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Wage Divergence and Unemployment: The Impact of Wage Setting Power and Training Costs*

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Abstract

Technological change increases the training needs for all workers intending to work in skilled jobs. This paper identifies the related training costs as one of the driving forces for wage divergence and unemployment in the wake of skill-biased technological change. A theoretical model argues that higher and increasing skilled wage mark-ups and lower incidence of mismatch unemployment in the USA in comparison with Germany stems from higher wage setting power of workers in skilled jobs in the USA. US workers in skilled jobs can charge higher wages without the risk of losing their jobs because the costs needed for training the unskilled are higher than in Germany.

Zusammenfassung

Der technologische Wandel erhöht den Weiterbildungsbedarf aller Beschäftigten, die in qualifizierten Arbeitsplätzen tätig sein wollen. Dieser Beitrag identifiziert die für die Weiterbildung anfallenden Kosten als eine der treibenden Kräfte für Lohnspreizung und Arbeitslosigkeit in Zeiten qualifikationsverzerrten technischen Fortschritts. Unser theoretisches Modell erklärt die höheren und steigenden Lohnaufschläge für qualifizierte Beschäftigte und die niedrigere Mismatcharbeitslosigkeit in den USA im Vergleich zu Deutschland mit der höheren Lohnsetzungsmacht dieser Beschäftigtengruppe. Qualifizierte Beschäftigte in den USA können höhere Löhne fordern ohne ihre Arbeitsstelle zu gefährden, weil die notwendigen Weiterbildungskosten von niedriger qualifizierten Mitarbeitern für qualifizierte Arbeiten höher sind als in Deutschland.

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1. Introduction

The wage mark-up for skilled jobs has increased since the 1980s in the USA, due to skill-biased technological change combined with a relatively

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slow growth in the supply of skills (Katz / Autor 1999; Acemoglu 2002; Blau / Kahn 2002; Beaudry / Green 2003). In contrast, wage inequality has remained unchanged in Germany (Katz / Autor 1999; Fitzenberger 1999; Devroye / Freeman 2001).[1, 2] Moreover, unemployment in the USA is low and cyclical, whereas Germany's labor market is characterized by high and persisting unemployment in recent years. Almost all those who suffered from the increase in German unemployment have been the less skilled.[3] If we take into account that between 1971 and 1995 the number of vacancies increased considerably in Germany and that these vacancies were mainly for skilled professionals[4], it is clear that unemployment in Germany consists to a large and growing extent of mismatch unemployment in the last decades (Entorf 1999). In the USA on the other hand, we do not observe a comparable mismatch level (Brunello / Medio 2001) or such an increase in mismatch unemployment (Entorf 2000). A direct comparison of both countries shows that the ratio of unemployment rates for highly skilled and less skilled workers increased in Germany, while this was not the case for the USA.[5] Table 1 summarizes these stylized facts.

The aim of this paper is to provide an innovative additional explanation for these labor market differences, because well-known arguments, such as differences in the impact of technological changes, supply of skilled employees, institutional rigidities or differences in capital accumulation, do not appear to be convincing for four main reasons. First, the patterns of technological

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1 Freeman and Schettkat (2001) find that the wage mark-up between the lowest skill equivalent and the next higher skill equivalent is larger in Germany than in the USA. Their metric might not be applicable to this paper, however, because it is based on school education levels instead of professional degrees. This means that we cannot distinguish between qualified and unqualified people according to our definition that refers to professional qualifications. Möller (2004) notes that the difference in income inequality between the first and fifth decile is comparable to that between the fifth and ninth decile. This means that also for higher qualified employees the wage gaps between qualification levels are lower in Germany.

2 We choose the comparison USA – Germany, because both countries have the largest differences in the development of wage inequality in recent years, and there are several bi-national studies that provide useful evidence for our argument. Our analysis is general enough, however, to provide insights into the development of wage inequality and unemployment in other countries as well.

3 Reinberg and Hummel (2002) find that the unemployment rate of the unskilled in West-Germany was around 5 % in the late seventies while since then it increased in two waves to almost 20 % in 2000 with peaks in 1983 (around 16 %) and 1997 (around 24 %). The unemployment of highly qualified employees remained remarkably constant since 1975 and never reached 5 %. In 2000, it was 2.6 %. The unemployment rate of the medium skilled in West-Germany swung cyclically around 5 %.

4 The number of vacancies reached 1.3 million while 4.1 million unemployed were registered in March 2000 (Entorf 2000).

5 Glyn (2001) sketches a similar picture. On the basis of OECD data, he argues that the relative employment rate of the lowest education quartile in comparison with the highest education quartile was by 10 percentage points lower in Germany than in the USA.

change seem to be very similar for both countries (Beaudry / Green 2003). Computers, for example, were adopted only at a slightly lower pace in Germany than in the United States (Acemoglu / Pischke 1999). Second, the relative supply of skills does not seem to have increased considerably faster in Germany than in the USA (Fitzenberger 1999, 8; Acemoglu 2002). Third, the institutional differences usually cited to explain labor market differences such as wage rigidities and effective minimum wages in Germany versus flexible labor markets in the USA,[6] have also been challenged. Nickell (1997) argues that wage rigidities are frequently introduced in the models in an ad hoc way and that they are not based on empirical facts.[7] Acemoglu (2002, 61) points out that purely exogeneous sources of the stable skill premium in Germany are hard to defend: "unless there are extremely rigid institutions that fix the skill premium exogeneously, skill-biased technical change should increase wage inequality irrespective of the degree of exogeneously imposed wage compression". Finally, the explanation put forward by Beaudry and Green (2003) of differences in the accumulation of physical capital can be criticized too. While their model fits the stylized facts, it remains agnostic on the precise forces that have let both countries to select different capital growth paths. Since our model does not include the capital market, a further elaboration of their argument is beyond the scope of this paper.

Instead of assuming exogeneously determined wage rigidities in Germany, we use institutional differences between Germany and the USA that endogeneously lead to the observed labor market differences and that are confirmed by empirical studies. For our argument, we first apply well documented effects of skill-biased technological change on training needs: new technologies induce the need for continuous training (Acemoglu / Pischke 1999; Brunello / Medio 2001; Zwick 2005). These training needs are positively correlated with the skill and sophistication necessary for the job (Acemoglu / Pischke 1999; Acemoglu 1999). The firms pay a large part of the training costs for the skilled employees, whereas the training costs for the unskilled workers whose jobs are less affected by technological changes have to be borne mainly by the employees themselves (OECD 1999b; Heckman 1999). Our second argument concerns the possibilities of unskilled outsiders to become skilled insiders: in order to be eligible to work in skilled jobs, unskilled employees have to invest in extra training. This extra training that promotes their career usually is financed by the employees in unskilled jobs themselves.

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6 An alternative candidate for an explanation of the wage differences is the more dispersed skill distribution in the USA in comparison with Europe (Nickell / Bell 1996; Wälde 2000). However, Devroye and Freeman (2001) show that dispersion of internationally comparable test scores among native born Americans are very similar to those in Germany while wage inequality among these native born Americans is much higher than among Germans.

7 A similar argument is found in Card and Krueger (1995) and Fitzenberger (1999, 3).

Table 1

Wage inequality and relative unemployment by skill level, USA and Germany

	Years°	USA	Germany
90 – 10 differentials of log hourly wages	1979 / 1985	1.3[a]	1.1[a]
	1991	1.4[a]	1.0[a]
	2000	1.4[c]	1.0[c]
Ratio unemployment: less to highly qualified[p]	1971 / 75 – 82	3.9[b]	3.8[b]
	1991 – 93 / 92	3.7[b]	4.9[b]
	2000	3.8[c]	7.3[c]

Sources: [a] Acemoglu / Pischke (1999, 137); [b] Nickell / Bell (1996, 303); [c] own calculations from CPS (USA), GSOEP and Mikrozensus (Germany). Wage differential values for 2000 are re-scaled in order to match values calculated by Acemoglu / Pischke (1999).

Remark: The year(s) after the slash, when indicated, pertain to Germany. [p] Less qualified individuals have no high school degree in the USA and no vocational qualification in Germany respectively, highly qualified individuals have a university degree or equivalent qualification.

We use the argument by Acemoglu and Pischke (1999) that the incentives for firms to train depend on the relative skilled wage mark-up. Their analysis is incomplete, however, since they focus on firm behavior and take the supply of skilled and unskilled employees and wage rigidities as given.[8] We elaborate their argument by endogenizing skill supply and wage setting behavior of both skill groups. This paper therefore complements the literature on the effects of skill-biased technological change on the wage structure, which mainly focuses on the training decisions of firms at a given supply of employees with certain educational attainments and an exogeneously determined wage structure.

Our main assertion is that skilled employees set the skilled wage mark-up in such a way that the unskilled employees do not threaten their jobs. Skill-biased technological change makes it necessary for everybody who wants to work in a skilled job to invest in training. In addition, unskilled employees have to invest in extra training that promotes their career and provides them with the necessary skills needed for skilled jobs. The firms decide between financing training of their skilled employees or replacing them by job entrants who paid for all training, including extra training, themselves. We argue that extra training costs that employees in unskilled jobs have to bear to improve

[8] With respect to worker behavior, Acemoglu and Pischke point out that for badly paid low skilled employees the motivation for investing in training themselves is lower in the USA than in Germany, because the wage cut caused by training costs and credit constraints has a deterrent effect. They conclude that in the USA "this divergence in the training patterns therefore exacerbates the already increasing wage gap between more and less educated workers" (Acemoglu / Pischke1999, 138).

their abilities with the aim of working in skilled jobs are higher in the USA than in Germany. In the USA, it is therefore more expensive for unskilled people to invest in training, enter the skilled labor market and replace the employees in the skilled jobs. Thus, the scope for skilled wage mark-ups is higher in the USA than in Germany, which partly explains the compressed wage structure there. As a corollary, we also find in our model that the lower relative skilled wages in Germany lead to higher relative skilled labor demand than in the USA. This demand is not satisfied, because not enough unskilled employees are motivated to invest in training. Thus, German firms are constrained in their demand for skilled labor, and mismatch unemployment occurs.[9]

In section 2, a benchmark labor market framework is developed in which all employees have an adequate job. In this scenario, skill-biased technological change increases the relative skill demand and requires investments in training of all workers who wish to work in skilled jobs. Wage setting behavior of employees in skilled jobs is introduced in the third section and the different labor market equilibria are derived. In section 4, we interpret the results in the light of the empirical observation that training costs for the unskilled are higher in the USA than in Germany. The last section provides some policy conclusions.

2. Skill-biased technological change and labor demand

In our analysis of the labor market, skill-biased technological change leads to an increase in relative skill demand. Technological change also implies training needs for the incumbent skilled workers and potential entrants. This section elaborates these two points.

Skill demand and technological change

We distinguish between skilled labor H and unskilled labor L as factors of production in a representative firm, with wages w_H and w_L respectively. The relative wage is $w = w_H/w_L$ and the relative demand for labor is $h = H/L$. We assume that skilled and unskilled employees are gross substitutes. This assumption is supported by empirical evidence for the USA and Germany (Freeman 1986; Falk / Koebel 1999; Acemoglu 2002). A convenient representation of the production structure then is a CES-production function $Y = \left[(A_l L)^\rho + (A_h H)^\rho\right]^{1/\rho}$ with an elasticity of substitution between skilled and unskilled labor of $\sigma = 1/(1-\rho) > 1$, while A_l and A_h are technology para-

[9] This is of course only one possible explanation for the German unemployment problems – Austria and Switzerland manage to keep their unemployment rates relatively low although these countries have comparable training and education systems and a compressed wage structure as well.

meters with $A_l < A_h$. For simplicity we assume that firms maximise profits in a myopic way, given output prices and wages.

Firm behavior results in the following relative labor demand curve:[10]

$$h^{d1}(w) = A^{\sigma-1} w^{-\sigma} \tag{1}$$

with $A = A_h/A_l$. Total supply of skilled and unskilled labor initially is n and m respectively, and relative supply is given by $h^* = n/m$. Labor market equilibrium with full employment, characterized by a relative skilled employment h^* and a relative wage rate of w^*, is found in point E in Figure 1, where the relative skilled labor demand curve is depicted by the curve h^{d1}.

The notion that technological change is skill-biased is represented by an increase of A to $A_n = \xi A$ with $\xi > 1$. This implies that for a given relative wage rate the relative demand for skilled labor increases.[11] Therefore, skill-biased technological change shifts the relative demand curve for skilled labor outwards from h^{d1} to h^{d2} in Figure 1. However, as we argued above, technological changes induce new skill requirements and this makes training necessary. Skilled jobs are more strongly affected by these training needs than unskilled jobs in the wake of technological change (Acemoglu / Pischke 1999).[12] This induces the necessity for all workers in skilled jobs – insiders as we elaborate below, represented by the subscript I – to train themselves at fixed costs C.[13] A large share $\gamma_I < 1$ of the costs C is usually paid by the firm for the insiders and a large fraction of the skill acquisition does not involve costs because it is training-on-the-job (Peraita 2001; Pischke 2001; Hakanson / Johanson / Mellander 2002; Zwick 2005). This implies that the new relative demand for labor from skilled insiders h_I^{d2} is given by:

$$h_I^{d2}(w) = (\xi A)^{\sigma-1} (w + \gamma_I C)^{-\sigma} \ . \tag{2}$$

At this stage, it is important to note that the pool of candidates for skilled jobs consists of two groups of employees. On the one hand, there are those incumbent employees who have been employed in a skilled job in the period

[10] In Muysken and Zwick (2000) we derive a similar relative labor demand function using a simple general equilibrium model with firms producing skill intensive and skill extensive goods, see also Davis (1998).

[11] This follows from the assumption that $\sigma > 1$ (see Acemoglu 2002, 18).

[12] Therefore we assume for simplicity that no training is needed for performing unskilled jobs.

[13] These costs C are relative to the fixed low-skilled wage w_L, which acts as the numéraire. This also holds for the extra costs C_0 and the turnover costs T introduced below. We assume all costs to be sunk. Since we assume myopic behavior, firms try to compensate for these costs immediately. If we would assume more forward looking behavior, only part of these costs should be included in the relative demand function for labor.

before, the insiders. On the other hand, there are employees in unskilled jobs who do not have sufficient education and formal training to work in skilled jobs. These typical outsiders, denoted by the subscript *O,* did not get the skilled insiders' training-on-the-job but need extra training at costs C_o that is not paid by their employers (Heckman 1999; Brunello / Medio 2001; Kuckulenz / Zwick 2003) in order to be eligible to work in skilled jobs. In addition, the unskilled outsiders also need the normal training at costs *C,* which may be partly covered by their employers if they get a skilled job. It seems plausible that the share γ_O of the normal training costs *C* for the unskilled workers (outsiders), the employers want to pay is smaller than the share taken over for the skilled employees (insiders), i.e. $\gamma_O \leq \gamma_I$.[14]

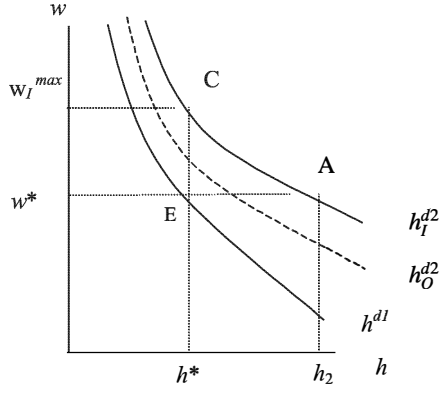

Figure 1: The impact of skill-biased technological change on labor demand

Before technological change, the firm can substitute newly skilled entrants for skilled employees by incurring turnover costs *T.* This is the standard insider-outsider situation depicted for example in the survey by Lindbeck and Snower (2002). The turnover costs typically consist of hiring and firing costs. Hence, if the employers want to hire outsiders instead of the insiders after skill-biased technological change, they have to pay both the turnover costs *T* and their share of the training costs $\gamma_O C$. Since it seems reasonable to assume that these costs exceed the costs paid for the training of the incumbent workers $\gamma_I C$, the relative demand curve for outsiders lies to the left of h_I^{d2} in Figure 1. It is given by:

$$h_O^{d2}(w) = (\xi A)^{\sigma-1}(w + T + \gamma_O C)^{-\sigma} \; . \tag{3}$$

[14] Notice that our argument also holds for $\gamma_O = 0$, i.e. if the firms do not pay anything for the normal training of the outsiders.

In line with the insider-outsider literature, we assume that both insiders and outsiders make wage offers to the employer which will be accepted or not (Lindbeck / Snower 2002). If the employer accepts the insiders' wage offer, the new equilibrium is on the new relative demand curve for labor h_I^{d2} according to equation (2), see Figure 1. If the insiders are replaced by the outsiders, however, the new equilibrium can be found on the relative demand curve h_O^{d2} according to equation (3), also see Figure 1.

3. Insider and outsider behavior

In our analysis, skill supply is endogenous and subject to a rational expected cost / benefit calculation for training (Zwick 2001). This implies that the necessity for outsiders to sink costs in extra training and in normal training[15] gives insiders in skilled jobs the scope to increase skilled wage demand without endangering their jobs until it is rational for unskilled outsiders to indeed invest in skills. We therefore analyze insider wage setting behavior together with the reaction of the employees in unskilled jobs (outsiders).

The behavior of the skilled employees

If the skilled insiders want to keep their skilled jobs, they have to invest in training. Since a share γ_I of the training costs for skilled workers C is paid by the firm, the skilled workers' training costs $c_I = (1 - \gamma_I)C$ are small, but not negligible. Note that for analytical simplicity, we define the skilled training costs c_I relative to the fixed unskilled wage, which is the numéraire.

The insiders aim at maximizing their utility, which consists of wages net of training costs, within the feasible wage range:[16]

$$U_I = w - c_I \qquad \text{subject to} \qquad c_I \leq w \leq \min[w_O^{\min}, w_I^{\max}] \; . \tag{4}$$

The feasible wage range is bounded from below by the skilled training costs, c_I. That is, the n insiders determine first whether the relative wage for skilled workers is high enough to invest in training and to stay in the skilled job (Gregg / Manning 1997). With the relative skilled wage at w^*, we assume that the insiders do cover their training costs. Therefore, the initial equilibrium E in Figure 1 is feasible.

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15 For example, the unskilled worker with a degree from the dual apprenticeship system attends a master craftsman course without having the guarantee from her employer that she will be promoted to a skilled job.

16 To keep the analysis as simple as possible, we also assume myopic behavior for insiders and outsiders. Moreover, as in the case of costs, utility is relative to the unskilled wage w_L.

In maximizing their utility the insiders aim at a higher wage than w^*.[17] However, following the literature we assume that it is never in the interest of the insiders to demand a skilled wage that leads to a skilled labor demand lower than *n,* given a feasible relative wage w^* (Blanchard / Summers 1986; Lindbeck / Snower 1994; Fiorillo / Santacroce / Staffolani 1999). Therefore, the highest relative wage the insiders may aspire to after skill-biased technological change is $w_I^{\max}$. At this level, skilled labor demand is equal to the number of insiders *n,* given the number of *m* employed outsiders, i.e. $h_I^{d2}(w_I^{\max}) = h^*$ – compare point *C* in Figure 1.

In addition, for the skilled insiders it is never utility-maximizing to get a wage $w_O^{\min}$ that allows outsiders to displace them (Fiorillo / Santacroce / Staffolani 1999; Muysken / Zwick 2000; Gottfries / Sjöström 2000). This means that the relative wage target is at the level $w_I^{\max}$ only if the outsiders have no credible threat to replace them, otherwise the insiders aim at a lower wage. In order to analyze this further, we look at outsider behavior.

The behavior of outsiders

The main difference between outsiders and insiders in this model is that the outsiders did not invest in education and training in the previous period and consequently worked in unskilled jobs (Lindbeck / Snower 1994). The outsiders have three options: either they do not invest in extra and normal training and stay ineligible for skilled jobs, or they train and join the insiders and get the additionally available skilled jobs, or they substitute the insiders by offering a higher profit to the firm than the insiders. We assume that the outsiders do not pose a credible threat to replace the insiders in the initial situation at point *E* in Figure 1.

In line with the majority of the insider-outsider literature, we assume that outsiders are homogeneous in their capabilities (Blanchard / Summers 1986; Lindbeck / Snower 1988, 2002; Gottfries / Sjöström 2000). This implies that either the outsiders replace all insiders or they remain unskilled. Another implication of homogeneous outsiders in our model is that all outsiders have to invest in human capital in order to replace the insiders. Both implications are not very realistic. Therefore we elaborated in Muysken and Zwick (2000) the distinction between "normal" and "clever" active outsiders and "passive" outsiders. The clever outsiders might prefer to join the insiders instead of cooperating with the normal outsiders, and in this version of the model therefore only some outsiders may decide to train while others stay unskilled. Since our analysis leads to qualitatively the same conclusions, we work with homogenous outsiders who pursue their own interests, taking into account the actions of the insiders (Lindbeck / Snower 1988).

[17] Since we assume full bargaining power for insiders, they will set the skilled wage mark-up on w^* as high as possible.

A credible outsider threat

We assume that the number of outsiders m exceeds the number of insiders, i.e. $m > n$. In order to derive the relative skilled wage level $w_O^{\min}$, at which outsiders would be interested in investing in human capital and able to replace the insiders, we calculate the outsider threat condition depending on the training costs $c_O = C_o + (1 - \gamma_o)C$ that are necessary to acquire the adequate skill level.

If the trained outsiders had the opportunity to replace the insiders, not all m outsiders but only a fraction $\delta(w) = h_O^{d2}(w)(1 + h^*)/\left(1 + h_O^{d2}(w)\right)$ of outsiders[18] would find a skilled job and earn the relative wage w, while the other fraction $\left[1 - \delta(w)\right]$ would remain in unskilled jobs and would be over-educated accordingly. That is, we assume that all trained outsiders perceive that they have the ability to get at least a low-skilled job and hence do not run the risk of becoming unemployed.

Then the expected utility U_O^{thr} of the outsiders associated with outperforming the insiders after training is given by:

$$U_O^{thr} = \delta(w)w + \left[1 - \delta(w)\right] - c_O \ . \tag{5}$$

If the outsiders do not invest in human capital, a fraction $u(w) = 1 - h^*/h_I^{d3}(w)$ of these outsiders is unemployed[19] and earns s – where $s \leq 1$ is the outside option (unemployment benefit) relative to the unskilled wage. The remaining outsiders are employed in unskilled jobs and earn the unskilled wage. The utility U_O^{notr} relative to the low-skilled wage for all outsiders without training then is:

$$U_O^{notr} = \left[1 - u(w)\right] + u(w)s \ . \tag{6}$$

As one might expect, this utility increases towards 1, thus in absolute terms to the unskilled wage, when the relative wage increases to $w_I^{\max}$, because all unskilled outsiders find a job at $w_I^{\max}$ where relative labor demand is unchanged (see point C in Figure 1).

It therefore is in the interest of the outsiders to invest in training if $U_O^{thr} > U_O^{notr}$. For a given relative wage w, the dividing line between a credible threat and an incredible threat of the outsiders to enter the skilled labor market therefore is at the following training costs:

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[18] Assuming that Δ outsiders find a skilled job, i.e. $\delta(w) = \Delta/m$, we can solve Δ from $h_O^{d2}(w) = \Delta/(n + m - \Delta)$ and $h^* = n/m$.

[19] The outsiders' rate of unemployment at relative wage w is given by: $u(w) = \left[m - n/h_I^{d3}(w)\right]/m$. We explain the function $h_I^{d3}(w)$in the next subsection – cf. equation (10) below.

$$c(w) = \delta(w)(w-1) + u(w)(1-s)\ , \tag{7}$$

compare equations (5) and (6). The m outsiders pose a credible threat to replace the insiders when $c_O < c(w)$ holds. Therefore we call $c(w)$ the "threat" condition. It is depicted by the line TT in Figure 2.[20] The wage $w_O^{\min}$ above which outsiders can displace the insiders then is given by $c_O = c(w_O^{\min})$.

The training costs at the upper end of the *TT*-line, $c_O^{\max}$, are defined if $w_I^{\max}$ is substituted in equation (7), that is $c_O = c(w_I^{\max})$ should hold. The m outsiders pose a credible threat as long as their training costs c_O do not exceed $c_O^{\max}$.

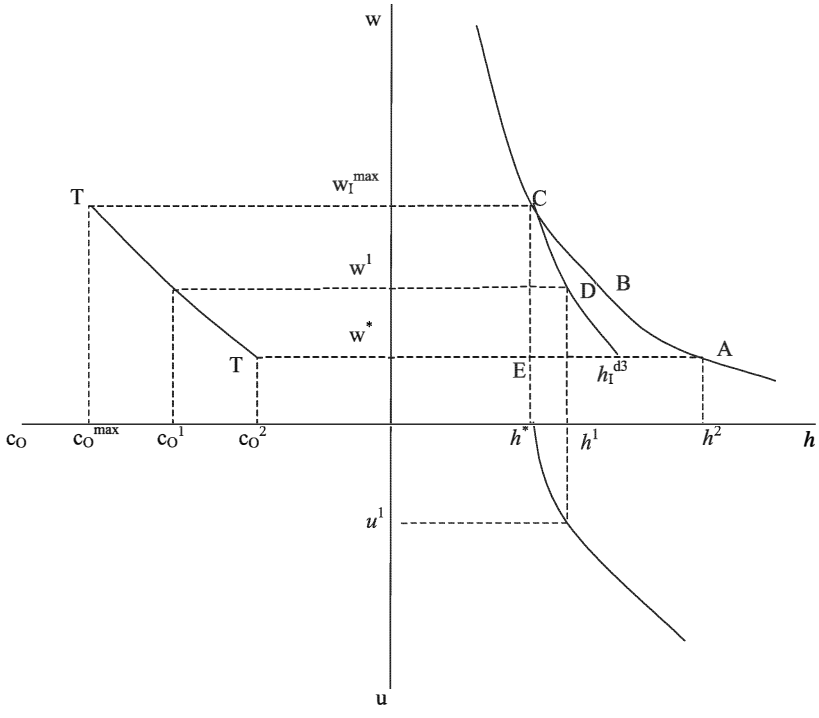

Figure 2: Full wage setting power by insiders

[20] Figure 2 assumes that the threat condition $c(w)$ is increasing over the whole relevant range. This is always the case if $s = 1$, but for $s < 1$ this is not necessarily true. If $c(w)$ is not strictly increasing until $w_I^{\max}$, the TT line first increases above the costs $c_O^{\max}$ in Figure 2 and then decreases to that level at $w_I^{\max}$. This does not change our analysis qualitatively, however. The only difference is that while in Figure 2 the wage gradually decreases from $w_I^{\max}$ along the threat line, once training costs fall below $c_O^{\max}$, in this case the wage first makes a jump from $w_I^{\max}$ to the point where the TT line crosses $c_O^{\max}$ again and then decreases gradually. The properties of the threat condition are elaborated in Muysken and Zwick (2000).

Labor Market Equilibrium

We assume that the insiders have full wage setting power, i.e., they react only to the outsider threat.[21] If outsiders' training costs are such that $c_O \geq c_O^{\max}$, the outsiders will never pose a credible threat. The insiders therefore set their wage at $w_I^{\max}$, and full employment remains at h^*, while the outsiders do not train. This equilibrium position is denoted by point C in Figure 2. However, when outsiders' training costs are lower such that $c_O < c_O^{\max}$ does hold, the outsiders are able to threat the insiders. As a consequence the insiders set their wage according to equation (7) with $c(w) = c_O$, i.e., on the TT-line in Figure 2, in order to avoid replacement. For instance, if $c_O = c_O^1 < c_O^{\max}$ in Figure 2, the insiders set the relative wage at w^1. Since the outsiders do not have an incentive to invest in training, relative skill supply remains at h^* while relative skill demand is higher than h^*.

When confronted with n insiders asking a relative wage w below $w_I^{\max}$, the relative demand function for labor of the firm is no longer $h_I^{d2}(w^1)$. Under the constrained situation the problem of the firm becomes:

$$\max_{(L)} \quad \left[(A_l L)^\rho + (A'_h n)^\rho\right]^{1/\rho} - w w_L n - w_L L \tag{8}$$

$$\text{subject to} \quad A_h'^{\rho} n^{\rho-1}\left[(A_l L)^\rho + (A'_h n)^\rho\right]^{1/\rho} = w w_L \,, \tag{9}$$

where equation (8) represents the profits of the firm working with n insiders asking a relative wage w, with $A'_h = \xi A_h$ – for notational simplicity we ignore the training costs here. Equation (9) is the demand curve for these insiders in that situation. Profits are maximized when:

$$w = \varphi(h) A'^{\rho} \rho - 1 \,, \quad \varphi(h) < 1 \tag{10}$$

holds.[22] Equation (10) implicitly defines the constrained relative demand for labor, $h_I^{d3}(w)$. Since $\varphi(h) < 1$, the relative wage is lower than it would be for a given relative demand on the insiders' demand curve. Therefore the demand curve for labor $h_I^{d3}(w)$ lies below its unconstrained counterpart $h_I^{d2}(w)$. From Figure 2 we see that at wage w^1, constrained relative demand is in point D on h_I^{d3}. As a consequence the firms have to reduce employment of the unskilled and unemployment u^1 prevails, as is depicted by the line in the second quad-

[21] The analysis can relatively easily be extended to include wage bargaining between employers and employees, with the outsiders wage as a threshold wage. In principle, the higher the bargaining power of the employers, the lower the resulting wage (compared with the outcome with full wage setting power of the employees). For the purpose of our analysis, however, this extension does not generate new insights.

[22] $\varphi(h)$ is given by: $\varphi(h) = \left[(1-\rho) - (1 + A'^{\rho} h^\rho)\right] / \left[(1-\rho) - \rho(1 + A'^{\rho} h^\rho)\right]$ and $\varphi(h) < 1$ since $0 < \rho < 1$.

rant of Figure 2. The resulting unemployment is typically mismatch unemployment since the unemployment of unskilled persons coincides with vacancies for skilled persons, represented by the gap BD, where point B on curve h_I^{d2} represents the unconstrained relative demand for labor at the wage w^1. Our model therefore predicts two possible equilibria: high skilled insider wages, no unemployment and high outsider training costs on one hand (point *C* in Figure 2) or low skilled insider wages (along line h_I^{d3}, below *C*) mismatch unemployment and low outsider training costs (along line *TT*) on the other hand.

4. Training costs for unskilled employees in the USA and in Germany

Our analysis in Figure 2 shows that lower training costs of the unskilled lead to a lower skilled wage mark-up and to mismatch on the labor market in the wake of skill-biased technological change. This is an innovative interpretation that complements the existing literature on the observed differences in the mark-up for skills and unemployment between the USA and Germany. When we overemphasize the differences, for the sake of the argument, the following picture emerges.

In the USA, the employees in skilled jobs can considerably increase the skilled wage mark-up in the wake of skill-biased technological change since the beginning of the 1980s, because their insider power has increased. The investment costs for unskilled employees, if they want to be eligible to work in skilled jobs, are so high in the USA that the outsiders do not pose any or only a small threat to the insiders. The increased skilled wage mark-up leads to no or only a small additional skilled employee demand. No unskilled outsider has a motivation to invest in extra and normal training, and therefore there is no over-qualification and no unemployment – compare point *C* in Figure 2.

The skilled wage mark-up is lower and stable in Germany because the powerful outsider threat forces the insiders to constrain their skilled wage demand. The outsider threat is more pervasive, because the costs of training, which is necessary for performing skilled jobs, are lower than in the USA for the employees in unskilled jobs. The lower wage mark-up w_1 in the wake of skill-biased technological change leads to a higher relative skilled labor demand h_1 – compare point *B* in Figure 2. The additional skilled labor demand is not satisfied, however, because it is not in the interest of the unskilled outsiders to train at this relative skilled wage. Therefore the firm keeps all *n* insiders and dismisses some outsiders. In the green card debate in Germany this point was frequently made: if more skilled workers were available, the vacancies for skilled jobs could be filled, unemployment could be reduced also for the lower skilled, and economic activity would surge.

The interpretation that the higher wage differentials in the USA stem from higher insider power is not new, see for example the survey in Teulings and Hartog (1998) and the empirical evidence in Holmlund and Zetterberg (1991). Insider power is motivated in this literature by the corporatistic labor market structure in Germany versus the competitive labor market in the USA. Our paper asserts that higher insider power in the USA also may be induced by higher training costs for outsiders and the increased importance of permanent training in the wake of skill-biased technological change. The crucial empirical question therefore is, whether training costs for the unskilled employees to perform skilled tasks are indeed lower in Germany than in the USA.

Lynch (1994), OECD (1999a), Acemoglu and Pischke (1999), and Brunello and Medio (2001) stress that the incidence of privately paid training for the unskilled in the USA is much lower than in Germany.[23] Heckman (1999, 30) even states that private sector training typically excludes low-skilled persons in the USA. In addition, there are more publicly subsidised training programs for less skilled workers in Germany than in the USA (OECD 1999a, 163 ff.). Lechner, Miquel and Wunsch (2004) show that training and re-training constitutes a large part of active labor market policy in Germany. In 1994, for example, €3.1 billion have been invested for these programs covering direct costs and maintenance allowances. Publicly financed training and re-training measures are directed at the unemployed, those threatened by unemployment but also at employees without a formal professional degree. As a consequence, in 1994, 55 % of the participants were unskilled. This suggests that in the USA the part of the extra and normal training paid by external sources for the unskilled is lower than in Germany.

A further argument for higher training costs for the unskilled employees in the USA is that the skill level of these groups is lower in the USA than in Germany.[24] Freeman and Schettkat (1999, 2001) show that especially the lower tail in internationally comparable numeracy and literacy test scores for employees is relatively fat in the USA while test scores of the highly qualified are about the same in both countries. Therefore the higher skills gap increases the necessary training costs. This is consistent with the argument that training pro-

[23] Only 4 % of young workers who are not university graduates get formal training at work in the United States (Lynch 1994). In addition, the share of US employees with less than high school that received some training to improve skills on the current job decreased from 18 % to 17 % between 1983 and 1991 while the analogous share for college graduates increased from 55 % to 63 %, see Constantine and Neumark (1994).

[24] See the survey in Muysken and Nekkers (2000) or the evidence in Nickell and Bell (1996), Lynch (1994), and Oulton and Stedman (1994). OECD (1999b) calculates that the change needed in volume of training provided to persons with less than upper secondary education to increase their participation to the level of those with an upper secondary education in percentage is 207 in the United States in contrast to 69 in Germany.

grams for unskilled workers in the USA also should entail prior training in basic skills, which would make them exceedingly costly (Heckman 1993).

Berg (1994, 85) remarks for the USA that "the job classification system (...) continues to encourage the division between skilled and non-skilled work. Some plants have (...) broadened the lines of demarcations between jobs." He notes that this is not the case in comparable German plants, because formal training of low skilled workers entails more general components there (also compare proposition 2 in Wälde 2000). Acemoglu (1999) also collects evidence for a broadening of the dividing lines between skilled and unskilled jobs in the USA in recent years. "Middling" jobs open to both skilled and unskilled workers are replaced by high-quality jobs designed for the skilled and low-wage jobs targeted at the unskilled in the USA. He also suggests that the separating phenomenon may not apply to Germany, because the developed training system for the less educated workers makes the strategy of creating separate jobs for the skilled less profitable. Therefore skilled jobs are in principle also accessible to less educated workers.

A final argument concerning skill-biased technological change is that in Germany also less educated workers can respond flexibly to skill demand shifts while in the United States a large segment of the labor force cannot cope with the demands implied by technological change (Nickell / Bell 1996). Finegold and Mason (1999) find in a direct comparison of production techniques between German and US firms that German firms use production processes allowing unskilled workers to switch flexibly between different process tasks, whereas unskilled workers in the USA typically only perform a small variety of tasks. This makes employees in unskilled jobs in Germany more apt to perform skilled jobs as well.

The evidence collected suggests that in the USA the training costs of the unskilled may be exceedingly high[25] and their flexibility to switch jobs low, while the high qualification gap reduces their potential to pose a credible threat to the employees in skilled jobs. In Germany, however, unskilled workers seem to be better educated and more flexible, they are better trained by the firms, and work processes allow switches between tasks with different skill levels required.

5. Conclusions and policy implications

This paper argues on the basis of a theoretical model that the skilled wage mark-up and unemployment in times of skill-biased technological change may also be attributable to differences in training costs for the unskilled. Our inter-

[25] This observation has more weight once one realizes that our model relates training costs to minimum wages (compare footnote 14) and in the United States minimum wages are both lower than in Germany and decreased in recent years (Acemoglu 2002).

pretation of the different skilled wage mark-ups and unemployment development in Germany and the USA in the wake of skill-biased technological change since the 1980s has some interesting policy implications for labor markets that increasingly need life-long training of those who are willing to work in skilled jobs. The lower insider power in Germany stems from a credible unskilled outsider threat to replace the skilled insiders and invest in training themselves. The higher outsider power, compared with the USA, may be the consequence of the elaborate and highly subsidized schooling and training system for lower skilled employees, the low demarcation lines between skilled and unskilled jobs, and the higher willingness of firms to pay for the training of unskilled employees. This reduces the skills gap between employees in skilled and unskilled jobs and increases the accessibility of skilled jobs for the unskilled. On the other hand, the skilled wage mark-up in Germany is too low to induce the available unskilled employees to actually invest in training that would enable them to work in skilled jobs and avoid skill gaps. Thus, high and structural mismatch unemployment results in Germany since firms increased their relative skilled labor demand in the wake of skill-biased technological change and moderate skilled wage mark-ups. As relative skill supply did not increase accordingly, which might also be due to outsider heterogeneity, they are constrained in their demand for skilled labor and therefore reduce their demand for unskilled work analogously.

Several observers propose public training subsidies for the unskilled to increase their incentives to invest in human capital and to enfranchise them to choose work in skilled jobs. Frequently mentioned measures are, for example, tax discounts or exemptions on training expenses, vocational training programs, paid training leave, tax levies that oblige employers to spend a certain percentage of their total wage bill in training, or training funds from employees, employers, and public sources (OECD 1999a, 166; Finegold / Mason 1999; Lindbeck / Snower 2002). Our model predicts that these measures might reduce wage inequality between skilled and unskilled employees. Moreover, these measures might simultaneously incur lower skill mismatch unemployment, since they lead to a lower outward shift of the relative insider demand curve for labor following new skill requirements.

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