funds is in any case necessary to avoid severe moral hazard problems and to preclude that the government must step in as financier of last resort.[22]

[22] See BMWi (1997), Reisen (1996, 179), and Pfirrmann et al. (1997, 64-65).

Figure 6: An International Comparison of the Importance of Pension Funds and of the Change in Unemployment



Sources: Nürk and Schrader (1995, 19) und OECD (1998).

V. Conclusions

As has been shown, the functioning of the capital market, in particular of the venture-capital market, is closely intertwined with the employment performance of a particular country. Rising volatilities reduce labor demand in countries where credit financing of firms is predominant such as in Germany, while they have a smaller negative effect on labor demand in countries where equity financing and venture capital play a much greater role such as the U.S. The induced reduction in labor demand is translated into rising structural unemployment if there are labor-market imperfections and if in particular real wages are rigid. Rising firm-specific volatilities are especially likely to increase structural unemployment in countries where wage setting takes place on a rather centralized level because there is a better chance that firm-level unions react with wage moderation to such firm-specific shocks. Hence, rising volatilities in tandem with capital- and labor-market imperfections fit very well with the much better unemployment performance in the U.S. compared to continental Europe in general and compared to Germany in particular in recent years.

Improving the functioning of both, capital- and labor markets, is therefore essential for achieving lasting reductions in unemployment. While labor-market imperfections have been at the center of the discussion on how to reduce unemployment for several years by now, capi-

tal market issues have at best played a minor role. As has been shown, though, enacting institutional reforms which improve the functioning of capital markets and which foster in particular the development of the venture-capital market can be an important step in fighting unemployment, not only by reducing the negative effects of rising volatilities on labor demand but also by creating a more dynamic labor market thus restraining wage setting. Interestingly, the two prime economic policy problems in the 1990s, fighting unemployment and stabilizing the pension system, therefore seem to be related: pay-as-you-go pension systems are hardly viable with the given demographic development. The example of the U.S. furthermore suggests that pension systems with much greater capital-funded elements induce the growth of pension funds, which can in turn help the venture capital market to thrive. Yet, political economy considerations suggest that reforming pay-as-you-go pension systems is similarly hazardous for governments as deregulating labor markets.

Appendix

This appendix explicitly derives the signs of the partial derivatives of equation (11) in the main text. The first partial derivative of equation (11) is straightforward:

$$\frac{\partial r_i}{\partial K_i} = \frac{\Phi_i}{L_i w} > 0. \tag{A1}$$

The other partial derivatives are slightly more complicated because the other three parameters affect Φ_i via changes in ε_i^*. Hence, equation (3) in the main text must be explicitly solved for ε_i^*, and the result must be plugged into the equation for Φ_i.

$$\varepsilon_i^* = \frac{(1+r_i)L_i w - C_i}{\mu (L_i)^{\alpha}} - 1 < 0. \tag{A2}$$

As banks are only willing to provide loans to firms if default is restricted to cases when the shock turns out to be worse than expected, ε_i^* must be negative considering that the expected value of ε_i is zero. Substituting (A2) into the equation for Φ_i yields:

$$\Phi_i = 0{,}5 + \frac{(1+r_i)L_i w - C_i}{2V\mu (L_i)^{\alpha}} - \frac{1}{2V}. \tag{A3}$$

Taking the derivative of (11) with respect to C_i yields:

$$\frac{\partial r_i}{\partial C_i} = \frac{2\mu (L_i)^{\alpha} V}{L_i w} \cdot \frac{\partial \Phi_i}{\partial C_i} + \frac{K_i}{L_i w} \cdot \frac{\partial \Phi_i}{\partial C_i} < 0, \tag{A4}$$

which is negative because

$$\frac{\partial \Phi_i}{\partial C_i} = -\frac{1}{2V\mu (L_i)^{\alpha}} < 0. \tag{A5}$$

Taking the derivative of (11) with respect to μ yields:

$$\frac{\partial r_i}{\partial \mu} = \frac{V (L_i)^{\alpha} \Phi_i}{L_i w} \left(\Phi_i + 2\mu \frac{\partial \Phi_i}{\partial \mu} \right) + \frac{K_i}{L_i w} \cdot \frac{\partial \Phi_i}{\partial \mu} < 0. \tag{A6}$$

The result is negative because

$$\frac{\partial \Phi_i}{\partial \mu} = -\frac{(1+r_i)L_i w - C_i}{2V (L_i)^{\alpha}} \cdot \frac{1}{\mu^2} < 0, \tag{A7}$$

and because

$$\Phi_i + 2\mu \frac{\partial \Phi_i}{\partial \mu} = \frac{\mu (L_i)^{\alpha} (V-1) - (1+r_i)L_i w + C}{2V\mu (L_i)^{\alpha}} < 0, \tag{A8}$$

as by assumption $\left|(1+r_i)L_i w\right| > \left|C_i\right|$.

Taking the derivative of (11) with respect to V yields:

$$\frac{\partial r_i}{\partial V} = \frac{1}{L_i w}\left[\mu (L_i)^{\alpha} (\Phi_i)^2 + 2\Phi_i V \mu (L_i)^{\alpha} \frac{\partial \Phi_i}{\partial V} + K_i \frac{\partial \Phi_i}{\partial V}\right] > 0, \tag{A9}$$

because

$$\frac{\partial \Phi_i}{\partial V} = \frac{1}{2V^2}\left[\frac{\mu (L_i)^{\alpha} - (1+r_i) L_i w + C_i}{\mu (L_i)^{\alpha}}\right] > 0. \tag{A10}$$

Furthermore, the positive effect of higher volatility on the risky interest rate rises with higher state verification and enforcement costs:

$$\frac{\partial^2 r_i}{\partial V \partial K_i} = \frac{1}{L_i w} \cdot \frac{\partial \Phi_i}{\partial V} > 0. \tag{A11}$$

Finally, higher volatility has a smaller positive effect on the risky rate of interest if firms can provide higher collateral:

$$\frac{\partial^2 r_i}{\partial V \partial C_i} = \frac{1}{L_i w}\left\{\frac{\partial^2 \Phi_i}{\partial V^2}\left[2\mu (L_i)^{\alpha} V + K_i\right] + 2\mu (L_i)^{\alpha} \cdot \frac{\partial \Phi_i}{\partial V}\right\} < 0. \tag{A12}$$

This is the case because

$$\frac{\partial^2 \Phi_i}{\partial V^2} = -\frac{1}{V^3}\left[\frac{\mu (L_i)^{\alpha} - (1+r_i) L_i w + C_i}{\mu (L_i)^{\alpha}}\right] \cdot \left[2\mu V (L_i)^{\alpha} + K_i\right] < 0, \tag{A13}$$

and because the whole term in parenthesis in (A12) is negative due to

$$2\mu (L_i)^{\alpha} + \frac{K_i}{V} > \mu (L_i)^{\alpha}, \tag{A14}$$

which is obtained by substituting (A10) and (A13) into (A12).

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