Institutions and Training Inequality

Wolfgang Lechthaler*and Dennis J. Snower†

July 19, 2007

Abstract

We analyze the interaction among important institutional variables in the labor market (firing costs, minimum wages and unemployment benefits) in determining firm-provided training. We find that the institutional interactions - specifically, their degree of complementarity and substitutability - depends on employees' abilities. On this account, the institutional interactions influence skills inequality. We derive how the influence of one of the institutional variables above is affected by other institutional variables with respect to inequality skills arising from firm-provided training. We derive several striking results, such as: (a) the minimum wage and unemployment benefits generate increasing skills inequality whereas firing costs generate diminishing skills inequality; (b) unemployment benefits and firing costs are complements in their effects on skills disequalization, (c) firing costs and the minimum wage are complements in their effects on skills equalization, and (d) unemployment benefits and the minimum wage are substitution in their effects on skills inequality.

JEL-Classification: H32, J24

Keywords: Firm Training, Skills Inequality, Institutions

*Kiel Institute for the World Economy. Financial support of the Swiss National Science Fund is gratefully acknowledged. Contact: wolfgang.lechthaler@ifw-kiel.de

†Kiel Institute for the World Economy and University Kiel

1 Introduction

This paper combines two important themes in the literature on labor market policy. First, as is well known, the influence of labor market institutions cannot be examined in isolation from one another; rather, their effectiveness depends on the way they interact. For example, several authors have shown that job security provisions, unemployment support and payroll taxes have complementary effects on employment and unemployment (see for instance Bassanini and Duval (2006), Coe and Snower (1996), Elmeskov, Martin and Scarpetta (1998), Orszag and Snower (1997), and Scarpetta (1996)).

The second theme is that institutions aimed at supporting the employed and unemployed often have important side-effects on training. For example, Acemoglu and Pischke (1999) argue that minimum wages raise firms' incentives to provide training since they compress the wage distribution. Empirical studies, however, typically find negative or insignificant effects (e.g. Acemoglu and Pischke (2003), Grossberg and Sicilian (1999) or Leighton and Mincer (1981)). Lechthaler and Snower (2006) explain these results by showing that minimum wages also reduce the profitability of low-skilled workers and thereby reduce firms' incentives to train. Moreover, an increase in unemployment benefits raises the returns from being unemployed, thereby increasing the likelihood of unemployment and thus reducing the incentives to train. Furthermore, an increase in firing costs raises the employee retention rate and thus raises training incentives by increasing the time span over which the gains from training accrue.[1]

The purpose of this paper is to examine the interplay between these two themes. In particular, we analyze how minimum wages, unemployment benefits, and firing costs interact in affecting firm-provided training. One interesting result of our analysis is that the interactions among these institutional variables - specifically, their degree of complementarity or substitutability - depend on the abilities of the employees. For example, institutional interactions that are complementary for workers of high ability may be sub-

[1]For example, Lechthaler (2006) shows how firing costs can increase training through lowering the turnover rate.

stitutable for low-ability workers, and vice versa. It is on account of these differences that institutional interactions affect skills inequality. Our analysis enables us to assemble these various effects into a single measure of skills inequality. Thereby we can examine how institutional interactions affect the distribution of human capital across the working population.

The paper is organized as follows. Section 2 describes the structure of our model and the decision faced by a firm that wants to invest in the human capital of its employees. Section 3 derives how firm training is influenced by each institutional variable above. The main innovation of the paper follows in Section 4, where we discuss the interaction of the institutional variables. Section 5 derives the influence on skills inequality. Section 6 concludes.

2 The Model

2.1 Basic Structure

Let there be constant returns to labor, so that each worker's productivity is independent of other workers. The production function is:

$$y = a + \tau + \varepsilon, \tag{1}$$

where y is output, a is the worker's "ability" (a positive constant representing worker's intrinsic skills), τ is "training" (the human capital generated by the firm's on-the-job training), and ε is a "match-specific shock" (a random variable that is firm-specific). ε is iid across workers, with a single-peaked, symmetric density $g(\varepsilon)$ and constant mean and variance. The firm decides how much to invest in the worker's human capital before the realized value of ε is observed. At that time the firm only knows the ability a of the worker and the distribution $g(\varepsilon)$.[2] We can define the worker's "skills" as the sum of her ability and training: $a+\tau$. Let the firm's training cost be $c(\tau)$, where $c'(\tau), c''(\tau) > 0$, i.e. the cost rises at an increasing rate with the training provided.

Wages are determined through Nash bargaining after the realization of the shock has been observed, following the standard practice in the relevant literature. Under agreement, the worker receives the wage w and the firm receives the profit $y - w - c(\tau)$. Under disagreement, the worker receives unemployment benefits b, whereas the firm still pays the training cost $c(\tau)$ and additionally the firing cost f.[3] Thus the Nash product is $(w-b)^{\mu}(a+\tau+\varepsilon-w+f)^{1-\mu}$, where μ (a constant, $0 < \mu < 1$) is the bargaining strength of the worker relative to the firm. Maximizing this Nash product with respect to the wage w, we obtain the following negotiated wage:

$$w^n = \mu(a+\tau+\varepsilon+f) + (1-\mu)b \tag{2}$$

Workers receive the negotiated wage as long as this is above the minimum wage; otherwise they get the minimum wage, i.e. the equilibrium wage is

$$w^* = \max\left(w^n, w^-\right) \tag{3}$$

where w^- is the minimum wage, which is exogenous.

We define the *minimum wage threshold* for the random productivity term ε as the value of ε at which the negotiated wage is exactly equal to the minimum wage: $\mu(a+\tau+\varepsilon+f) + (1-\mu)b = w^-$, so that the threshold value is

$$\varepsilon = \Omega = \frac{w^- - (1-\mu)b}{\mu} - a - \tau - f \tag{4}$$

[2] This is a standard way to endogenize separations in a matching framework (see for instance Mortensen and Pissarides (1994)).

[3] As rationale for the firm's fallback position, we assume that under disagreement the worker imposes the maximal cost on the firm (through work-to-rule, sabotage, and other actions) without giving the firm an incentive to fire.

Whenever ε is above this threshold, the worker receives the negotiated wage, and if ε is below the threshold, the minimum wage is received.

The firm's firing decision depends on whether the worker's productivity term ε falls short of a particular threshold value. Specifically, a worker is fired whenever her value to the firms drops below the cost of firing the worker, i.e. when $a + \tau + \varepsilon - w^* < -f$. Thus the *firing threshold* is

$$\varepsilon = \Phi = w^* - a - \tau - f \tag{5}$$

In practice, unemployment benefits often rise with the negotiated wage and then it is possible that the bargaining position of a worker is so good that the minimum wage will never be paid. To avoid this trivial result, we concentrate on workers with such a low ability that

$$b < w^- \tag{6}$$

which ensures that the minimum wage threshold (4) is greater than the firing threshold (5).

2.2 The Training Decision

The firm's expected profit is:

$$\pi(\tau) = \int_{\Omega}^{\infty} (a + \tau - w^n + \varepsilon)\, g(\varepsilon) d\varepsilon + \int_{\Phi}^{\Omega} \left(a + \tau - w^- + \varepsilon\right) g(\varepsilon) d\varepsilon - \int_{-\infty}^{\Phi} -fag(\varepsilon) d\varepsilon - c(\tau) \tag{7}$$

$$= \int_{\Omega}^{\infty} \left[(1-\mu)(a + \tau + \varepsilon - ba) - \mu f a\right] g(\varepsilon) d\varepsilon$$
$$+ \int_{\Phi}^{\Omega} \left(a + \tau - w^- + \varepsilon\right) g(\varepsilon) d\varepsilon - \int_{-\infty}^{\Phi} -fag(\varepsilon) d\varepsilon - c(\tau)$$

The firm's training decision maximizes its expected profit, so that:

$$\frac{\partial \pi(\tau)}{\partial \tau} = (1-\mu) \int_{\Omega}^{\infty} g(\varepsilon) d\varepsilon + \int_{\Phi}^{\Omega} g(\varepsilon) d\varepsilon - c'(\tau) = 0 \tag{8}$$

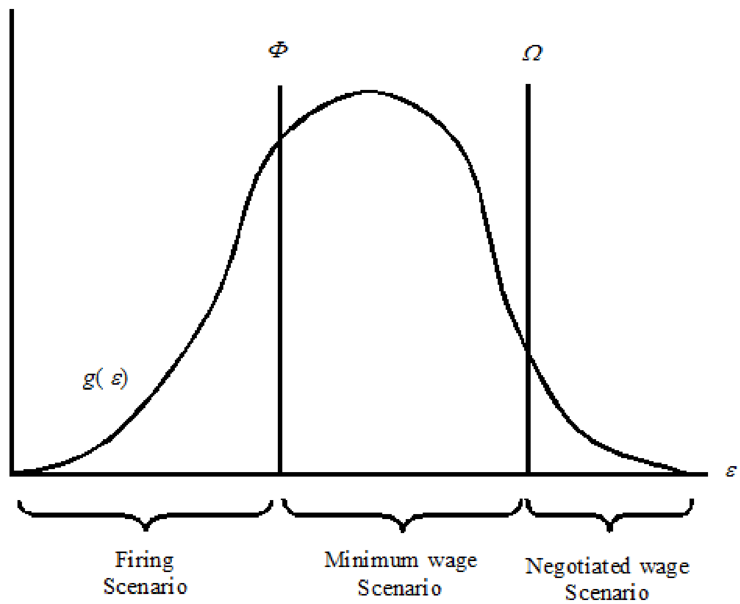

Figure 1: Three Scenarios

The two thresholds divide the productivity distribution of every worker into three areas, which are illustrated in figure (1): Below the firing threshold Φ the worker is fired and in this case the firm has no interest in improving the human capital of the worker. Above the minimum wage threshold Ω the wage is negotiated via Nash-bargaining. Since this assures that the firm receives a share $1-\mu$ of the total surplus, the firm also receives a share $1-\mu$ of the increases in productivity, i.e. of the returns to training. In between the two thresholds, the wage is constant and equal to the minimum wage. Therefore, the firm can reap all the returns to training.

3 Institutions and Training

3.1 Training and Minimum Wages

The influence of minimum wages on training[4] may be summarized in the following proposition:

Proposition 1 ***The training effect of the minimum wage:*** *The minimum wage generates "**skills disequalization**":*

- *For low-ability workers (below* $(\Omega + \Phi)/2$*), an increase in the minimum wage decreases training.*
- *For high-ability workers (above* $(\Omega + \Phi)/2$*), an increase in the minimum wage increases training.*
- *Thus the minimum wage creates skills inequality.*

*The minimum wage creates "**increasing skills inequality**": For workers of all abilities, the skills disequalization from the minimum wage becomes stronger with the magnitude of the minimum wage.*

To see this, differentiate the FOC-condition (equation (8)) with respect to the minimum wage to obtain:

$$\frac{\partial^2 \pi(\tau)}{\partial \tau \partial w^-} = \frac{\partial \Omega}{\partial w^-} \mu g(\Omega) - \frac{\partial \Phi}{\partial w^-} g(\Phi) \tag{9}$$

The first right-hand term ($\frac{\partial \Omega}{\partial w^-} \beta g(\Omega)$) is the *wage compression effect* already present in Acemoglu (1997) and discussed above. The second right-hand term ($-\frac{\partial \Phi}{\partial w^-} g(\Phi)$) is the

[4] This has already been modeled in Lechthaler and Snower (2006). In the current paper this result is placed in the wider context of how interactions among minimum wages, unemployment benefits and firing costs all affect incentives to train.

turnover effect introduced in Lechthaler and Snower (2006). Substituting the threshold equations (4) and (5) into the training effect of the minimum wage (9) yields:

$$\begin{aligned} \frac{\partial^2 \pi(\tau)}{\partial \tau \partial w^-} &= g(\Omega) - g(\Phi) \\ &= g(\frac{w^- - (1-\mu)b}{\mu} - a - \tau - f) - g(w^- - a - \tau - f) \end{aligned} \tag{10}$$

The intuition is straightforward. For low-ability workers, the probability of being at the firing threshold ($g(\Phi)$) is greater than the probability of being at the minimum wage threshold ($g(\Omega)$), and that a marginal rise in the minimum wage destroys more training incentives than it creates. The increase in turnover outweighs the increased probability that the minimum wage is binding.

Since we have assumed a symmetric distribution for the idiosyncratic shock ε, the two effects will cancel each other out for a worker whose ability lies exactly in the middle of the two thresholds ($a = (\omega + \Phi)/2$). For a high-ability worker, the PDF at the minimum wage threshold is higher while the PDF at the firing threshold is smaller.

To see how these effects depend on the magnitude of the minimum wage, we differentiate equation (10) with respect to the minimum wage:

$$\frac{\partial^3 \pi(\tau)}{\partial \tau \partial w^{-^2}} = \frac{1}{\mu} g'(\Omega) - g'(\Phi) \tag{11}$$

Given our distributional assumptions, for workers with very low ability, the slope at the minimum wage threshold is negative but higher than the slope at the firing threshold (which is also negative). Therefore, the derivative in equation (11) is negative which implies that the negative effect of the minimum wage is stronger when the minimum wage is higher. For workers with intermediate ability the slope of the PDF at both thresholds turns positive but since the binding threshold is larger, the PDF is initially more flat at this threshold. Only for workers with high ability, can the sign in equation (11) turn positive. Since the effect of the minimum wage is positive for these workers, this positive

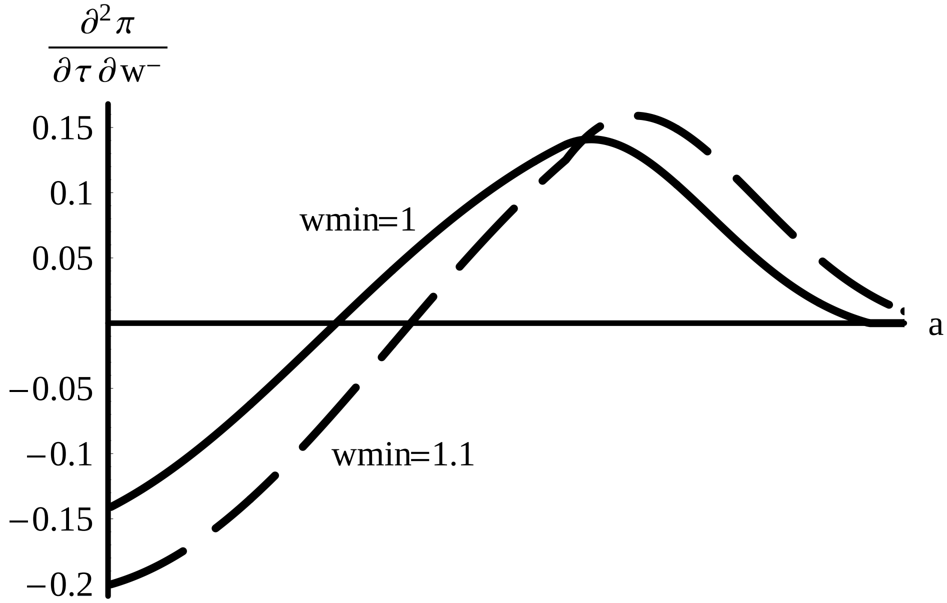

Figure 2: Change in the Minimum Wage

effect is stronger for higher minimum wages.[5] This concludes the proof of proposition 1.

Figure (2) illustrates the effects of a marginal increase in the minimum wage (equation (10)) for workers of different abilities. The calibration used is the same as in Lechthaler and Snower (2006): Bargaining power μ is 0.5, the idiosyncratic shock is assumed to be normally distributed with 0 mean and 0.75 standard deviation and the minimum wage is normalized to one. However, Lechthaler and Snower (2006) implicitly set firing costs and unemployment benefits equal to zero. Here we assume that both depend positively on the expected wage of a worker which depends on her innate ability. Specifically, we use the rules $b = 0.6w^e$ and $f = 0.6w^e$.[6] This implies that both unemployment benefits and firing costs are at least 60 percent of the minimum wage, but will be higher for workers with more ability. The figure also illustrates how the effect of the minimum wage changes with the magnitude of the minimum wage: The solid line is valid our baseline calibration

[5] There might exist an intermediate class of workers for whom the positive effect of the minimum wage is weakened.

[6] These numbers are in line with Grund (2003).

while the dashed line illustrates the training effect of the minimum wage starting with a minimum wage 10% higher.

3.2 Training and Unemployment Benefits

Proposition 2 ***The training effect of unemployment benefits:*** *Unemployment benefits lead to* ***deskilling****: An increase in unemployment benefits unambiguously decreases firm training for all workers.*

Unemployment benefits create ***increasing skills inequality****: As unemployment benefits are increased, their deskilling effect becomes stronger for low-ability workers, but weaker for high-ability workers.*

To derive the influence of unemployment benefits on training, we proceed in the same way as above, i.e. we differentiate the FOC-condition (8) with respect to unemployment benefits and obtain:

$$\frac{\partial^2 \pi(\tau)}{\partial \tau \partial b} = \frac{\partial \Omega}{\partial b} \mu g(\Omega) - \frac{\partial \Phi}{\partial b} g(\Phi) \tag{12}$$

Using the definition for the thresholds, this equation simplifies to:

$$\frac{\partial^2 \pi(\tau)}{\partial \tau \partial b} = -\left(1 - \mu\right) g(\Omega) < 0 \tag{13}$$

Thus, unemployment benefits unambiguously decrease the firm's returns to training. The reason for this result lies in the level-effect of unemployment benefits on wages. Unemployment benefits improve the bargaining position of workers and thereby the negotiated wage, as can be inferred from equation (2). Since the overall level of wages increases but the minimum wage stays constant, it becomes less likely that the latter is binding. In other words the compression of the wage structure decreases, as illustrated in figure (3). In line with Acemoglu (1997) the decrease in wage compression reduces firm training.

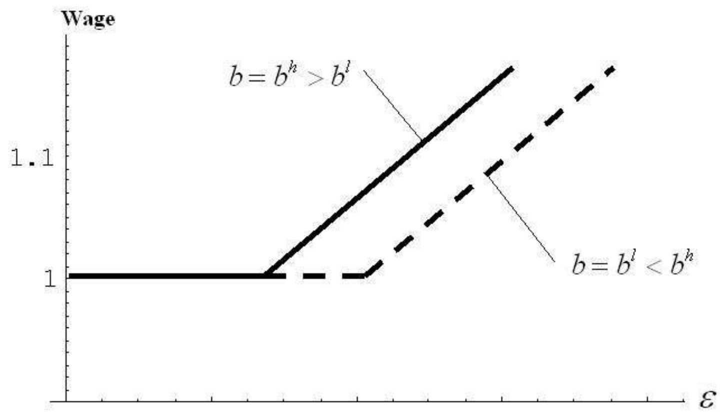

Figure 3: Unemployment Benefits and the Wage

Note that unemployment benefits only affect the training decision through the above effect on the likeliness that the minimum wage is binding. It does not affect the firing decision and it does not affect the compression of the freely negotiated wage.[7] [8]

To prove the second part of proposition 2, differentiate equation (13) with respect to unemployment benefits:

$$\frac{\partial^3 \pi(\tau)}{\partial \tau \partial b^2} = \frac{(1-\mu)^2}{\mu} g'(\Omega)$$

which is negative for workers with low ability and positive otherwise.

Figure (4) illustrates the effect of a marginal increase in the replacement ratio for the same economy as described in the section above. It can be seen that the effect on training is negative throughout for all workers. However, the effect is larger for workers with

[7] Or put formally: $\frac{\partial w^n}{\partial \tau \partial b} = 0$ and $\frac{\partial \Phi}{\partial b} = 0$.

[8] This is different for workers whose ability is high enough so that the minimum wage is never binding. For them an increase in unemployment benefits increases turnover. Although the transmission channel is different the result is still the same: Unemployment benefits decrease firm training.

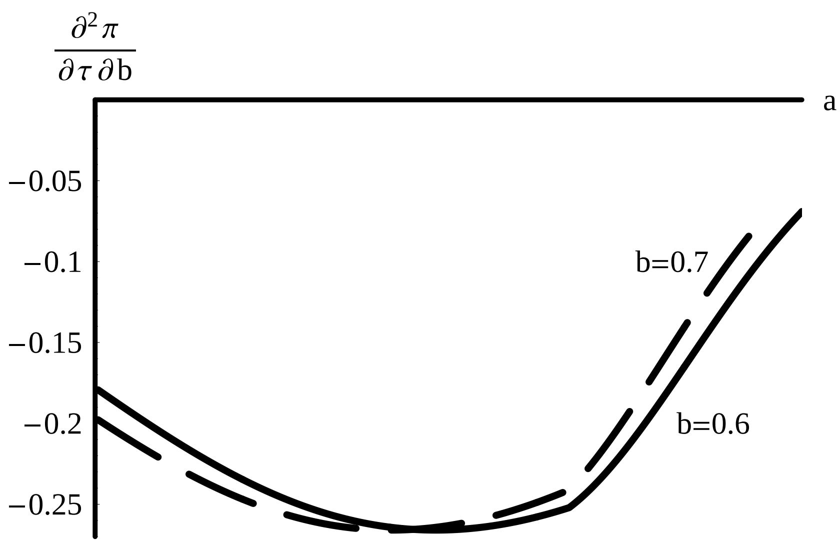

Figure 4: Change in Unemployment Benefits

relatively low ability. For higher ability the effect becomes smaller, because the negotiated wage becomes larger and larger and thereby the probability that the minimum wage is paid converges towards zero. The importance of the magnitude of unemployment benefits is illustrated by the dashed line which shows the same marginal impact of unemployment benefits but starting with a higher status-quo of 70% replacement ratio.

3.3 Training and Firing Costs

Proposition 3 ***The training effect of firing costs:*** *Firing costs generate "****skills equalization****":*

- *For low-ability workers (such that $g(\Phi) > \mu g(\Omega)$), an increase in firing costs increases firm training.*
- *For high-ability workers, (such that $g(\Phi) > \mu g(\Omega)$), an increase in firing costs decreases firm training.*

*Firing costs exhibit "**decreasing skills equalization**": As firing costs are increased, their equalizing effect on skills becomes progressively weaker.*

To see this, note that the derivative of the FOC-condition (8) with respect to firing costs is:

$$\frac{\partial^2 \pi(\tau)}{\partial \tau \partial f} = \frac{\partial \Omega}{\partial f} \mu g(\Omega) - \frac{\partial \Phi}{\partial f} g(\Phi) \tag{14}$$

Using the definition for the thresholds this equation simplifies to:

$$\frac{\partial^2 \pi(\tau)}{\partial \tau \partial f} = -\mu g(\Omega) + g(\Phi) \tag{15}$$

which directly yields the result in the first part of proposition 3. Firing costs have a similar level-effect on wages as unemployment benefits. They improve the bargaining position of workers by worsening the threat-point of the firm. Thus, the same reasoning as above applies to firing costs as well: The compression of the wage structure is diminished and incentives to train decrease (first term on the right-hand side of equation (15)). But contrary to unemployment benefits, there is a second effect: The probability of separations goes down.[9] Thus, it is more likely that the worker stays in the training firm and incentives to train increase.[10] As illustrated by figure (5), in our calibration of the model the positive effect always dominates and therefore firing costs increase training for all workers.

For the second part of the proposition differentiate equation (15) once more with respect to firing costs:

[9] Or put formally: $\frac{\partial \Phi}{\partial f} = -1$.

[10] The first effect is already present in Acemoglu (1997) but the second effect is ruled out by the exogeneity of separations Acemoglu assumes. It is introduced in Lechthaler (2006) which analyzes the interrelationship of firing costs and firm training. However, in that paper firing costs unambiguously increase firm training. The difference in results stems from the interaction between different institutions. In Lechthaler (2006) there is no minimum wage and therefore the effect on wage compression described above is not present.

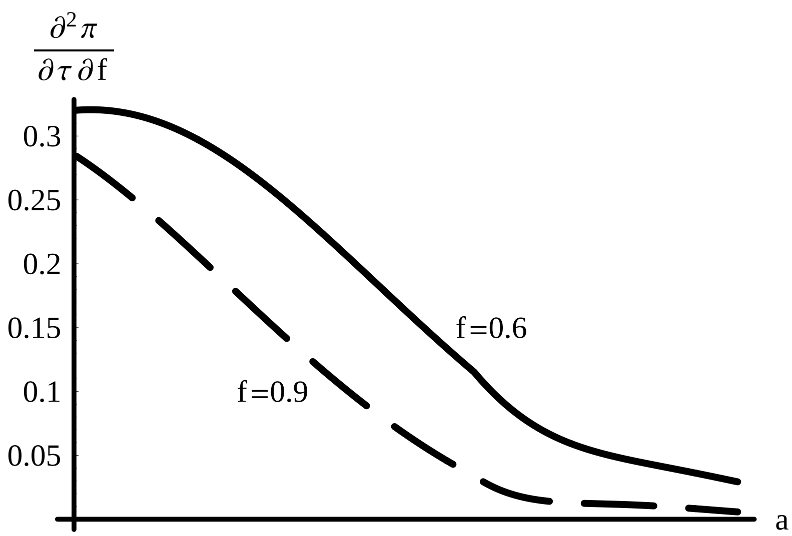

Figure 5: Change in Firing Costs

$$\frac{\partial^3 \pi(\tau)}{\partial \tau \partial f^2} = \mu g'(\Omega) - g'(\Phi)$$

which is always negative with our calibration. The influence of the magnitude of firing costs is illustrated by the dashed line in figure (5).

4 Institutional Interactions

4.1 The Minimum Wage and Unemployment Benefits

Thus far we have considered only the isolated training effects of minimum wages, unemployment benefits and firing costs . In this section we analyze how these institutional variables interact with each other in influencing training.

First we examine how the training effect of unemployment benefits is influenced by minimum wages (or, equivalently, how the training effect of minimum wages is influenced by unemployment benefits).[11]

Proposition 4 ***The interaction between unemployment benefits and the minimum wage:*** *Unemployment benefits and the minimum wage are* ***substitutes in their effect on skills inequality****: While unemployment benefits increase skills inequality, the minimum wage weakens this effect. (Equivalently, while the minimum wage increases skills inequality, unemployment benefits weaken this effect.)*

The reason is straightforward: For low-ability workers (below $(\Omega + \Phi)/2$) and high-ability workers (such that $g'(\Omega) > 0$), an increase in unemployment benefits weakens the training effect of the minimum wage. For workers of intermediate ability, an increase in unemployment benefits strengthens the positive effects of the minimum wage.

To see this, observe that

$$\frac{\partial^3 \pi(\tau)}{\partial\tau\partial w^- \partial b} = -\frac{1-\mu}{\mu} g'(\Omega)$$

As already mentioned, an increase in unemployment benefits improves the bargaining position of the worker thus moving the minimum wage threshold Ω to the left. For workers whose ability is below this threshold, a decrease in the threshold will imply an increase in the probability of lying at that threshold (see figure (1)). In other words, the threshold's movement to the right (induced by the change in benefits) increases the influence of the minimum wage on wage compression. The opposite is the case for workers with abilities above the threshold. An increase in benefits still decreases the minimum wage threshold, but for high-ability workers this will further diminish the importance of the minimum wage and thereby its positive effects.

The result is illustrated in figure (6). Both lines in the figure illustrate the change in training induced by a marginal increase in the minimum wage. The solid line (which is the same as in figure 2) is valid for a replacement ratio of 60 percent whereas the

[11] Clearly, $\frac{\partial^3 \pi(\tau)}{\partial\tau\partial w^- \partial b} = \frac{\partial^3 \pi(\tau)}{\partial\tau\partial\partial b w^-}$.

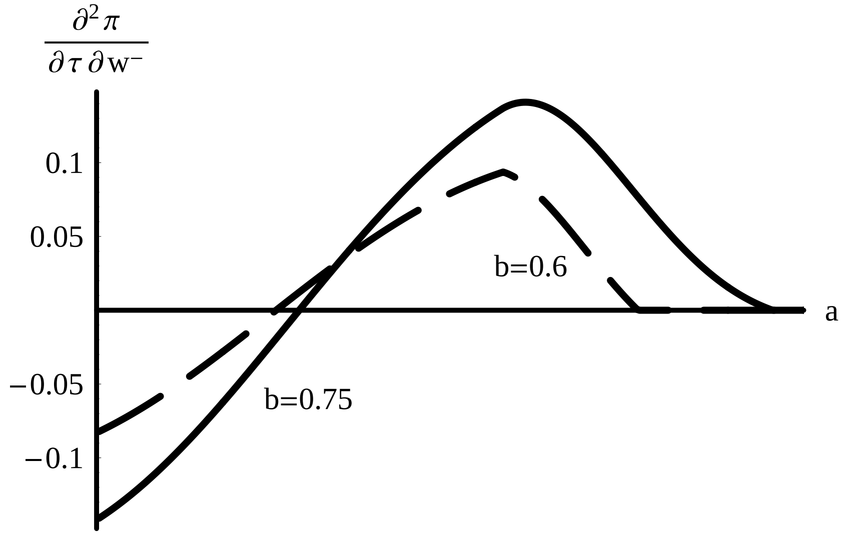

Figure 6: Unemployment Benefits and the Minimum Wage

dashed line illustrates a replacement ratio of 75 percent. In this way, the figure illustrates the outcome of Proposition 4: For low-ability workers, the negative training effect of the minimum wage is weakened by unemployment benefits; for high-ability workers, the positive training training effect of the minimum wage is also weakened by unemployment benefits.

4.2 The Minimum Wage and Firing Costs

Proposition 5 ***The interaction between firing costs and the minimum wage:*** *Firing costs and the minimum wage are* ***complements in their effects on skills equalization****: While firing costs equalize skills, the minimum wage strengthens this effect. (Equivalently, while the minimum wage increases skills inequality, firing costs weaken this effect.) Thus the interaction between firing costs and the minimum wage promotes skill equalization.*

In particular, for low-ability workers (below $(\Omega + \Phi)/2$) and high-ability workers (such that $g'(\Omega) > g'(\Phi) > 0$), an increase in firing costs weakens the training effect of the

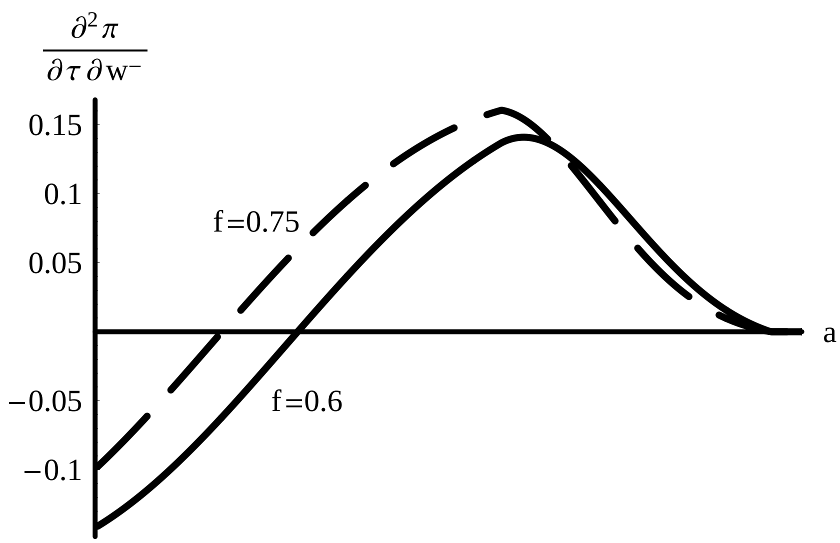

Figure 7: Firing Costs and the Minimum Wage

minimum wage. For workers of intermediate ability, an increase in firing costs strengthens the positive effect of the minimum wage.

To prove this, we differentiate equation (10):

$$\frac{\partial^3 \pi(\tau)}{\partial \tau \partial w^- \partial f} = -g'(\Omega) + g'(\Phi)$$

which is negative if $g'(\Omega) > g'(\Phi) > 0$ and positive otherwise.[12]

To understand this result, recall that the minimum wage tends to increase training due to the wage compression effect and to decrease training due to higher risk of separation. For a low-ability worker, the second effect dominates and therefore training decreases with the minimum wage. An increase in firing costs moves both thresholds to the left. For workers with low or intermediate ability, this implies that the wage compression effect becomes relatively more important and thus an increase in the minimum wage

[12]In principle, it is also negative if $g'(\Phi) < g'(\Omega) < 0$ but this case can be ruled out for plausible calibrations. Replacement ratios as low as 30% are needed to allow for this effect and then it would be very small compared to the other effects.

is less harmful for low-ability workers and even more positive for intermediate-ability workers. For high-ability workers, the opposite is the case, since the turnover effect becomes relatively more important and therefore the positive effect is weakened.

4.3 Unemployment Benefits and Firing Costs

Proposition 6 ***The interaction between firing costs and unemployment benefits:*** *Firing costs and unemployment benefits are* ***complements in their effects on skills disequalization****: While unemployment benefits increase skills inequality, firing costs strengthen this effect. Equivalently, while firing costs reduce skills inequality, unemployment benefits weaken this effect. Thus the interaction between firing cost and unemployment benefits promotes skills disequalization.*

For workers with relatively low (high) ability the training destruction effect of unemployment benefits is strengthened (weakened) by an increase in firing costs. To see this, consider the derivative of equation (13) with respect to firing costs:

$$\frac{\partial^3 \pi(\tau)}{\partial \tau \partial b \partial f} = (1-\mu) g'(\Omega)$$

which is negative for workers with the lowest ability and positive otherwise. Again the result is illustrated graphically, see figure (8).

The result is explained by the effect of firing costs on the minimum wage threshold which is decreased. For low-ability workers (with a below the maximum of the shock-distribution) this means that the negative effect of unemployment benefits (a further decrease in the minimum wage threshold) is strengthened while it is weakened (i.e. becoming less relevant) for high-ability workers.

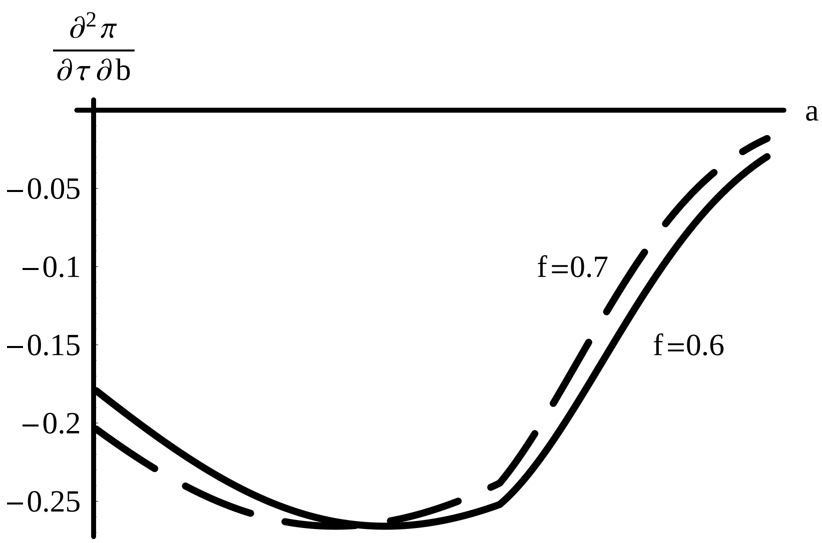

Figure 8: Firing Costs and Unemployment Benefits

5 Summary of Results and Conclusions

The results of the previous two sections can be compactly summarized in three tables. To do so, we subdivide workers into low, intermediate and high ability groups.[13]

The tables should be read as follows. The second column of Table (1) shows how a worker of low ability is affected by isolated changes in each of the three institutional variables under consideration (the minimum wage, unemployment benefits and firing costs). Thus, the entry in the third row of the table (the "−") refers to the first part of proposition 1 and tells us that an increase in the minimum wage will lower the training of a worker with low ability. Columns 3 to 5 illustrate the interaction with the other institutions. Thus, the entry in line 4 and column 5 ("strengthened") refers to proposition 6 and tells us that the negative effect of unemployment benefits is strengthened with increases in

[13] It should be noted that these groups are defined with respect to the effects of a specific institution. As becomes clear from the propositions above, these definitions are not exactly equivalent for all institutions. Thus, for instance a worker who is defined intermediate in the row of the minimum wage might be defined low-ability in the line of firing costs.

firing costs.[14]

Table 1: Summary of Effects for Workers with low Ability

	Isolated Effect	Interactions		
		∂w^-	∂b	∂f
$\frac{\partial \tau}{\partial w^-}$	$-$	*strengthened*	*weakened*	*weakened*
$\frac{\partial \tau}{\partial b}$	$-$	*weakened*	*strengthened*	*strengthened*
$\frac{\partial \tau}{\partial f}$	$+$	*strengthened*	*weakened*	*weakened*

Table 2: Summary of Effects for Workers with intermediate Ability

	Isolated Effect	Interactions		
		∂w^-	∂b	∂f
$\frac{\partial \tau}{\partial w^-}$	$+$	*weakened*	*strengthened*	*strengthened*

Finally, the results so far can be further compressed into a statement about the effects of institutions on skills inequality. This is done in Table (4). Consider unemployment benefits, for example. As can be seen from Figure (4), unemployment benefits decrease training for all workers, but the effect is larger for workers with relatively low ability and therefore the inequality in training is increased (the "$-$" in the second column of the fourth row). As can be seen from tables (1) and (3), an increase in the minimum

[14]Note that Tables 1 and 3 each have five rows, whereas Table 2 has only three rows, implying that only the analysis of the minimum wage requires the categories of "low," "intermediate," and "high" ability workers, whereas the analysis of unemployment benefits and firing costs requires only the categories of "low" and "high" ability workers. The reason is that the effect of the minimum wage on training changes sign as ability rises, whereas the effect of unemployment benefits on training is always negative and the effect of firing costs on training is always positive. Thus, the effect of a change in the minimum wage (illustrated in Fig. 2) requires consideration of three ability classes, whereas the effect of a change in unemployment benefits and firing costs (illustrated in Figs. 4 and 5, respectively) requires consideration of only two ability classes.

Table 3: Summary of Effects for Workers with high Ability

	Isolated Effect	Interactions		
		∂w^-	∂b	∂f
$\frac{\partial \tau}{\partial w^-}$	$+$	*strengthened*	*weakened*	*weakened*
$\frac{\partial \tau}{\partial b}$	$-$	*strengthened*	*weakened*	*weakened*
$\frac{\partial \tau}{\partial f}$	$+$	*weakened*	*strengthened*	*weakened*

wage weakens the effect for low-ability workers but strengthens the negative effect for high-ability workers. Unemployment benefits still increase skills-inequality, but the effect is weakened by the increase in minimum wages (see Row 4, Column 3 of Table (4)). Conversely, an increase in firing costs strengthens the inequality effect of unemployment benefits (row four, column five of table (4)).

Table 4: Effects of Institutions on the Inequality of Training

	Isolated Effect	Interactions		
		∂w^-	∂b	∂f
$\frac{\partial \tau}{\partial w^-}$	more unequal	*strengthened*	*weakened*	*weakened*
$\frac{\partial \tau}{\partial b}$	more unequal	*weakened*	*strengthened*	*strengthened*
$\frac{\partial \tau}{\partial f}$	less unequal	*strengthened*	*weakened*	*weakened*

This table summarizes the propositions above in the following way:

- Moving downward along the diagonal from Row 3, Column 3 toward Row 5, Column 5, we see that the minimum wage and unemployment benefits both create increasing skills inequality and that firing costs create decreasing skills inequality.
- Row 4, Column 3 and Row 3, Column 4 indicate that the minimum wage and unemployment benefits are substitutes in their effects on skills inequality.

- Row 5, Column 3 and Row 3, Column 5 show that firing costs and the minimum wage are complements in their effects on skill equalization.
- Finally, Row 5, Column 4 and Row 4, Column 5 indicate that firing costs and unemployment benefits are complements in their effect on skill disequalization.

With regard to our measure of skills inequality above, these results suggest a ranking among the three institutional variables. Unemployment benefits have the most harmful effects, in the sense that they reduce firm training for workers of all abilities and especially for low-ability workers. In addition, they reduce the skills-equalization effects from firing costs.

Firing costs have the least harmful effects, with regard to skills inequality. They are the only institutional variable that stimulates firm training for workers of all abilities, and especially for low-ability workers.

The minimum wage occupies an intermediate position on this ranking. As shown, it reduces the skills of low-ability workers, while increasing the skills of high-ability workers. But although skills inequality is increased unambiguously, the minimum wage at least mitigates skill disequalization (amplifies skill equalization) arising from the other institutional variables, i.e. it weakens the skill disequalization from unemployment benefits and it strengthens the skill equalization from firing costs.

6 References

Acemoglu, Daron (1997), "Training and Innovation in an Imperfect Labor Market," *Review of Economic Studies*, 64, 445-464.

Acemoglu, Daron, and Jörn-Steffen Pischke (1999), "The Structure of Wages and Investment in General Training," *Journal of Political Economy*, 107, 539-572.

Acemoglu, Daron and Pischke, Jörn-Steffen (2003): Minimum Wages and On-the-Job Training, *Research in Labor Economics*, 22, 159-202.

Bassanini, Andrea and Romain Duval (2006), "Employment Patterns in OECD Countries: The Role of Policies and Institutions," *OECD Economics Department Working Paper*, 486.

Coe, David and Snower, Dennis (1997): Policy Complementarities: The Case for Fundamental Labor Market Reform, *IMF Staff Papers*, 44, 1-35.

Elmeskov Jorgen, Martin John and Scarpetta Stefano (1998): Key Lessons for Labor Market Reforms: Evidence from OECD Countries' Experiences, *Swedish Economic Policy Review*, 5.

Orszag, Michael and Snower, Dennis (1998): Anatomy of Policy Complementarities, *Swedish Economic Policy Review*, 5, 303-345.

Scarpetta, Stefano (1996)), Assessing the Role of Labor Market Policies and Institutional Settings on Unemployment: A Cross-Country Study, *OECD Economic Studies*, 26.

DiNardo John, Fortin Nicole and Lemieux Thomas (1996): Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach, *Econometrica*, 64, 1001-1044.

Grossberg, Adam and Sicilian, Paul (1999): Minimum Wages, On-the-Job Training, and Wage Growth, *Southern Economic Journal*, 65, 539-556.

Grund, Christian (2003): Severance Payments for Dismissed Workers in Germany, *IZA DP*, 875.

Lechthaler, Wolfgang (2006): The Interaction of Firing Costs and Firm Training, *University St. Gallen discussion paper, 01-2006*,

Lechthaler, Wolfgang and Snower, Dennis (2006): Minimum Wages and Firm Training, *Kiel Working Paper*, 1298.

Leighton , Linda and Mincer, Jacob (1981): The Effect of Minimum Wages on Human Capital Formation, in Rottenberg, Simon (editor): *The Economics of Legal Minimum Wages*, Washington, American Enterprise Institute for Public Policy Research, 155-173.

Mortensen, Dale and Pissarides, Christopher (1994): Job Creation and Job Destruction in the Theory of Unemployment, *Review of Economic Studies*, 61, 397-415.