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Abstract

This paper analyzes the effects of firing costs in a broader setup than what is usually done, allowing for on-the-job training. By doing so the traditional analysis is extended with respect to two points: On the one hand firing costs clearly increase firm training because worker and firm are less likely to separate.

On the other hand, firm training gives firms the opportunity to lower the costs of firing restrictions: After all the value of output of a well-trained worker is less likely to turn negative. Through these two channels firm training is able to diminish the negative effects of firing restrictions usually discussed in the literature.

Keywords

Firm Training, Firing Costs, Human Capital

JEL Classification

E24, J24, J63, J68, M53

1 Introduction

Quite often labor market institutions are held responsible for the relatively high unemployment rates in continental Europe. These institutions - union wage-setting, minimum-wage laws, employment protection and high labor taxes to name but a few - are claimed to create rigid labor markets, which are not able to cope with the needs of a constantly changing economic environment and technological progress - especially when compared to the flexible labor markets of the United States.

We concentrate on one of these institutions - namely firing costs - and show in a two-period overlapping-generations model with search-frictions and firm-training that there are some positive effects as well. As Acemoglu (1997) has shown, a firm will underinvest in its workers' training if there is a positive probability that the worker will leave the firm, because it does not take into account the higher productivity of the worker in her next job.

We demonstrate that firing costs can alleviate this inefficiency because the probability of separations is decreased. Foreseeing this, the firm invests more in training because it benefits more often. Of course, this comes at the cost of inefficient separations - in some cases the firm may keep the worker even if, for society, a separation would be the better alternative.

Concerning unemployment two effects have to be distinguished. First, as already mentioned, firing costs lead to fewer separations which unambiguously reduces the unemployment rate. Secondly, at the same time they impose a restriction on firms, thereby decreasing their value - some firms drop out of the market and for unemployed workers it becomes harder to find a new job. Analytically, it is not clear which of these two effects dominates but numerical simulations suggest that an increase in unemployment is more likely if not necessary. These two channels are well known in the literature.[1] However, the novelty of this paper is that it modifies the working of these channels by allowing firms to

[1] See further below.

invest in their workers' human capital. By training workers the firm can reduce the risk of having to fire a worker since the value of output of well-trained workers is less likely to turn negative. Thus the possibility of firm training lowers the costs of firing restrictions and therefore the decrease in workers' job finding rates is not that severe.

This paper builds on two different branches of the literature. The first focuses on firms' training investments and workers' mobility and the second on firing costs and unemployment. To my knowledge there is only one other paper trying to combine both aspects (Belot et al. (2002)), however natural it seems when evaluating a policy instrument.

Empirical results concerning the relationship between firing costs and unemployment are rather mixed. For instance, Nickell (1998) and Bertola (1992) do not find a negative relationship whereas Scarpetta (1996) and Elmeskov et al. (1998) do. This lack of unambiguity could be explained by theoretical models predicting a non-linear relationship between firing costs and unemployment (such as Belot et al. (2002) or this work).

Supporting our results is a study by Layard and Nickell (1999) who show in a cross-country regression that productivity growth and employment protection are positively correlated.

There exists ample evidence on the positive relationship between on-the-job-training and the duration of jobs (see for instance Lynch(1991), Loewenstein and Spletzer (1999) or Parent (1999)). However, this kind of literature mainly focuses on the effect of training and turnover and not vice versa. Since firms profit from the enhanced productivity of their workers, they are more reluctant to fire well-trained workers. Direct evidence on the relationship between firing costs and training investments is virtually non-existent although – as Adnett et al. (2001) mention - there can be found some reassuring examples in non-traditional labor markets such as sports or armed forces. In addition, Adnett et al. argue that some indirect evidence on the subject can be derived by analyzing the portability of pension plans, which might impose a mobility restriction on workers. In fact, Dorsey and MacPhearson (1997) find a positive and significant relationship between pension coverage and training.

On the theoretical front Ljungqvist and Sargent (1998, 2002) try to cope with the problem that during the 1960s unemployment in Europe was lower than in the U.S. While this relationship has reversed during the last two decades, one cannot say that labor market institutions in Europe have been built up dramatically – rather the opposite is true. Ljungqvist and Sargent argue that the way these institutions affect unemployment depends crucially on the degree of economic turbulence. They build a model in which workers accumulate knowledge when working (learning by doing), but loose human capital when unemployed. Economic turbulence is modelled by a parameter determining how much of her human capital a worker looses after she is fired. Ljungqvist and Sargent (2002) show that firing taxes (paid by the workers) might decrease the unemployment rate during tranquil times by lowering the number of quits. However, when turbulence increases – as for instance Gottschalk and Moffitt (1994) have shown to be the case for the last two decades – this relationship will reverse. Workers now search with less effort because the firing tax decreases the value of a job. In their model this unambiguously depresses overall welfare.

Compared to our paper there is one major difference: In the papers by Ljungqvist and Sargent human capital accumulates as a by-product of working, so there is no investment-decision and thus a positive effect of firing costs on human capital is inherently excluded. In contrast, our model allows agents to choose the amount of training themselves and therefore firing costs have a different impact on the level of human capital. Nonetheless, our model is able to duplicate their result that firing costs are doing more harm during economically turbulent times.

Most closely related to our model is the work of Belot et al. (2002). They as well use a matching model and show that firing costs could potentially increase overall welfare. However, in their model inefficiencies stem from two other channels than in our model. The first are distorting taxes and the second is a hold-up problem. The worker has to finance her training on her own and wages are negotiated after these costs have been sunk – knowing that the firm is able to reap some of the profits the worker underinvests. Here firing costs work as a commitment device of the employer and the worker reacts with higher investments.

In turn, our model does not need to rely on the inefficiencies created by distorting taxes or on the hold-up problem. Inefficiencies stem from the fact that the training firm does not take into account that its fired workers are more productive in their following employment-relationships as well - this kind of inefficiency is very well confirmed by the empirical literature (see for instance Loewenstein and Spletzer (1998 and 1999). But the main advantage of our model is that Belot et al. cannot explain satisfactorily why the firm and the worker do not agree on a firing-fee on their own, although both parties would gain from such an agreement. In contrast, a firm in our model is hurt unambiguously by the firing cost and thus would never agree on it. This paper concentrates on the positive effects of firing costs. However, a former version did as well a welfare-analysis and could be provided by the author.

Adnett et al. (2001) and Booth and Chatterji (1989) follow a similar approach by theoretically examining the relationship between firing costs and training investments but they do not consider unemployment at all.

In Adnett et al. (2001) a worker is hit by two separate productivity-shocks – one affecting her productivity with her current employer and one affecting her productivity outside of the firm – which are totally independent of each other. In this model it might be the case that the outside option of the firm is so good that it never trains its workers – firing costs can change this situation by lowering the value of this outside option.

Booth and Chatterji (1989) have a different claim: They want to explain why redundancy payments differ so much between firms and industries in Britain. They assume that the costs of training are shared between worker and firm. For the worker to accept this she needs to be compensated in case of a layoff. The value of this redundancy payment is negotiated between worker and firm and depends on the variance of a productivity-shock.

We will proceed as follows. The next section gives a non-technical description of the model, while the formal model is presented in section three. Section four illustrates the solution of the model, whereas the impact of firing costs is discussed in section five. Finally, some numerical results follow in Section six. Section seven provides a conclusion.

2 General description

We consider a discrete-time overlapping generations (OLG) model. Production takes place in worker-firm pairs; no capital is needed. Firms are infinitely lived. Workers live for two periods (young and old). The productivity of young workers is given exogenously and is equal for all workers, but they can be trained on the job to increase their productivity for the second period.

At the beginning of each period a number of individuals n is born and immediately engages in job-search. With probability P_{find} - which is specified further below - a young worker finds a job and with probability $(1 - P_{find})$ she remains unemployed for the whole period. In this case she can apply again for a job at the beginning of her second period. Since we are not interested in endogenizing search-intensity, we can disregard unemployment-benefits. If a young worker's search is successful, she will be trained on the job, with the firm bearing the cost. Training is assumed to be general, which means that the resulting stock of human capital can be used in every other firm without any restrictions. In other words, the productivity increase of the worker is the same regardless of the firm that trained her. This is in contrast to specific training which will increase the output of the worker only if she stays with the training firm.[2] Wages are determined via Nash-bargaining before the investment-decision has taken place.[3]

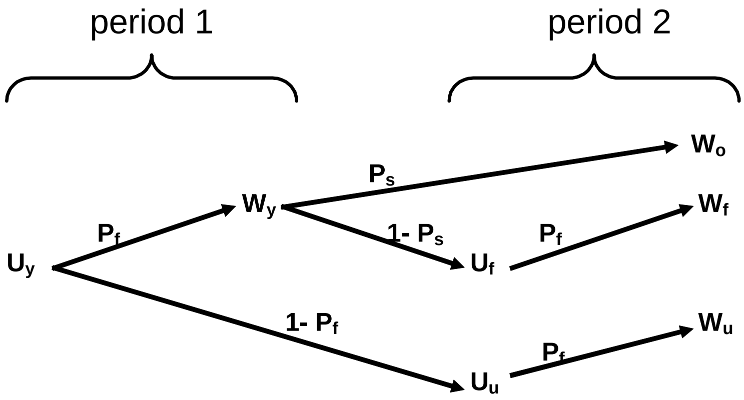
At the end of the first period the worker-firm pair is hit by a randomly distributed, firm-specific productivity shock, which could potentially turn the profits of the firm negative. In that case the firm would like to fire the worker, but that will cost an exogenously

[2]General training is the more interesting case because, according to Becker (1962), firms should not invest in general training at all.

[3]Letting negotiations take place after the investment-decision would only complicate the analysis but does not qualitatively change the results.

determined firing cost F, which takes the form of administrative costs and therefore is completely lost. A worker who was fired cannot immediately be rehired by another firm in the same period. Consequently, the worker engages in job-search at the beginning of her second period, but with the prospect of higher earnings (compared to a worker who was unemployed when young) due to her higher stock of human capital.

Figure 1: Life-cycle



Thus, ex-post at the beginning of each period there are four different groups of workers, although ex-ante workers are homogenous (in brackets find the notation for the value of each type of worker) : [4]

- Young workers who are always born unemployed and untrained (U_y);
- old workers who did not find a job when young and therefore are still unemployed and untrained at the beginning of their second period (U_u);
- old workers who were employed when young but were fired due to a bad shock - they are trained and unemployed (U_f);

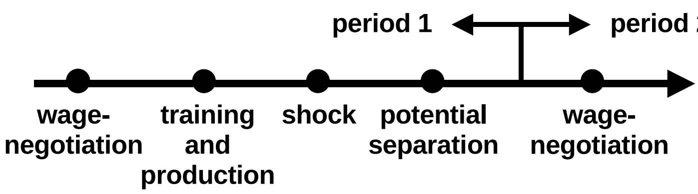
[4]There could be more groups distinguished if we look at the middle of a period, but since job-search takes place at the beginning of each period this is the relevant dimension.

- and finally old workers who remained in their initial jobs (W_o).

We will keep this notation for the remainder of the paper: The letter U denotes the value of an unemployed worker, whereas the letter W is used for workers with a job. For the firms we use V for a vacancy and J for a filled job. The subscript y stands for young workers and u, f and o for old workers who were unemployed, who were fired and who retained their jobs, respectively. These subscripts are also used for the firms to denote the type of worker that currently fills a position.

Figure (1) illustrates graphically the possible life-time careers of the typical worker whereas figure (2) clarifies the timing of certain events.

Figure 2: Time-path



Following the above classification, at any time there are three different types of workers available on the job-market.[5] We assume that the firm cannot direct its search towards one of these groups and therefore never knows which worker it will get. The probability of drawing a certain type of worker depends on the share of this type in the entire pool of unemployed workers. Depending on the type of worker a firm finally hires (if any), we can distinguish five different states for firms:

- A vacancy (V);
- a job filled by a young worker (J_y);
- a job filled by an old worker who was trained within the same firm (J_o);

[5] We do not consider on the job search.

- a job filled by an old worker who was unemployed when young (J_u);
- a job filled by an old worker who was fired at the end of her first period and received training from another firm (J_f).

3 The model

3.1 Value-functions

In this section we derive the Bellman equations for the different states of firms and the types of workers described above. The notation is very much in line with Pissarides (2000).

3.1.1 Firms

The value of a vacancy consists of the firms' prospects of finding a worker of the three different types. This value is diminished by the search-costs, which have to be paid for every period of active search:[6]

$$\begin{aligned} V(\theta, g, ge) &= -sc + P_{young}J_y + P_{fired}J_f + P_{unemp}J_u \\ &\quad + \left[1 - P_{young} - P_{fired} - P_{unemp}\right]\rho V \end{aligned} \tag{1}$$

The arguments of the value-function for a vacancy are the tightness of the labor market θ, the amount of human-capital investments the firm would undertake in the case that it finds a young worker g and the investments of other firms ge, sc are the exogenous and constant search-costs, P_{young}, P_{fired} and P_{unemp} are the probabilities of finding a young worker, an old worker who was fired or an old worker who was unemployed, respectively.

[6] To keep the notation simple we omit the arguments of value functions when they are used inside any other function.

In these cases the firm earns the corresponding value J_y, J_f or J_u. If search was not successful, the firm will keep the value of the vacancy V. Of course, this value has to be discounted for one period by the discount factor $\rho = 1/(1+r)$. The probabilities are exogenous to the firm (although endogenous to the model) and are treated in more detail further below.

For a firm the value of a young worker consists of the current profit and the discounted value of the following period. This value can either be the value of an old worker who was trained in the firm (if the worker stays) or the value of a vacancy minus the firing costs in case of a negative shock leading to a separation - both values are weighted with their probabilities:

$$J_y(g) = v_y - w_y - c(g) + P_{stay}\rho E\left(J_o\right) + \left[1 - P_{stay}\right]\rho(V - F) \tag{2}$$

where v_y is the value of production and w_y is the wage of a young worker, $c(g)$ are the costs of human capital investments, which are assumed to increase at a rising rate, i.e. $c'(g) > 0$, $c''(g) > 0$ and P_{stay} is the probability that the worker will stay in the firm. Since the value of the shock is not known at this point in time, the exact value of an old worker (J_o) is unknown as well and we have to use an expectations-operator. This conditional expectation is given by:

$$E(J_o) = \frac{\int_{\overline{\lambda}}^{\infty} J_o d(\lambda) d\lambda}{P_{stay}} \tag{3}$$

where $d(\lambda)$ is the density-function of the firm-specific productivity shock λ and $\overline{\lambda}$ is the reservation-productivity: For any shock below this threshold the worker will be fired. A more detailed definition follows further below.

Once the shock is known, the value of the worker is determined as:

$$J_o(g, \lambda) = v_o\left(g, \lambda\right) - w_o\left(g, \lambda\right) + \rho V \tag{4}$$

By assumption, the worker-firm pair will split with certainty after this period and the firm retains the value of a vacancy. The value of human capital g is (or better, was) in control of the firm.[7]

The values of old workers, who were unemployed when young or who were fired are, respectively:

$$J_u = v_u - w_u + \rho V \tag{5}$$

$$J_f(ge) = v_f\,(ge) - w_f\,(ge) + \rho V \tag{6}$$

where in the second equation ge replaces g to indicate that the human capital of fired workers is not in the control of the actual firm since she was trained by some other firm.[8] Both values are independent of λ since the shock is specific to the firm in which the worker was trained, so $v_o\,(g, \lambda)$ in equation (4) is the only productivity that is dependent on the shock and it is also the only productivity that is dependent on the firm's own human-capital investments.

3.1.2 Workers

The value-functions for the unemployed workers are:[9]

$$U_y = P_{find} W_y + [1 - P_{find}]\,\rho U_u \tag{7}$$

$$U_u = P_{find} w_u \tag{8}$$

[7] Of course the firm cannot control for g after the shock has become known but at the beginning of period one.

[8] A firm's probability of matching again with a worker who was trained in the same firm is assumed to be zero.

[9] The value functions for old workers are just equal to their wages: $W_u = w_u$, $W_o = w_o$, $W_f = w_f$.

$$U_f(ge) = P_{find} w_f\,(ge) \tag{9}$$

With probability P_{find} a young unemployed person will find a job that is of worth W_y. If she is not matched with a firm she will stay unemployed for the whole period and can search again at the beginning of the second period, when she will be old and untrained (U_u). The values for the other two types of unemployed workers are straight-forward: She gets a job and thereby a wage or she dies without any further earnings.

Since the firms cannot direct their search, the hazard-rates of finding a job are the same for all unemployed, irrespective of their employment history, i.e. an old, untrained worker has the same chances of finding a new job as a young worker.

It remains to determine the value of a young worker who had the good fortune to find a job immediately. Her value function is:

$$W_y(g) = w_y + P_{stay} \rho E(w_o\,(g, \lambda)) + [1 - P_{stay}]\,\rho U_f \tag{10}$$

She earns a wage w_y and has a positive probability of keeping the job (P_{stay}), in which case she will earn the uncertain wage of an old worker $w_o\,(g, \lambda)$ (uncertain because it depends on the shock λ). If she experiences a bad shock, she will lose her job but have the chance to find another job in period two (U_f). One should keep in mind that U_f is also dependent on g, although the argument has been omitted.

3.1.3 Free-entry condition

We assume free entry of firms, so that new firms will enter the market as long as profits are possible - this drives down the value of a vacancy (through increasing the tightness of the labor market and thereby lowering the firms' probability of finding a worker) until it is zero. If V were larger than zero, firms would make positive profits on average and this would attract new firms to the market. The probability of firms finding a worker would go down and with it the profits of firms, until V reached zero. Only then are there no incentives for further entries. The reverse would happen if V were negative: Some firms drop out of the market, improving the probability of the remaining firms finding a worker. Thus, the free-entry condition or zero-profit condition is:

$$V(\theta, g, ge) = 0 \tag{11}$$

3.2 Wages

Wages are determined via Nash-bargaining.[10] Let β denote the bargaining power of workers. Then for instance the wage of a worker who was unemployed when young but who found a job in her second period is the solution of the Nash-maximand: [11]

$$w_u = Arg\max(W_u - dead)^{\beta}(J_u - V)^{(1-\beta)} = Arg\max {W_u}^{\beta} {J_u}^{(1-\beta)}$$

i.e. the wage maximizes the product of the surpluses of both parties, weighted by their respective bargaining-powers. This yields:

$$W_u - dead = \beta(W_u - dead + J_u - V) \tag{12}$$

The worker's gain from the match is just a share β of the joint value, whereas the firm keeps a share of $(1-\beta)$. By plugging in these values[12] into equation (12) we arrive at:

[10] See for instance Shaked and Sutton (1984) for a game-theoretic foundation of Nash-bargaining or Pissarides (2000) for an application to the matching framework.

[11] The values *dead* and V are the threatpoints of the worker resp. the firm. Thus, it is implicitly assumed - as is common in the literature - that the worker and the firm cannot return to the labor market in the same period if negotiations brake down.

[12] W_u is just equal to w_u while J_u is given by equation (5).

$$w_u = \beta v_u \tag{13}$$

which is the wage of old workers who did not have a job when they were young. By following the same procedure we get the wages for workers who were fired and who retained their first-period jobs. The respective expressions are:

$$w_f(ge) = \beta v_f(ge) \tag{14}$$

$$w_o(g,\lambda) = \beta\left(v_o(g,\lambda) + F\right) \tag{15}$$

Again workers get a share β of the joint surplus, where the old worker, who is still in the same firm, has the advantage that the firm's threat-point is diminished by the firing cost F.[13] This directly improves the bargaining position of the worker because both parties know that it is costly for the firm to get rid of the worker.

For young workers things are a bit more complicated, since they will live for another period, of which the state is unknown. By following the same approach as above we derive:

$$\begin{aligned} w_y^u &= \beta\left[v_y - c(g) + P_{stay}\rho E(J_o) + [1-P_{stay}]\,\rho(V-F)\right] \\ &- (1-\beta)\left[P_{stay}\rho E(w_o(g,\lambda)) + [1-P_{stay}]\,\rho U_f - P_{find}\rho w_u\right] \end{aligned} \tag{16}$$

where

$$E(w_o) = \frac{\int_{\bar{\lambda}}^{\infty} w_o(g,\lambda)\, d(\lambda) d\lambda}{P_{stay}} \tag{17}$$

[13] Note that the firing-cost has to be paid only if an old worker who was trained in the same firm is fired. We assume that F does not have to be paid only because wage-negotiations have started - therefore, F does not enter the wages of formerly unemployed and fired workers.

This seemingly complicated equation can be interpreted as follows. A young worker gets a share - according to her bargaining-power β - of the firm's expected value of the match (in the first square-brackets of the equation), which consists of the current value of production (first term) and the expectation of the future-value (second and third term). In turn, the firm gets a share - according to its own bargaining-power $1-\beta$ - of the worker's expected gain from this match (inside the second square-brackets), which is the surplus of the expected value of the match (first and second term) over the alternative of staying unemployed for her first period. Thus, the wage bargaining in the first period assures that not only current profits are shared according to bargaining powers but expected future profits as well.

3.3 Probabilities

In this section we derive the probability that a worker-firm pair will split after one period. In addition we discuss the hazard-rates of firms and workers. For a more detailed discussion of the matching framework see Pissarides (2000).

3.3.1 Job-finding-rates

As is standard we assume a concave, constant returns to scale matching function $m = m(nu, v)$, which gives the total number of matches per period as a function of the number of all job-searchers nu and vacancies v. Because of the constant returns property we can simplify the matching function to a function of one argument by dividing through v:

$$q(\theta) \equiv \frac{m(nu, v)}{v} = m(\frac{nu}{v}, 1) \tag{18}$$

where $\theta = \frac{v}{nu}$ is a measure for the tightness of the labor market. Since $q(\theta) = \frac{m(nu,v)}{v}$ is the number of matches per vacancy, it gives directly the probability that a firm will find a worker. In turn, the probability that a worker will find a vacancy is given by $\frac{m(nu,v)}{nu} = \theta q\left(\theta\right)$ or

$$P_{find}(\theta) = \theta q(\theta) \tag{19}$$

It is clear that an increase in θ implies a better chance for workers to find a job but a lower probability of firms finding a worker since the number of vacancies per unemployed workers has increased.

So far we have determined the chances of a firm finding any worker. To learn the probabilities that the firm will find a young or an old worker we need to know their respective share in the pool of all unemployed. Since all the young are born unemployed, their number is simply the rate at which young individuals are born: $nu_y = n$. The number of old workers who got fired in their first job is given by $nu_f = n\theta q(\theta)[1 - P_{stay}]$. The number of young workers who found a job last period is $n\theta q(\theta)$ and $[1 - P_{stay}]$ is the share of those workers who have lost their job. Finally, the number of old workers who did not get a job when they were young is given by $nu_u = n(1 - \theta q(\theta))$. The total number of unemployed is the sum of these three groups:

$$nu = n + n\theta q(\theta)[1 - P_{stay}] + n(1 - \theta q(\theta)) \tag{20}$$

and their respective shares are $\widetilde{u}_y = \frac{nu_y}{nu}$, $\widetilde{u}_f = \frac{nu_f}{nu}$ and $\widetilde{u}_u = \frac{nu_u}{nu}$. Finally, the probability of the firm finding a worker of a certain type is simply given by the product of the probability of finding any worker and the share of this type in the pool of all unemployed:[14]

$$P_{young}(\theta, ge) = q(\theta)\widetilde{u}_y \tag{21}$$

$$P_{fired}(\theta, ge) = q(\theta)\widetilde{u}_f \tag{22}$$

[14] Since human capital has an influence on the separation probability, it also affects the composition of the unemployed-pool.

$$P_{unemp}(\theta, ge) = q(\theta)\,\widetilde{u}_u \tag{23}$$

3.3.2 Separations

As already mentioned above, at the end of the first period the worker-firm-pair is hit by a negative, firm-specific shock which reduces the output of period two. In the absence of firing costs it would be best for the firm to separate if the shock were so large that profits were negative – in this case the firm would not be willing to pay any positive wage and both agree to split.

But if the firm has to pay some firing costs it will be loss-minimizing to produce as long as the running losses are not above this firing cost. The worker, knowing this, is able to bargain a positive wage and therefore prefers production as well.[15] This effect of firing costs on wages can be seen from equation (15) showing the wage of an old worker. Only if the loss from production was larger than the firing cost would there be no positive wages and again both agree to separate. This reasoning leads to the following separation rule:

$$J_0 < -F$$

$$v_o(g, \lambda) - \beta(v_o(g, \lambda) + F) < -F$$

$$(1-\beta)(v_o(g, \lambda)) - \beta F < -F$$

and finally:

$$v_o(g, \lambda) < -F$$

This, in turn, results in the following definition of the reservation shock $\overline{\lambda}$:

[15] Fella(2005) assumes that firing-costs are subject to negotiation as well and thereby comes to a different result.

$$v_o\left(g,\overline{\lambda}\right) = -F \tag{24}$$

such that a shock worse (i.e. smaller) than $\overline{\lambda}$ causes a separation. Therefore, ex ante the probability of staying together for two periods is

$$P_{stay}(g) = P(\lambda > \overline{\lambda}) = 1 - D(\overline{\lambda}) \tag{25}$$

where $D(\lambda)$ is the CDF of $d(\lambda)$.

From a welfare point of view this decision is of course inefficient – production takes place even though the value of the product is less than the costs of producing it. However, it must be noted that even in the absence of firing costs separation-decisions need not be efficient, because it is possible that the worker will stay in the firm although she would be more productive in another firm.[16] This kind of inefficiency is due to our modelling of the separation decision: If we relax assumptions by allowing workers to quit immediately after they have learned the shock at the end of period one, then they would do so whenever their expected earnings outside the firm are greater.[17] Then separations would occur efficiently, if firing costs were zero.

But even in this case - as well as in the case where we do not allow workers to quit at the end of period one - the introduction of firing costs does add some extra-inefficiencies due to the additional distortion of the separation decision. Since it is this kind of inefficiency that's relevant for our question we will stick to the simplifying assumption of not allowing workers to quit at the end of period one.

[16] In the absence of firing-costs separation takes place whenever $v_o\left(g,\lambda\right) < 0$, but the value of an alternative use of the worker is $P_{find}w_f\left(g\right) > 0$. So for a productivity between zero and $P_{find}w_f\left(g\right)$ even in the absence of firing-costs there would be no separation although separation was efficient.

[17] New separation-rule: $v_o\left(g,\lambda\right) < P_{find}w_f\left(g\right)$.

4 Solution of the model

The model has to be solved in the three unknowns: The labor market tightness θ and the optimal investment-decisions g and ge. First we will discuss the optimal training decision of the representative firm and the inefficiencies of that decision. In the symmetric equilibrium all firms will provide the same amount of training. Finally, market tightness is determined by the zero-profit condition.

4.1 Investment-decision

After a firm has been matched with a young worker and the wage of the first period has been negotiated, the firm has the opportunity to invest in the worker's human capital, in the hope that she will stay with the firm. It chooses human capital investments to maximize the value of having a young worker, which includes the value of an old, trained worker:[18]

$$\underset{g}{max} J_y = v_y - \overline{w_y} - c(g) + P_{stay}\rho E(J_o) + [1 - P_{stay}]\,\rho\,(V - F) \tag{26}$$

and the first-order condition (FOC) yields (using the zero profit condition $V = 0$):

$$c'(g) = \tfrac{\partial P_{stay}}{\partial g}\rho E(J_o) + \tfrac{\partial P_{stay}}{\partial g}\rho F + P_{stay}\rho\tfrac{\partial E(J_o)}{\partial g}$$

Since by definition the value of the firm is equal to the negative firing cost at the firing-threshold (i.e. $J_o = -F$), the first two terms on the right-hand side drop out. Using equations (4) and (15) the condition for optimal training simplifies to:

$$c'(g) = P_{stay}\rho\frac{\partial E(J_o)}{\partial g} = P_{stay}\rho(1-\beta)\frac{\partial v_o}{\partial g} \tag{27}$$

[18] The young worker's wage is marked by a bar to signal that it is already negotiated and fixed.

which is just a variation of the standard marginal cost equals marginal revenues rule. On the left-hand side we see the marginal cost of training and on the right-hand side the marginal returns which is the increase in the value of the firm ($\frac{\partial E(J_o)}{\partial g}$). This return has to be discounted by the interest-rate and the risk of separation. The increase in firm value is the increase in production multiplied by the bargaining power of the firm since part of the return is reaped by the worker through higher wages.

It might seem surprising that the change of the separation probability does not show up in the optimality condition. After all, training makes the worker more productive and thereby decreases the rate of separations and the likelihood that the firm has to pay the firing cost. However, at the threshold the firm is indifferent between firing and keeping the worker and therefore it does not gain anything from this change in the separation-probability. This is the reason why the terms containing the change in separation-probabilities cancel out.

It is obvious from equation (27) that training does not depend on the tightness of the labor market. At first sight this is very surprising: An increase in tightness improves the chances of the worker on the labor market and thereby her bargaining-position. This is reflected in an increase in the wage of the first period. However, as mentioned above it is assumed that the worker cannot return to the labor market if negotiations break down during the second period. This is the reason why the value of unemployment does not show up in the wage of an old worker. Since the compression of the wage structure with respect to old workers is relevant for the training decision (see equation (27)), market tightness is irrelevant.

The second-order condition is given by:

$$-c''(g) + \frac{\partial P_{stay}}{\partial g}\rho\frac{\partial E(J_o)}{\partial g} + P_{stay}\rho\frac{\partial^2 E(J_o)}{\partial g^2} \tag{28}$$

The first term is negative by assumption. The third term will be non-positive if productivity-gains from human capital are not increasing but the second term is definitely positive. Therefore, we have to assume that the progressiveness of training-costs is sufficiently large to assure that the second-order condition is satisfied.

So far we have discussed the solution for a representative firm. In the symmetric equilibrium all firms are assumed to be identical. Of course, this implies that provided training is identical for all firms as well:

$$ge = g \tag{29}$$

4.2 Inefficiencies

The investment-decision described above bears two different kinds of inefficiencies which is in line with the results of Acemoglu (see for instance Acemoglu (1997) and Acemoglu and Pischke (1999)):

- Even though the worker bears part of the training-costs by accepting a lower first-period wage (see equation (16)), the firm decides privately about the magnitude of training. Therefore, it takes into account only its own gains from higher productivity and neglects the gains of the worker through higher second period wages. As a result the firm underinvests in its worker's human capital. This kind of inefficiency could be eliminated if it were possible to sign contracts on the magnitude of training - in this case the worker would be willing to accept even lower levels of first-period wages in return for more training and both parties would be better off. However, in the training literature it is usually assumed that provided training is not observable by others and therefore it is not possible to sign such contracts.[19]
- The second kind of inefficiency stems from the fact that the worker might be fired. In this case the training firm would no longer be able to participate in the worker's

[19] See for instance Acemoglu and Pischke (1999).

higher productivity. But since the worker has the chance to find another employer, this higher productivity would not be lost entirely. However, the training firm does not take into account the higher output of the worker's new employer. This kind of inefficiency is even harder to come by than the first one, since a contract would need to include this future employer, whose identity cannot be known in advance.

4.3 Closing the model

Finally, the equilibrium of the labor market has to be determined. This is done by solving the free-entry condition for market-tightness θ yielding the following equation:

$$-sc + P_{young}J_y + P_{fired}J_f + P_{unemp}J_u = 0 \tag{30}$$

If tightness is too high, firms will make losses on average and some will drop out of the market - this lowers the number of vacancies and thereby the tightness of the market. The probabilities to find workers will increase until equation (30) is fulfilled. Whereas if it is possible to make profits on average, new firms will enter the market thereby lowering the probability of filling a vacancy and depressing profits.

Once the equilibrium-θ is determined, equation (20) gives the number of unemployed at the beginning of each period. Since this is only an infinitely small point in time, the number of unemployed during a period is a better measure for unemployment. This measure calculates as the product of the number of unemployed at the beginning of a period and their probability of staying unemployed:

$$u = nu(1 - P_{find}) \tag{31}$$

Finally, the number of vacancies is given by:

$$v = \theta \cdot nu \tag{32}$$

5 Firing costs

5.1 Effect on human capital

The effect of firing costs can be found by taking the derivative of the right-hand side of the FOC, equation (27) with respect to F:

$$\frac{\partial MR}{\partial F} = \frac{\partial P_{stay}}{\partial F}(1-\beta)\rho\frac{\partial v_o}{\partial g} > 0 \tag{33}$$

By using equations (24) and (25) we find:

$$\frac{\partial P_{stay}}{\partial F} = -\frac{\partial\overline{\lambda}}{\partial F}d(\overline{\lambda}) > 0$$

which is larger than zero since $\frac{\partial\overline{\lambda}}{\partial F}$ is negative. A larger (i.e. more negative) shock is necessary to lead to a separation. In consequence, the marginal revenue of training-investments increases and thus the worker is provided with more human capital. In other words, firing costs make dismissals more expensive and therefore the firm is more reluctant to fire a worker even when the output of the worker cannot cover its costs. On the other hand the firm, anticipating that the worker is more likely to stay within the firm, will invest more in human capital. Thus firing costs have the potential to alleviate the inefficiencies of the training decision discussed above.

5.2 Effect on unemployment

Here we have to distinguish two possibly opposing effects. To make things more clear take equations (20) and (31) giving the rate of unemployment and rearrange to get:

$$u = (1 - P_{find})\left[2n - nP_{find}P_{stay}\right]$$

Not surprisingly, we see that an increase in the probability of not getting fired (P_{stay}) unambiguously decreases the unemployment rate. Since an increase of firing costs has exactly this effect (of increasing P_{stay}) they tend to increase employment through this channel.

But this is only half of the story. At the same time firing costs influence the profitability of firms, thereby changing labor market tightness θ and the probability of workers finding a job (P_{find}). The relevant value-function to look at is the value of a vacancy V as given by equation (1), since it is the zero-profit condition which determines the equilibrium-θ. In turn, the value-function of V contains three other value-functions. Two of these depend on the level of firing costs: The value of a young worker (J_y) and the value of a fired worker (J_f).

As was proven in the section on training investments, firing costs increase the human-capital of old workers. It follows that J_f rises unambiguously (see equation (6)), since a firm with an old trained worker is not affected directly by firing costs[20] but gains from the higher training of old workers. In fact, the only type of firm that is directly affected by firing costs is the one employing a young worker. Since for those a fee on layoffs is an additional restriction and an additional cost-factor their value is diminished.

It seems plausible that the increase in J_f outweighs the decrease in J_y but additionally the change in weights (i.e. probabilities) of the value-functions in equation (1) has to be considered. A higher firing costs implies for instance a lower number of young workers and workers who got fired.

It turns out that the problem of unemployment cannot be solved analytically and so we refer to the following section where we show by numerical simulations that a positive relationship between firing costs and unemployment is the rule.

As already mentioned in the introduction, the possibility to train workers will have an effect on the costs of firing restrictions. It is plausible that these costs are diminished since firm training offers an opportunity to avoid firing costs - at least partially - since the

[20] I.e. it does not have to pay them in case of a separation and it does not affect the wage it has to pay.

output of well-trained workers is likely to turn negative. Although the structure of the model is too complicated to gain analytical insights, we were able to confirm this claim in the numerical simulations that follow.

6 Numerical Simulations

6.1 Calibration

The output of the first period is normalized to one, while the output of an old worker who was retained by the firm shall be:

$$v_o(g, \lambda) = 1 + g + \lambda \tag{34}$$

so both human capital and the productivity shock are assumed to be additive. The shock λ is normally distributed with zero mean. The variance of the shock is our measure of economic turbulence and is chosen to match certain probabilities of separation (10%, 20% and 30%). The cost of training investments is quadratic to get an inner solution and multiplied by a constant factor tc to be able to model economies with more and less costly investment opportunities:

$$c(g) = g^2 tc$$

The calibration of the labor market is very much in line with the recent papers by Hall (2005), Hall and Milgrom (2005) and Shimer (2005). The matching function used is:

$$q(\theta) = \mu\theta^{-\gamma}$$

where γ is the elasticity of the matching function and μ a parameter describing the efficiency of the labor market.

Using US-data Hall (2005) estimates an elasticity of 0.765 for the matching function and a market tightness of 0.767 (year 2000). To avoid inefficient unemployment rates I assume that the Hosios condition is fulfilled (see Hosios (1990)) and set the bargaining power of workers equal to the elasticity of the matching function (i.e. $\beta = \gamma$).

Table 1: Parameters of the Numerical Model

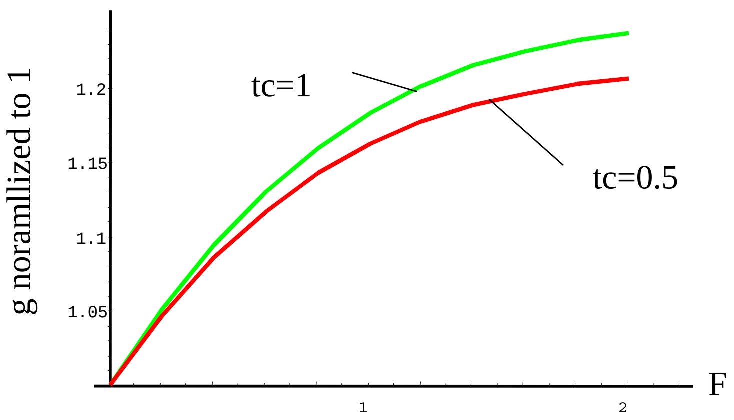
Parameter	Value	Comment
r	0.05	
tc	1	Normalization
F	0	Normalization
σ^2	1.19	Calibrated to get $P_{stay} = 0.8$
γ	0.765	Hall (2005)
θ	0.767	Hall (2005)
u	0.08	Assumed
P_{find}	0.877	Calibrated to match u
μ	0.937	Calibrated to match θ
sc	0.43	Calibrated to get $V = 0$

I target an unemployment rate of 8% for the economy with a separation rate of 20% as the baseline. I choose this relatively large unemployment rate since its is assumed that all workers are born unemployed and in a model of only two periods this is half of the population. To get lower unemployment rates, very high job-finding rates would be necessary and therefore the target of 8% is sort of a compromise. Given a separation rate of 20% this implies a job-finding rate of 0.88 which is still higher than the 0.77 that Hall (2005) finds. Given the estimated market-tightness of 0.767 and the chosen job-finding rate of 0.88, I calibrate 0.937 as the efficiency parameter μ of the matching function. This value is very close to the 0.947 in Hall. Finally, I calibrate the search-cost sc so that the parameters above fulfill the zero-profit condition. The resulting parameters are illustrated in table (1).

6.2 Results

In this section we show that firing costs increase the level of unemployment but that this effect is smaller in an economy with better training opportunities. As well, we are able to show that they do more harm in times of high economic turbulence. Thus we can replicate the phenomenon that Europe had lower unemployment rates in the 60s but has higher unemployment since the 80s, while the structure of institutions did not change too much. As in Ljungqvist and Sargent (1998 and 2002) it is the degree of economic turbulence that is crucial for the way firing costs affect unemployment, although this turbulence is modelled differently in the present paper: In our model it is the uncertainty about future worker-productivity whereas in Ljungqvist and Sargent's papers it is the magnitude of human-capital a worker looses when she is fired.

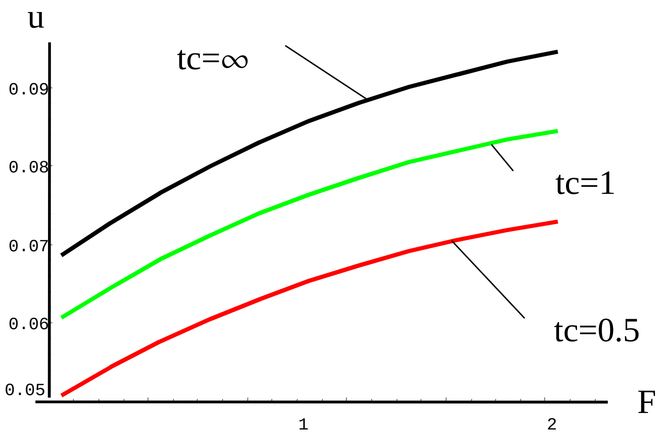
Figure 3: Effect of Firing Costs on Training



As already mentioned in the section above, we have calibrated the model for a baseline economy with a separation rate of 20% and no firing costs. In this baseline economy training raises the output of a worker by approximately 10% and the cost of training is around 1% of output. We compare our baseline economy with an economy that has better investment opportunities ($tc = 0.5$ so that training costs are halved) and with an economy that does not have any training opportunities at all (i.e. $tc = \infty$). The first graph (figure (3)) illustrates the effects of firing costs going from zero to 200% of output per (young) worker and shows percentage changes in training. So a firing cost of 1 (100% of output) increases training by more than 15% in the baseline economy and a little bit less in the economy with low training costs. It might seem surprising that the effect is relatively higher in the baseline economy. This is due to the fact, that the impact of firing costs is similar in absolute terms, but since the baseline economy starts out with a lower level this means bigger changes in relative terms.

The next graphs concentrate on the effect of firing costs on unemployment and on the way in which this interaction is influenced by the possibility of firm training. Figure (4) shows that an increase in firing costs increases unemployment. This is true for all three economies although they start out with different levels of unemployment (which is clear since better training opportunities imply better profit opportunities as well). The result is not sensitive to the choice of economic turbulence although the magnitude of the reaction is, as will become clear in a minute.[21]

Figure 4: Effect of Firing Costs on Unemployment



To be better able to compare the effects of firing costs in the three economies (and therefore how this effect is influenced by the possibility of training), figure (5) compares the absolute changes in unemployment caused by an increase in firing costs for the economy

[21] In principle it is possible to construct cases in which firing costs decrease unemployment, but these cases are rather artificial (implying for instance extremely low separation rates).

with high uncertainty.[22] It can be seen that the increase in unemployment is largest for the economy without training opportunities. This is not surprising and the intuition for this is result is the fact, that training gives firms a possibility to lower the costs of firing constraints - the output of better trained workers is less likely to turn negative. However, the differences are relatively small and they are so small that the order of lines is reversed if we look at relative changes as is done in figure (6). This reversal is due to the fact, that the economy without training starts out with higher unemployment and therefore similar absolute changes are smaller in relative terms.

Figure 5: Absolut change in Unemployment

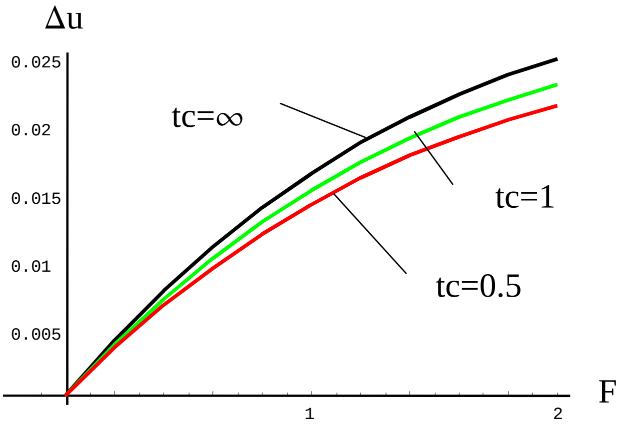


Figure (6) also illustrates that the effect of firing costs is not so small: A firing cost of 100% of per-period output causes unemployment to rise by 30%. This number is much smaller in more tranquil economies: It is only 8% for the economy with separation rate 0.2 and below 1% for the economy with separation rate 0.1.

A big disadvantage of the graphs presented so far, is the fact that the economies with differing training opportunities start out with such different rates of unemployment. This makes comparisons rather hard, as the reversal of order in figures (5) and (6) illustrated.

[22] We have chosen the economy with high uncertainty since the results are more clear-cut. However, qualitatively the results are the same for all degrees of turbulence.

Figure 6: Relative Change in Unemployment

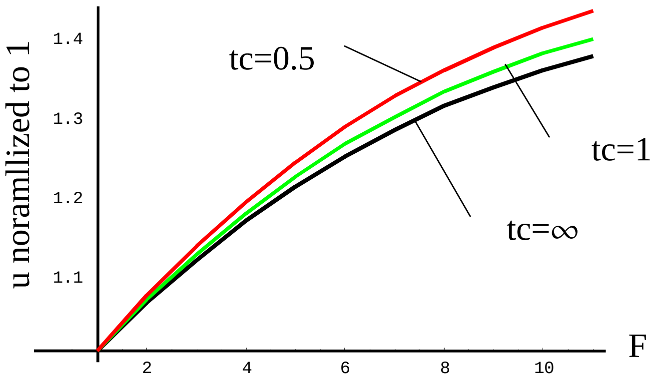
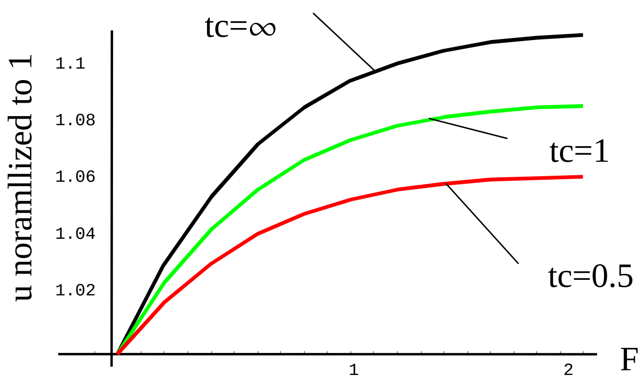


Figure 7: Relative Change in Unemployment II



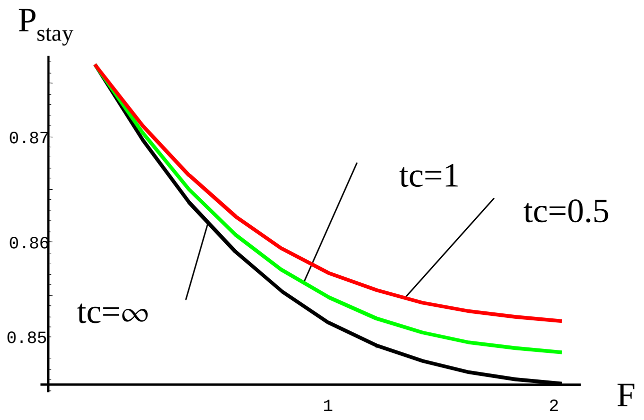
This is the reason why - in a second simulation based on the same calibration as above - we modified the numerical models in such a way that all economies with differing training opportunities start out with the same rate of unemployment.[23] Of course in such an environment a reversal of order between relative and absolute measures is no longer possible. The result is illustrated in figure (7) which shows that the increase in unemployment is considerably smaller in the economies with training opportunities. This suggests that firing costs are less harmful for economies with a lot of training.

This claim is further supported by figure (8) which shows the effect of firing costs on the probability of workers to find a job: The better the possibilities to train, the lower the effect of firing costs on job-finding rates. Behind these job-finding rate lies the profitability of firms. The higher the profits of a firm having a worker are, the more firms will open up vacancies - this is the zero-profit condition. More open vacancies imply a higher tightness on the labor market and better chances for workers to find a job. This is the channel through which firing costs negatively affect the unemployment rate: They decrease the profitability of firms by constraining them in their decisions. The possibility to train offers an opportunity to mitigate these constraints and therefore the decline in job-finding rates is smaller for economies with lower training costs. For figure (8) the baseline economy with a separation rate of 20% was chosen. However, the result does not depend at all on the specification of the model or on the measure (relative or absolute differences) chosen.

As already discussed above the effect of firing costs on unemployment depends considerably on the degree of economic turbulence. This fact opens up a possible explanation for the empirical fact mentioned in the introduction: That Europe had lower unemployment rates than the US during the 60s but higher unemployment for the last two decades. The story is similar to the one provided by Ljungqvist and Sargent (1998 and 2002): Rigid labor market institutions are more of a problem in a world with high economic turbulence. The higher the uncertainty of future output and the higher the risks of separation, the

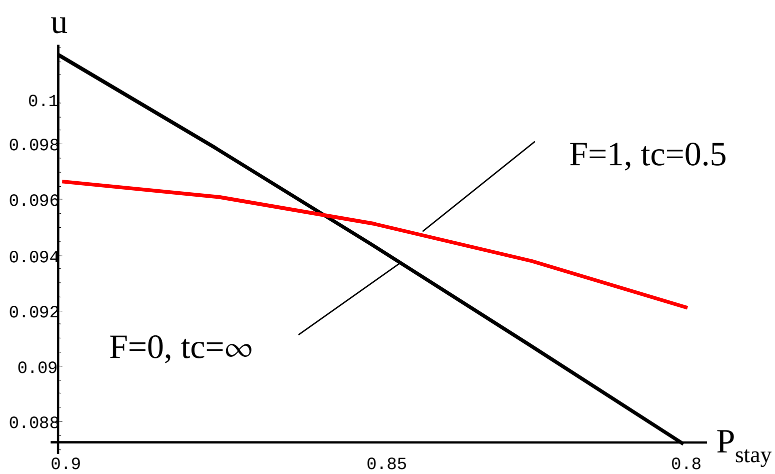
[23] This is done by adding lump-sum transfers to the firms in such a way that tightness and separation rates are the same in all models (for zero firing costs).

Figure 8: Effect of Firing Costs on Job-finding Rates



more harmful restrictions on firing become. To illustrate figure (9) shows the development of two different economies. The one economy has no training at all and also no firing restrictions ($F = 0$, $sc = \infty$), whereas the other has considerable firing costs but good opportunities to train workers ($F = 1$, $sc = 0.5$).

Figure 9: Effect of Variance on Unemployment



During times of low turbulence the economy with training opportunities is better off. However, as times become more uncertain, firing restrictions become more harmful and unemployment is higher in the training-economy. Of course, this tells only part of the story: After all, the picture suggests that unemployment decreased in both economies which is not true. However, it explains one channel through which rigid institutions might be less harmful at times and more harmful at other times.

7 Conclusion

Quite often labor market institutions in Europe are made responsible for the relatively high unemployment rates compared to the US. In this paper we were able to show that these institutions have positive effects as well, which are usually not considered in public discussions. Firing costs imply that firms and workers are bound together more closely. In times when profits are low (or even negative) firms will be more reluctant to fire workers in the presence of firing costs. This is anticipated by firms. They know that the probability of separations is lowered and therefore they provide more training to workers. Since firms typically provide inefficiently low training (see for instance Acemoglu (1997)), there might be a potential for welfare-improvements.

Of course, the negative effects of firing costs from the firms perspective cannot be denied: The separation decision becomes inefficient and firing costs improve the bargaining position of insiders. However, the last result is anticipated by firm's and young workers and therefore reflected in wage negotiations at the beginning of a match. Young workers are willing to accept lower wages in return for higher wages in the future. Thus, this effect of firing costs can be mitigated and will have no negative effects on the employment decision of firms. However, the problem that firing costs lead to inefficient separations cannot be avoided. Separations are inefficient because worker and firm stick together even in cases when it would be more efficient to look for new partners. Of course, this inefficiency reduces the profitability of firms which is reflected in the employment decision of firms: Fewer vacancies are posted. This clearly tends to increase the unemployment rate.

Nevertheless, the effect of firing costs on unemployment is not unambiguous. Due to the lower risk of separations, not only the outflow out of unemployment is decreased but also the inflow into unemployment. Analytically, it is not clear which of the two effects dominates. However, numerical simulations suggest that unemployment is more likely to increase with firing costs. What's important for the result is the degree of economic turbulence measured by the variance of the worker's output. The higher this variation is, the more harm a further increase in firing costs will do to unemployment. This is in line with the results of Ljungqvist and Sargent (1998 and 2002) who argue that the increase in economic turbulence is the main reason for the bad employment performance of many European countries since the 1980s.

There is a second channel through which the possibility of firm training lowers the negative effects of firing costs: They decrease the negative effect of firing restrictions on unemployment because training offers an opportunity to avoid these restrictions at least partially. The output of a well-trained worker is less likely to turn negative and therefore it becomes less likely that the firing costs have to be paid. This positive effect of training is also dependent on the degree of economic turbulence. If uncertainty is high, the possibility to train becomes less important.

Our trade-off between unemployment and productivity is closely related to the trade-off between training and turnover discussed in Acemoglu and Pischke (1999). In their paper wage compression is explained by asymmetric information. Depending on parameter values multiple equilibria are possible: One with high training and low turnover and one with low training and high turnover. It is not clear which of the two equilibria is more efficient because the one with lower turnover suffers from a lower quality of matches. This quality of matches is an alternative interpretation of our inefficient separations. In both cases the match is continued although output is very low. Thus, the equilibria with different values of firing costs can be interpreted in a similar way as the multiple equilibria in Acemoglu and Pischke (1999), although in our model multiple equilibria are not possible.

It might be interesting to put our model into a more realistic framework with more periods or a setup where second period wages are affected by conditions on the labor market. It does not seem very plausible that the bargaining position of an old worker does not depend at all on the tightness of the labor market. If this were modified, training would no longer be independent of market tightness. As shown in chapter three of this dissertation, an increase in tightness tends to decrease the degree of wage compression thus depressing firm training. In the present model, this would mean that the effects of firing costs are even more positive since market tightness is unambiguously decreasing in the magnitude of firing costs.

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