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Firm-Provided Training and Labor Market Institutions

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Abstract

This paper studies firm-provided training in the presence of the following labor market institutions: minimum wages, assistance unemployment benefits, firing costs, unions and severance payments. It shows that minimum wages, severance payments and unemployment benefits may either increase or decrease firm-provided training relative to a competitive labor market benchmark where firm-provided training takes place. In contrast, training incidence should be greater when firing costs are higher and there is more unionization.

The paper argues that the large observed cross-country heterogeneity in labor market institutions is a plausible candidate to explain the large observed variation in training incidence across different countries, workers and industries. The reason is that the effect of any institution on firm-provided training depends crucially on the other institutions in placed.

1 Introduction

Human Capital is a key determinant of economic performance. Post-school training is key to augment and adapt the existing human capital to technical and structural changes, to decrease the risk of unemployment, to increase wage and to improve career prospects. Employer-sponsored training is the single most important source of further education and training for the working age population (OECD, 2000).[1] The OECD International Adult Literacy Survey (IALS) shows that in almost all countries, governments play a very modest role in financing further education and training. Most of the training sponsored by firms is general in nature. Estimates from Europe typically document that 80 to 90 percent of the training is general in nature, whereas U. S. based studies provide estimates of general training in the vicinity of 60 to 70 percent of all training spells (see, for instance, Barron, Berger, and Black, 1999, Loewenstein and Spletzer, 1998, 1997, Booth and Bryan, 2002).

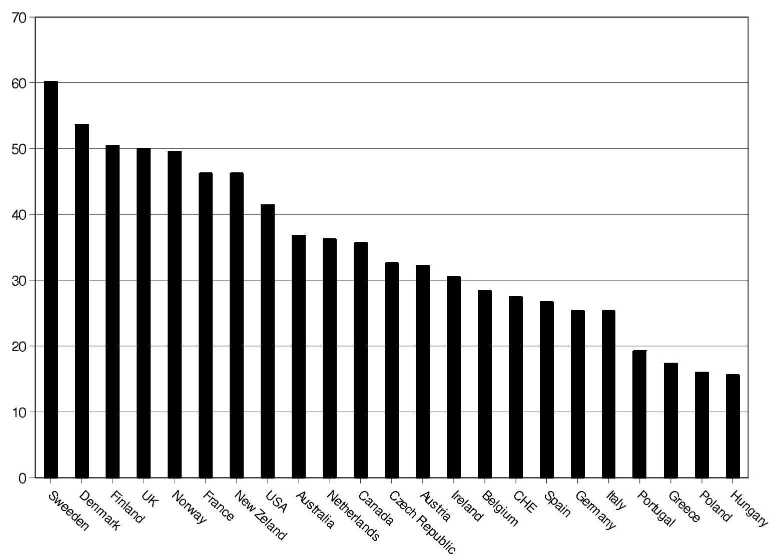


Figure 1: Training Incidence (%) workers aged 25-64 (source: OECD 2004)

In spite of the importance of firm-provided training, there is a large variation in the amount

[1]Bassanini, Booth, Brunello, De Paola, and Leuven (2005) find that, on average, the entire cost of 3/4 of the training courses is directly paid by employers and there is no evidence that employees indirectly pay for this training by accepting lower wages. The IALS data that includes 16 OECD countries shows that, on average, 80% of vocational training courses are paid for or provided by employers. Although cross-country variation is large, in all countries at least 50% of vocational training courses are employer-sponsored. A similar pattern emerges in the ECHP data, where on average 72% of the training courses on which there is information on the source of financing is employer-sponsored.

of training across different countries, workers and industries (see, figure 1). Bassanini *et al.* (2005), after controlling for a relatively large set of time varying individual, job and firm characteristics, find that cross-country variation in training incidence remains large.[2] Indeed, after controlling for individual characteristics, country effects account for almost one-half of the explained variation in training across European countries.[3] In addition, Freeman (2007) documents a large cross-country heterogeneity in Labor Market Institutions (LMI hereafter).

This paper's goal is to understand better the relationship between training and LMI and asks, at the theoretical level, whether LMI can explain the large cross-country variation in training incidence. In light of the empirical importance of firm-provided training, this entails to explain how differences in LMI can explain the variation in firm-provided general training incidence. In order to do so, an adequate benchmark model in which firm-provided training takes place in the absence of LMI is needed. The reason is twofold. First, the empirical evidence shows that firm-provided training occurs in most countries, industries and for all kinds of workers (those affected and those who are not affected by any given institution) and this represents the vast majority of training. Second, the use of any benchmark theory that yields no firm-provided training as the unique equilibrium outcome in the absence of LMI against to which to compare the effect of any given institution on firm-provided training incidence can lead only to the conclusion that a new institution does not decrease training.

In this paper I adopt a slightly modified version of the competitive labor-market model in Balmaceda (2005), since this model predicts firm-provided training as equilibrium phenomena in the absence of LMI, to study how minimum wages, firm-specific unions, unemployment assistance benefits, firing costs, and mandated severance payments modify firms' incentives to provide general training.

The crucial assumptions of the model are: (i) workers' second-period productivity is uncertain and its distribution depends positively on training and skills in the sense of first-order stochastic dominance; (ii) workers acquire non-contractible on-the-job specific training, which is neither complement nor substitute with general training; (ii) firms decide whether

[2]For example, a Danish employee has still a 20 percentage point greater probability of taking training than a Portuguese. The estimated range of variation among country effects is far greater than that estimated for educational levels (7.6 percentage points), age classes (6.2), firm size classes (7.7), occupations (13) and industries (12.4).

[3]Part of this variation is probably due to measurement error and cross-country differences in definitions and perceptions of training.

to provide workers with costly general training. This is observable, yet non-verifiable and non-contractible; and (iv) wages are determined by Rubinstein's alternating-offer bargaining game with outside options.[4] In other words, assuming that bargaining and employment on the spot market are mutually exclusive. Thus, in contrast to most models in the literature, here the no-trade payoffs for the firm and worker enter the bargaining process as outside options instead of as inside options.

I show that the effect of any given institution on firm-provided training stems from the effect of it on the following margins: the wage level itself, the worker's outside option and the firm's outside option. For instance, a minimum wage imposes a lower bound on the negotiated wage, firing costs lower firms' outside option, mandated severance payments increase workers' outside options and decrease firms' outside options, and they may also place a lower bound on the negotiated wage. This depends on the other institutions in placed. For instance, when there is no minimum wage, in no state the wage can be lower than the sum of unemployment assistance benefits and severance payments, while when there is a minimum wage, mandatory severance payments cannot be undone and represent a tax on separations. Thus, the effect of any given institution on firm-sponsored training is much more complex to device than previous studies based on a single institution suggest, and it depends on the institutional setting in which a given institution is modified or introduced.[5]

The imposition of minimum wages, unemployment benefits and severance payments have ambiguous effects on training incidence, while unions and firing costs increase training incidence. In some cases such as the effect of unions on firm-provided training, the rationale for the result is different from the ones already proposed in the literature (see, for instance, Dustmann and Schönberg, 2008), in other cases, such as the effect of severance payments on training, no prediction has been made and in other cases, such as the minimum wages, the predictions are different from the ones already made in the literature (see, for instance, Acemoglu and Pischke, 2003). In particular, a more realistic analysis of the effect of minimum wages on firm-provided training is proposed. Based on these results, I argue that heterogeneity in LMI across countries is a good candidate to explain the observed cross-country heterogeneity in training incidence. In fact, I show that training incidence should be greater in countries with stronger EPL and higher union density. Furthermore, this is more likely to be the case in

[4] When outside options are treated as inside options, the existence of firm-specific training that is neither complement nor substitute with general training does not create incentives to provide general training.

[5] In the next section I present some evidence to substantiate this claim empirically.

economies with higher minimum wages and unemployment assistance benefits. The downside of all this is that unemployment should also be greater in these economies.

I also extend the model to allow for both firm- and worker-financed training. It is then shown that in the absence of LMI, most training is paid-by for workers, while in the presence of LMI, firm-financed training is more likely to arise. This could help us to understand why firm-provided training incidence is greater in Continental Europe than in Anglo-Saxon economies.

The related theoretical literature studying the effect of LMI on either firm- or worker-financed training is to some extent scarce.

Belot, Boone, and Van Ours (2007) present a one shot matching model to formalize the idea that firing costs may stimulate workers to invest in training. Fella (2005) studies the effect of conditional and privately negotiated separation payments on the firm's incentives to provide general training. He shows that large enough conditional separation payments may induce firms to invest in general training. Booth and Zoega (2003) show that employment protection increases welfare when the workers' human capital embodies more than match-specific abilities. Teuling and Hartog (1998) argue that when workers can invest in non-contractible firm-specific training, employment protection could help to stimulate this type of investment, which would otherwise be suboptimal due to the hold-up problem. Etienne (2006) proposes a job-matching model in which workers in more flexible labor markets (that is, markets with little employment protection and low unemployment benefits) tend to invest in general human capital, while in more rigid markets with generous benefits and higher duration of jobs workers are more inclined to invest in specific training. Acemoglu and Pischke (2003) show that firms invest in general training in the presence of minimum wages. Lechthaler and Snower (2008), using a model where outside options are treated as inside payoffs and thus in the absence of minimum wages there is no firm-provided training, show that a marginal increase in minimum wages may either increase or decrease training intensity, but they say nothing about training incidence.

In contrast to the papers in the literature, this paper considers several institutions at once, emphasizes the different effects that LMI can have on the incidence of firm-provided training, and provides a market equilibrium in which firms pay for training as a benchmark against to which to compare the effects of LMI on firm-provided training.

The rest of the paper is structured as follows. In the next section, Section, some stylized facts with regard the relationship between training incidence and LMI are provided. In Section 3 the model is presented. In the next Section, I derive the first-best efficient amount of training and the optimal training incidence when there are no LMI. In Section 5, I derive the optimal training incidence in the presence of LMI. In the following section, I ask how each institution affect firms' incentives to provide training in an otherwise competitive labor market. In Section 7, I study how a marginal change in any given institution changes training incidence under different institutional settings. In Section 8, I extend the model to allow for both firms and workers' financed training. And finally, Section 9 offers some concluding remarks.

2 Training and Labor Market Institutions: Stylized Facts

In this section, I provide some stylized facts about the effect on training incidence for the OECD countries in table 1 of minimum wages (MW), measured by the minimum wage over the median wage, employment protection legislation (EPL), as measured by the OECD index of protection,[6] unemployment assistance benefits (UB) and union density (UD), as reported by the OECD.[7]

The existent evidence on the effect of LMI on training is scarce mainly due to the lack of cross-country training data and LMI. Brunello (2006), using training data from the EHCP and institutions data from the OECD, finds that the effect of union density on training is very small and imprecisely estimated. He also finds that training incidence is lower when the degree of EPL, as measured by the OECD index of both regular workers and temporary workers, increases, although this effect is statistically different from zero at the five percent level of confidence only for the former. Brunello (2006) argues that this is due to the fact that it is well known that employment protection is associated with firing costs, and that these costs have both a transfer and a tax component. While the transfer part could be undone by properly designed labor contracts, the tax component is difficult to undo.

An alternative explanation advanced by Brunello is selection. When firing costs are high, employers cannot easily dismiss less able or less suitable regular employees and therefore end up with a more heterogeneous regular labor force than employers who can more easily dismiss

[6] The OECD index refers to strictness of employment protection for regular jobs; the "waste" component is defined as the part of the OECD index that is not related to "notice and severance pay for no-fault individual dismissals" (Source: OECD 2004).

[7] This variable has been used in the literature as a proxy of union influence, mainly because of the availability of time varying data. An important drawback, however, is that the variable of interest in the empirical analysis is the effect of unionization on wages, which might be poorly related to union density.

unsuitable employees. If training and ability are complements, or if labor force heterogeneity imposes a negative firm-specific externality on individual productivity, employers with a more homogeneous regular labor force should train more.

The first column of table 1 presents the average training incidence over the period 1997-2007, where training incidence corresponds to data collected by labor force surveys in any learning activities 4 weeks before the survey over the population older than 24 years old and younger than 65 years old.[8] The second column shows the OECD indicator of strictness of protection of regular jobs. As shown, there is lot of variation across countries, but little variation within countries. The protection of regular jobs was strongest in Portugal and Netherlands and it was relative weak in Ireland and United Kingdom. Hourly minimum wages where the highest in Belgium and Netherlands, while they were small in Czech Republic, Slovak Republic and Poland. Union density was highest in Belgium and lowest in France, and unemployment assistance benefits were highest in Netherlands and lowest in United Kingdom and Czech Republic. This shows that there is a fair amount of variation in institutions across countries. So, in this section I take advantage of this variation to provide some support to the idea that the variation in training incidence may well be explained by the heterogeneity in LMI across countries.

The empirical analysis is based on data for the 13 countries for which information on each of the institution in table 1 are available. I estimate linear pooled OLS with training incidence as a dependent variable and institutions and their interaction terms as independent variables.[9] Due to the sample size, estimation results must be taken cautiously.

Each of the first four columns in table 2 captures the effect of a given institution on training when no other institutions are controlled for. It follows from these regressions that EPL and minimum wages result in less training, while union density and unemployment assistance benefits increase training incidence, although the last effect is imprecisely estimated. Column

[8] The results are very similar when the training variable corresponds to participation in Continuing Vocational Training collected by EU for years 1999 and 2005. However there were only 26 country-time data points.

[9] When time and country dummies are included none of them are significant, but for the dummy for UK and Ireland and the coefficients are imprecisely estimated. These is in part due to the fact that there is little variation in EPL within countries and the small sample. The Hausmann test indicates that the correct model is a random effect model rather than a fixed effect model. The chi-squared statistics is 17.56, which results in a $Prob > \chi^2 = 0.0628$.

Table 1: Training and LMI: Means by Countries

Country	**Training**	**EPL**	**MW**	**UD**	**UB**
Austria	9.99	2.67	n.a.	0.36	1.00
Belgium	6.50	1.72	0.52	0.52	1.15
Czech Republic	5.57	3.29	0.33	0.29	0.24
Denmark	22.72	1.63	n.a.	0.73	1.59
Finland	19.61	2.22	n.a.	0.74	1.42
France	4.81	2.42	0.60	0.08	1.38
Germany	6.25	2.80	n.a.	0.23	1.98
Greece	1.53	2.29	0.48	0.26	0.33
Hungary	3.40	1.92	0.45	0.22	0.36
Iceland	23.75	n.a.	n.a.	0.87	0.80
Ireland	6.43	1.60	0.54	0.37	0.51
Italy	5.23	1.77	n.a.	0.34	0.29
Luxembourg	6.45	n.a.	0.41	0.43	1.87
Netherlands	15.20	3.04	0.46	0.22	0.54
Norway	16.24	2.25	n.a.	0.55	0.25
Poland	4.66	2.06	0.42	0.21	0.87
Portugal	3.62	4.27	0.47	0.20	0.17
Slovak Republic	4.85	2.40	0.42	0.33	1.38
Spain	5.58	2.54	0.43	0.16	0.79
Sweden	27.00	2.86	0.30	0.78	0.81
Switzerland	30.15	1.16	n.a.	0.20	n.a.
Turkey	1.31	2.57	n.a.	0.10	n.a.
United Kingdom	23.60	1.07	0.43	0.29	0.25
Total	11.42	2.31	0.45	0.37	0.94

Table 2: Parameter Estimates Training Equations (OLS)[a]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Const.	21.40	29.10	3.35	11.55	21.75	127.67	111.42	124.46
	(2.03)***	(4.22)***	(1.04)***	(1.26)***	(7.72)***	(28.18)***	(19.38)***	(26.80)***
EPL	-4.50				-1.10	-34.93	-32.64	-35.53
	(.77)***				(1.45)	(8.52)***	(6.91)***	(7.55)***
MW		-45.30			-27.70	-221.61	-212.55	-222.09
		(8.47)***			(11.09)**	(51.10)***	(39.91)***	(50.50)***
UD			21.92		20.00	41.08	87.74	64.36
			(2.01)***		(5.33)***	(55.50)	(24.21)***	(46.07)
UB				-.24	-3.17	-111.64	-93.51	-101.51
				(1.02)	(1.75)*	(19.95)***	(11.44)***	(13.75)***
UD*EPL						-13.02	-20.32	-11.97
						(12.89)	(10.19)**	(11.31)
UB*EPL						29.18	26.74	23.82
						(5.35)***	(4.28)***	(3.84)***
UB*MW						77.11	61.49	80.94
						(17.37)***	(15.37)***	(15.29)***
UD*MW						22.46		-29.07
						(63.17)		(55.16)
EPL*MW						56.81	58.63	61.32
						(15.80)***	(14.95)***	(13.09)***
UB*UD						21.21		17.55
						(15.97)		(10.97)
Obs.	204	131	205	169	88	88	88	88
R^2	.13	.18	.28	.0003	.35	.76	.76	
F statistic	34.3	28.62	118.38	.05	7.82	32.69	35.17	

[a] Dependent variable: training incidence; robust standard errors are reported; Significance level * 95%, **99%, ***99.9%. Panel-corrected standard errors presented in parenthesis.

[b] GLS with panel-corrected standard errors.

5 presents the parameter estimate for each institution when controls for the other institutional variables are included and interaction are ignored. As shown, the marginal effects have the same sign as those arising from regression without control, but the magnitudes suffer substantial changes except in the case of union density and all coefficients are precisely estimated. Furthermore, the LMI included explain around a third of variation of training incidence.

Column 6 presents the parameter estimate for each institution when controls for the other institutions as well as for all possible interactions terms are included, while column 7 is a stepwise regression in which only those interaction terms that have a significant level of 0.5% or less are included in the regression. Column 8 fits cross-sectional time-series linear models using feasible generalized least squares correcting for heteroscedasticity across panels. The analysis of the results is based on the coefficients in equation 8.

To see the importance of controlling for other LMI when estimating the effect of any institution on training incidence, I calculate the marginal effect on training for each institution for all countries and also for 6 different countries. The results are shown in table 3.

Table 3: **Average Marginal Effects**

LMI	**All**	**UK**	**Portugal**	**Netherland**	**France**	**Greece**	**Spain**
EPL	45,58	28,82	30,50	38,32	59,83	34,15	43,30
MW	-15,05	-144,74	47,73	1,95	14,11	-62,61	-6,97
UD	89,63	90,74	54,26	74,56	108,18	81,59	82,62
UB	-12,43	-44,52	32,51	3,39	7,36	-12,91	-11,87

It follows from table 3 that on average higher minimum wages and unemployment assistance benefits result in a lower average training incidence, while greater union density and a strict employment protection legislation rise training incidence. However, these predicted effect are not homogeneous across countries.

It follows from the results in table 3 that higher minimum wages result in less training in economies with low EPL and unemployment assistance benefits such as UK and Ireland, while they are likely to increase training in countries with high union density and high unemployment benefits such as Portugal and to lesser extent France. The effect of unemployment assistance benefits on training incidence also depend on the institutional setting. In particular, countries with higher EPL have more training when benefits go along with stronger EPL such as in Netherland and Portugal, while this have a negative effect in countries such as France with low union density and relatively lower EPL. The table also shows that union density as well as the strictness of employment protection increase training regardless of the institutional setting.

The main conclusion of this section is that the effect of any given institution on training cannot be inferred unless controls for the country's institutional setting are included. Furthermore, this shows that a given institution can be positive for training in one country, but negative in others.

3 The Model

3.1 Set-Up

I consider a two-period model between homogeneous firms (f) and heterogeneous workers (l), both of whom are risk neutral. Each worker has a publicly known schooling or skill level $a \in [0, A]$, with $A > 0$. At the beginning of period 1, which is viewed as the early stage of a worker's career, firms and workers negotiate one period contracts for the supply of one unit of labor and then firms decide whether or not to provide non-contractible training to hired workers. To focus on training incidence, I assume that training is indivisible, so only $\tau = 0$ (no training) and $\tau = 1$ (training) are possible. The cost of training, which is independent of skills, is incurred in terms of lower output in the first period and is equal to $C > 0$. There is free-entry at zero cost and all firms have access to the same constant-return to scale technology; i.e. the total productivity of a firm is equal to the sum of each worker's productivity.

At the beginning of period 2, after training has been undertaking, workers' productivity, denoted by y, is publicly realized. After productivity becomes known, the parties either negotiate a one period contract for the supply of one unit of labor, or alternatively, they may either refuse to trade, or agree to trade with a third party instead. The wage determination procedure, which I discuss in detail below, is based on the outside option principle found, for example, in Sutton (1986).

- Assumption 1: Productivity y has density $f(\cdot \mid \tau, a)$ with fixed support $Y \equiv [y_L, y_H]$, positive mean $E(y \mid \tau, a)$ and constant variance. f is twice-continuously differentiable and the cumulative distribution function satisfies the following conditions: $F(y \mid 1, a) < F(y \mid 0, a)$ for all $y \in Y$, $F_a(y \mid \tau, a) < 0$ and $F_a(y \mid 1, a) \leq F_a(y \mid 0, a)$ for all $y \in Y$.

This assumption says that training and skills improve the output distribution in the sense of first-order stochastic dominance (hereafter FOSD). This in turn implies that for any given skill level, average productivity is higher when a worker receives training and, for any given training level, average productivity is higher, the higher a worker's skill level. The last part of assumption 1 imposes that training and skills are complements, which will result in that training incidence is higher, the higher the skills.

The evidence on firm-provided training is eloquent with respect to who is more likely to receive training. Bassanini *et al.* (2005) shows that the average training incidence is higher in European countries where the percentage of the active population with at least upper secondary education is higher. Arulampalam, Booth, and Bryan (2004b) find, estimating separate models for each European country, for both men and women, that there are seven out of ten countries in which highly educated individuals are significantly more likely to get training than the base group of workers with less than upper secondary level.[10] Black and Lynch (1998), using data from a 1994 survey of U.S. establishments, find that formal training programs were positively associated with establishment size, the presence of high-performance work systems (such as Total Quality Management), capital-intensive production, and workers' education level.

Existing evidence also shows strong complementarities between education and training (see, Booth (1991); Arulampalam and Booth (1998); Brunello (2001)). In addition, Ariga and Brunello (2006) find that the strength of this complementarity depends on whether training is provided on-the-job or off-the-job. Thus, the fact that the model will predict that only workers with a skill or schooling level exceeding a given threshold will receive training is consistent with this evidence.

A worker's with a skill level a produces $E(y \mid 0, a) - \tau C$ in period 1; that is, the average output as an untrained worker minus training costs. In period 2, when he stays with the first-period employer, he produces $y + \eta$, while when he leaves the first-period employer, he produces y, where η is interpreted as the productivity gain due to on-the-job specific human capital. Thus, the technology is such that τ is general in Becker's sense; that is, the marginal product of general training inside the firm is the same as that with any alternative employer and skills and training are complements.

[10] For both sexes, the common set of countries comprises Britain, Denmark, Finland, Italy and Spain. However highly educated women in France and the Netherlands, and men in Austria and Ireland, are more likely to experience training starts than the base. Only in Belgium education have no significant effect, ceteris paribus.

3.2 Institutional Setting

No worker can be paid less than the minimum wage set by the authority at $\underline{w} > 0$, and when unemployed he or she receives unemployment assistance benefits in an amount μ,[11] with $\mu \leq \underline{w}$. This is financed by the government through general taxes.

An employment protection legislation (EPL) that considers firing costs and mandated severance payments is also in placed. Firms have the authority to terminate unproductive jobs by firing workers and, symmetrically, workers have the right to quit and search for a new match at any time. The government enforces a severance payment $P > 0$, which represents a pure transfer from the firm to the worker upon job separation. There are also administrative firing costs of an amount $T > 0$, which include the costs associated with following whatever procedure is necessary in order to terminate a relationship. These costs represent transfers to a party outside the match and thus they are a pure waste from the match's viewpoint.

Let $D = (\underline{w}, T, \mu, P)$ denote the institutional setting and $\theta \equiv max\{\mu + P, \underline{w}\}$ be the wage floor. From here onwards, I will denote a labor market without institutions as $D \equiv \mathbf{0}$ and a labor market with institutions as $D > \mathbf{0}$.[12] In this setting, a worker's outside option is $y + P$ if upon a separation he is able to find a job and $\mu + P$ if upon a separation he is not able to find a job. Thus, a worker's outside option at the time he negotiates with the first-period employer is $max\{y + P, \mu + P\}$ and no employer can paid him less than the minimum wage. This implies that the negotiated wage must be as least as large as the maximum between the minimum wage and the worker's outside option; that is, $\underline{w}(D) = \max\{y + P, \theta\}$. The firm's outside option is given by $\pi - T - P$, and for the sake of simplicity, it is assumed that $\pi = 0$.[13] Finally, firm-specific unions will be model as a combination of the LMI considered here and I postpone the discussion on how they are combined until after the analysis of minimum wages is carried out.

[11] Most countries that have unemployment assistance benefits programs opt for a fixed amount schedule. For instance, among OECD countries, only Germany (53% of net earnings) and Austria (92% of UI benefits) have a variable system. In addition, some countries have a unlimited duration for these benefits and some have finite durations.

[12] Bolds denote vectors.

[13] This assumption is consistent with a competitive labor market since in the absence of specific training the firm has to pay a worker his productivity.

3.3 Wage Determination

Here, I turn to the issue of how a worker's compensation is determined after y is realized. The key is that the no-trade payoffs enter the bargaining process as outside options instead of as inside options.

The bargaining between a firm and a worker adopted here is Rubinstein's alternating-offer game with the addition of outside options for both, the firm and worker. Bargaining takes place over a number of rounds. At the beginning of each round, the worker is chosen to be a proposer with probability $\frac{1}{2}$–the worker's bargaining power–and the firm with probability $\frac{1}{2}$–the firm's bargaining power.

If the proposer is the worker, he proposes a wage w. The firm can either accept or reject this offer, if it accepts, then the firm gets $y + \eta - w$, while if it rejects, then the firm and the worker get zero and bargaining either goes to the next round where the firm makes a proposal or chooses to terminate the bargaining process taking its outside option. If bargaining is terminated because the responder takes his or her outside option, the worker gets his outside option which is equal to $\max\{y + P, \mu + P\}$.

Note that only the responder is allowed to choose to terminate bargaining. This ensures a unique solution for the bargaining game. Furthermore, because complete information is assumed, the bargaining process ensures that trade is ex-post efficient conditional on that the worker cannot be paid less than $\underline{w}$ and there are positive firing costs and severance payments; that is, the firm-worker relationship continues whenever continuing the relationship generates more than separating; *i.e.,* $y + \eta \geq \max\{y + P, \theta\} - P - T$.

It follows from this and the outside option principle that when neither the outside option nor the minimum wage binds, the surplus from continuing the relationship is divided according to each party's bargaining power (hereafter, the surplus-sharing outcome);[14] that is, the worker gets $\frac{1}{2}(y + \eta)$ and the firm gets $\frac{1}{2}(y + \eta)$; when only the worker's outside option binds and it is optimal to continue the relationship, the worker gets the maximum between his outside option and the minimum wage, and the firm gets the total surplus minus the worker's wage; that is, $y + \eta - \max\{y + P, \theta\}$; and when only the firm's outside option binds, the worker gets the total surplus from continuing the relationship and the firm gets its outside option $-P - T$.

Finally, when the worker and the firm's outside options are both binding, they are better-off terminating the relationship and each getting his or her outside option because what is

[14] See, Sutton (1986).

generated by continuing the relationship is less than what can be generated if the firm and worker terminate their relationship.

3.4 Period-2 Equilibrium Payoffs

Let $y_L(D)$ be equal to $\min\{\eta - 2P, 2\theta - \eta\}$ and $y_H(D)$ be equal to $\max\{\eta - 2P, \theta - P\}$. Given these thresholds, a firm's period-2's expected payoff is given by:

$$\begin{aligned} U_f(\tau \mid a, D) \equiv & \int_{y_H(D)} (y + \eta - (y + P)) dF(y \mid \tau, a) + \int_{y_L(D)}^{\eta - 2P} \frac{1}{2}(y + \eta) dF(y \mid \tau, a) + \\ & \int_{\theta - P - T - \eta}^{y_L(D)} (y + \eta - \theta) dF(y \mid \tau, a) - \int^{\theta - P - T - \eta} (P + T) dF(y \mid \tau, a) \end{aligned} \tag{1}$$

and a worker's period-2 expected payoff is given by:

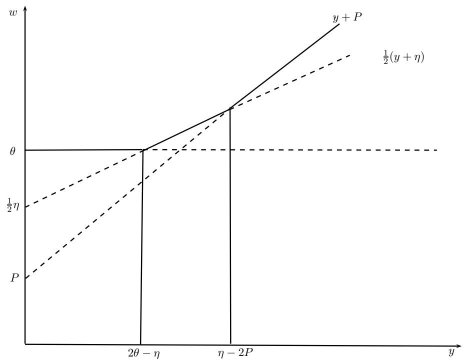
$$\begin{aligned} U_l(\tau \mid a, D) \equiv & \int_{y_H(D)} (y + P) dF(y \mid \tau, a) + \int_{y_L(D)}^{\eta - 2P} \frac{1}{2}(y + \eta) dF(y \mid \tau, a) + \\ & \int_{\theta - P - T - \eta}^{y_L(D)} \theta dF(y \mid \tau, a) + \int^{\theta - P - T - \eta} (\mu + P) dF(y \mid \tau, a). \end{aligned} \tag{2}$$

It follows from equations (1) and (2) that total second-period expected surplus is given by:

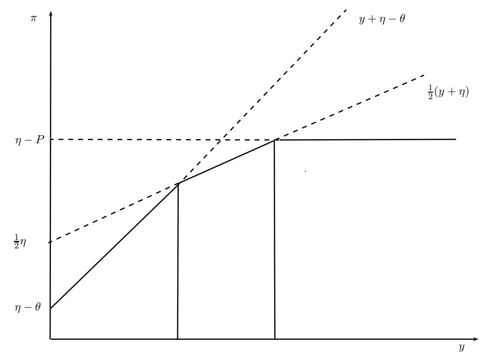
$$S(\tau, a, D) = \int_{\theta - P - T - \eta} (y + \eta) dF(y \mid \tau, a) + \int^{\theta - P - T - \eta} (\mu - T) dF(y \mid \tau, a). \tag{3}$$

Observe that $y_H(D) > y_L(D)$ for all $\eta > \theta + P$. When this holds and productivity is low (i.e., $y > \theta - P - T - \eta$), the relationship is severed and the firm must paid the firing costs $T + P$ and it gets no return to worker's productivity from general training. When productivity is higher enough to keep the working relationship going, but lower than or equal to $y_L(D)$, the worker is paid the wage floor θ. In this case the firm gets the full return to worker's productivity from general training. When productivity is higher, the worker and the firm share the surplus and thus the firm gets a share $\frac{1}{2}$ of the return to worker's productivity from general training. Lastly, when productivity is high, the worker is paid his productivity outside the firm (see, figure 2(a)) and thus the firm gets no return to general training. In contrast, when $\eta \leq \theta + P$, $y_H(D) = y_L(D)$. When this holds and productivity is low (i.e., $y \leq y_L(D)$), but large enough to keep the relationship going, the worker is paid the minimum wage and thus the firm gets the full return to general training, else he is paid his outside productivity and thus the firm gets no return to training. The main difference between these two parameterizations stands for the fact that when the wage floor is sufficiently high (i.e., $\eta \leq \theta + P$), the firm and the worker never share the surplus and therefore the firm and worker never share the return to training. Either the firm or the worker gets the full return to it.

To save on case analysis, from here onwards, I will focus on the case in which $\eta \geq \theta + P$. This ensures that the surplus sharing outcome is feasible. Furthermore, assuming the opposite does not change the results in a qualitative sense, since it only rules out the surplus sharing outcome.



(a) Wage Determination



(b) Profit Determination

In addition, I will assume that $\theta \geq P + T$. This guarantees that in the presence of LMI separations take place.

4 Training Level in the Absence of LMI

4.1 The First-Best Efficient Training Level

In this sub-section, I determine the first-best efficient training level in the absence of LMI (i.e., when $D = \mathbf{0}$). In this case for any training level τ and productivity y, trade must be at the efficient level; that is, separations take place if and only if what is generated by staying together is lower than what can be created by severing the match. That is, a match is severed if and only if $y + \eta \leq y$. Thus, a separation never occurs since the worker specific training makes the worker more productive with the first-period employer for any realization of y.

Given efficient trading, the efficient investment further requires that τ maximizes total expected gains from the employment relationship. Thus, training maximizes total second-period expected surplus minus training costs; that is,

$$\max_{\tau \in \{0,1\}} \{S(\tau, a, \mathbf{0}) - \tau C\}.$$

Let τ_a^* be the efficient investment in training. Then $\tau_a^* = 1$ if and only if

$$S(1, a, \mathbf{0}) - C \geq S(0, a, \mathbf{0}). \tag{4}$$

Integrating-by-parts once, equation (4) reduces to the following condition

$$\int \big(F(y \mid 0, a) - F(y \mid 1, a)\big)dy - C \geq 0$$

Observe that this inequality is satisfied when there are no training costs since the distribution of output when the worker receives training FOSD that when the worker does not receive training. This, together with the assumption that training and skills are complements, implies that there is a skill threshold, denoted by $a^*(C)$, such that equation (4.1) is satisfied for all workers with an ability level greater than or equal to the skill threshold.

Then the next result summarizes the discussion so far.

Proposition 1 *It is first-best efficient to train a worker with skill level a if and only if $a \geq a^*(C)$, with $a^*(C)$ increasing in training costs C.*

From here onwards I shall assume that $A \geq a^*(C)$, which guarantees that training incidence is positive. In fact, this implies that it is efficient to provide training to a mass of workers equal to $1 - G(a^*(C))$, and those receiving training are the more skillful ones as the evidence provided in Section 3 shows.

4.2 The Optimal Training Level in the Spot Market

Here the case of spot contracting is studied when there are no LMI–that is, $D = \mathbf{0}$. The firm then chooses τ to maximize its total expected profits $U_f(\tau \mid a, \mathbf{0}) - \tau C$ rather than the expected total surplus.

Let τ_a^s be the optimal investment in training under spot contracting, where s stands for spot market. Then provided that a firm hires a worker with a skill level a, the firm provides him with training if and only if second-period expected profits minus training costs are greater when training is provided; that is,

$$U_f(1 \mid a, \mathbf{0}) - C \geq U_f(0 \mid a, \mathbf{0}),$$

This together with equation (1) and integration by parts imply that a worker with a skill level $a \in A$ receives training if and only

$$\frac{1}{2}\int_{-\eta}^{\eta} [F(y \mid 0, a) - F(y \mid 1, a)]dy - C \geq 0. \tag{5}$$

This equation captures the fact that training rises the worker's productivity outside of the firm by the same amount as it does it within the relationship when productivity is high and that the firm and worker share the return to general training only when the productivity is lower than η. Thus, the firm gets a share of the return to training when the surplus-sharing outcome occurs, but no return to general training and the full return to specific training when the worker's outside option binds.

Observe that at $C = 0$, the inequality in equation (5) is satisfied since the term in square brackets is positive for all skill levels. In addition, because training and skills are complements, this rises with skills.[15] Thus, I can define the skill threshold $a^s(C)$ as the lowest skill level at which the inequality in equation (5) is satisfied. In the case in which the inequality in equation (5) does not hold for $a = A$, I adopt the convention that $a^s(C) = A$.

Next, I turn to the hiring decision. Because in the first period, firms compete for workers in a Bertrand-like fashion with the well-known result that in equilibrium firms have zero expected profits, $E(y \mid 0, a) - w_1 + U_f(\tau_a^s \mid a, \mathbf{0}) - \tau_a^s C$ must be equal to zero, where $E(y \mid 0, a) - w_1 - \tau_a^s C$ is the first-period profit and $U_f(\tau_a^s \mid a, \mathbf{0})$ is the second-period expected profit.

The zero expected profit condition implies that the first-period wage is given by $w_1 = E(y \mid 0, a) + U_f(\tau_a^s \mid a, \mathbf{0}) - \tau_a^s C$, which is the sum of the worker's productivity in the first period and the firm's second-period expected profit.

Note that $U_f(\tau_a^s \mid a, \mathbf{0}) - \tau_a^s C \geq 0$, since the firm can always ensure a payoff of at least zero by investing zero and hiring an untrained worker or closing down.[16] Thus, the firm is always willing to hire any worker with skill level $a \in A$. In addition, when a firm trains the worker, it cannot recoup investment costs by paying the worker less than his marginal product as an untrained worker. Thus, the condition in equation (5) is necessary and sufficient for firm-sponsored training to take place.

Observe that equation (5) evaluated at $a = a^*(C)$ re-writes as follows

$$-\frac{1}{2}\int_{-\eta}^{\eta}[F(y \mid 0, a^*(C)) - F(y \mid 1, a^*(C))]dy < 0. \tag{6}$$

This implies that there are workers that should receive training, but firms have no incentives to train them.

Then I am ready to state the main results of this section.

[15] The partial derivative of the term in square brackets with respect to a is $\int^{\eta}[F_a(y \mid 0, a) - F_a(y \mid 1, a)]dy$.

[16] Note that compensation is front-loaded since firms anticipate the rent that they will receive in the second period, and thus they are willing to bid higher than the worker's current productivity.

Proposition 2 *Suppose that $\eta > 0$. Then it is optimal to employ all workers and to train those with a skill level $a \geq a^s(C)$, there is under-investment in training and $a^s(C)$ rises with training costs (C) and falls with the productivity of specific training (η).*

As in the standard neoclassical model, workers find a job regardless of their skill level, but, in contrast to Becker's Human Capital theory and consistent with the empirical evidence around the world, there is firm-sponsored general training. Yet, training incidence is lower than first-best efficiency requires.

Observe that in the absence of firm-specific training, Becker's result is obtained; that is, there is no firm-sponsored training since the worker must be paid his total productivity in every state and therefore the firm never gets a positive return to training. In contrast, in the presence of firm-specific training, the surplus-sharing outcome occurs and thus the firm invests in training. Observe also that as the productivity of specific training rises, more workers receive training. Thus, general and specific training are strategic complements in spite of the fact that they are neither substitutes nor complements in the production function. This suggests that an institution aimed at boosting firm-specific training productivity will also boost firms' incentives to invest in general training.

In equilibrium, training incidence is $T^s(C) = 1 - G(a^s(C))$, and again as then evidence shows, the more skillful workers are those receiving training.

5 Training in the Presence of Labor Market Institutions

In this section, I study a firm's incentive to invest in training in the presence of LMI. As when there are no LMI, a firm chooses τ to maximize its expected profits $U_f(\tau \mid a, D) - \tau C$ rather than total expected surplus.

Let τ_a^D be the optimal investment in training in the presence of LMI. Then provided that the firm hires a worker with a skill level $a \in A$, the firm provides him with training if and only if expected profits are greater when training is provided; that is,

$$U_f(1 \mid a, D) - C \geq U_f(0 \mid a, D).$$

This together with equation (1) and integration by parts imply that a worker with a skill level $a \in A$ receives training if and only

$$\frac{1}{2}\int_{2\theta-\eta}^{\eta-2P}[F(y \mid 0, a) - F(y \mid 1, a)]dy + \int_{\theta-P-T-\eta}^{2\theta-\eta}[F(y \mid 0, a) - F(y \mid 1, a)]dy - C \geq 0. \quad (7)$$

Observe that the first term captures the firm's return to training when the surplus-sharing outcome occurs, while the second term captures the firm's return to general training when the worker is paid the wage floor. In states in which the latter occurs, the firm gets the full return to training and thus LMI transform general human capital into an extreme form of specific training in the sense that the return to this is not shared with the worker.

In the absence of LMI only the first term arises although more frequently than in the presence of LMI, while the second term is due exclusively to the presence of LMI.[17]

Because skills and training are complements in the sense that skills improve the output distribution more in the sense of FOSD when the worker receives training that when he does not, the LHS of equation (7) rises with skills. This implies that there is a skill threshold, denoted by $a^D(C)$, such that inequality in equation (7) is satisfied for all skill levels greater than $a^D(C)$. In the case in which the inequality in equation (7) does not hold for $a = A$, I adopt the convention that $a^D(C) = A$.

As opposed to the case without LMI, condition (7) is not sufficient to provide training. Firms also need to make non-negative profits in order to be willing to hire a worker with ability level a. In period one, firms compete for workers in a Bertrand-like fashion and therefore total firm's expected profits should be zero. This results in that the first-period wage should be set to $w_{1a}^D = E(y \mid 0, a) + U_f(\tau_a^D \mid a, D) - \tau_a^D C$. However, the minimum wage legislation prevents the firm from paying w_{1a}^D when this is lower than the minimum wage. Thus, a worker with skill level a will be able to find a job in period 1 only when $w_{1a}^D \geq \underline{w}$ (that is, when the firm does not make negative profits).

Integrating-by-parts once equation (1), the necessary condition for a worker with skill level a and training τ_a^D to be hired is

$$E(y \mid 0, a) + \eta - P - \frac{1}{2}\int_{2\theta-\eta}^{\eta-2P} F(y \mid \tau_a^D, a)dy - \int_{\theta-P-T-\eta}^{2\theta-\eta} F(y \mid \tau_a^D, a)dy - \tau_a^D C \geq \underline{w}. \quad (8)$$

All workers for whom conditions (7) and (8) are satisfied will be hired and trained, while those for whom condition (7) is violated, but condition (8) is satisfied when $\tau_a^D = 0$ will be hired but will not receive training.

Given this, it is possible now to determine the equilibrium level of employment and training.

[17]It is worthwhile to note that, in contrast to the case in which there are no LMI, firms may still have an incentive to provide workers with training when there are no on-the-job specific training acquisition; i.e., when $\eta = 0$. This is due to the fact LMI makes the firm full residual claimant in those state in which the worker is paid the wage floor and the firm's outside option is negative due to the EPL.

Because an increase in skills improves the output in the FOSD sense, the LHS of equation (8) rises with skills. Thus, I can define the skill threshold $a(\tau_a^D, \underline{w})$ as the lowest skill level at which the inequality in equation (8) is satisfied. It follows from this that any worker with training level τ_a^D and skills greater than or equal to $a(\tau_a^D, \underline{w})$ will be hired.

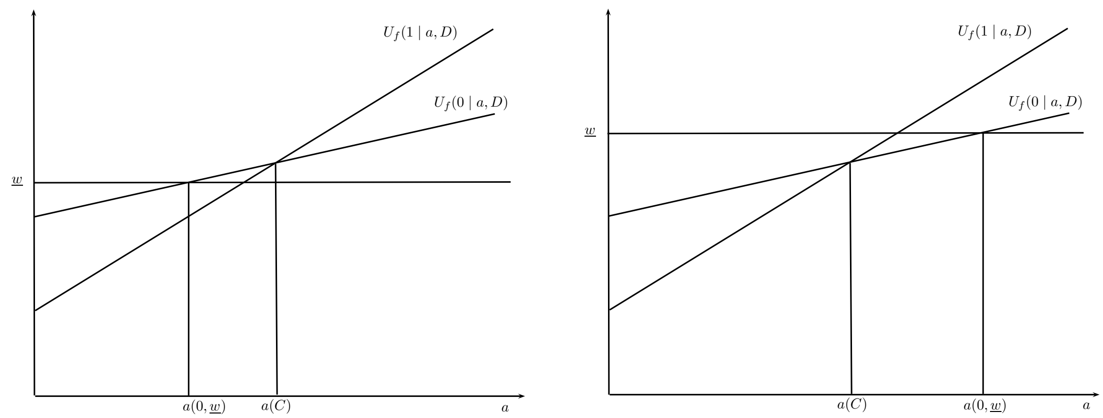


Figure 2: Hiring and Training Decision under LMI

Observe that equation (7) evaluated at the efficient skill threshold $a^*(C)$ re-writes as follows

$$-\frac{1}{2}\int_{2\theta-\eta}^{\eta-2P}[F(y \mid 0, a^*) - F(y \mid 1, a^*)]dy - \int^{\theta-P-T-\eta}[F(y \mid 0, a^*) - F(y \mid 1, a^*)]dy - \int_{\eta-2P}[F(y \mid 0, a^*) - F(y \mid 1, a^*)]dy < 0 \tag{9}$$

This together with FOSD implies that firms invest in training, but as with spot contracting in the absence of LMI, they do not invest at the first-best efficient level. The reason is that there are states in which the firm is not the full residual claimant to the return to training.

I can now state the main result of this section:

Proposition 3 *If $a^D(C) > a(0, \underline{w})$,*[18] *then it is optimal to employ all workers with a skill level $a \geq a(0, \underline{w})$ and train only those with a skill level $a > a^D(C)$, while if $a^D(C) \leq a(0, \underline{w})$, then it is optimal to employ and train all workers with a skill level $a \geq a(1, \underline{w})$, there is under-investment in training and $a^D(C)$ and $a(1, \underline{w})$ rise with training costs (C) and falls with the productivity of specific training (η).*

[18] Observe that if $\underline{w}$ is such that $a(0, \underline{w}) = a^D(C)$, then $a(0, \underline{w}) = a(1, \underline{w})$ since at $a = a^D(C)$, $E(y \mid 0, a) + U_f(1 \mid a, D) - C = E(y \mid 0, a) + U_f(0 \mid a, D)$. This together with the fact that the worker's utility rises with skills implies that if $a(0, \underline{w}) \leq a^D(C)$, then $a(0, \underline{w}) < a(1, \underline{w}) < a^D(C)$, otherwise $a(0, \underline{w}) > a(1, \underline{w}) > a^D(C)$.

As in the standard neoclassical model, minimum wages reduce employment since there are workers who will not be able to find a job. It is easy to see that the number of unemployed workers in period one is

$$U^D(C) \equiv G(\min\{a(1,\underline{w}), a(0,\underline{w})\}) > 0, \tag{10}$$

and training incidence is equal to

$$T^D(C) \equiv 1 - G(\max\{a^D(C), a(1,\underline{w})\}). \tag{11}$$

Thus the number of workers who are hired but will not receive training is equal to

$$1 - T^D(C) - U^D(C) \geq 0. \tag{12}$$

6 How Labor Market Institutions Affect Firm-provided Training?

In this section, I ask the question of how the introduction of a given institution affects training incidence in an otherwise competitive labor market.

The key to understand the effect of any given institution on training is to choose the most adequate benchmark against to which to make the comparison. Most papers in the literature, such as Acemoglu and Pischke (2003) for the case of the minimum wage and Dustmann and Schönberg (2008) for the case of unions, have argued that the introduction of institutions such as the minimum wage and unions respectively results in more firm-sponsored training than the one obtained under a model that predicts no firm-sponsored training in the absence of the corresponding institution. Here, in contrast, I use as a benchmark the solution to the spot-contracting model in the absence of LMI presented in sub-section 4.2. This is a more realistic benchmark against to which to compare the effect of any institution since firm-sponsored general training takes place even in the absence of it. In short, I study whether $T^s(C)$ is greater or smaller than $T^D(C)$ and study each institution in turn.[19] This entails to compare the skill threshold above which training occurs in a sport market in the absence of the corresponding institution, $a^s(C)$, to that in the presence of it, $\max\{a^D(C), a(1,\underline{w})\}$.

In what follows, I will focus on the most interesting and realistic case in which not all hired workers are trained after the imposition of a given institution; that is, $a^D(C) > a(1,\underline{w})$.[20]

[19] It is useful to have in mind that $T^D(C) = T^s(C)$ when $D = \mathbf{0}$.

[20] This fits well with reality since training incidence in developed countries never reaches 100% of the workers.

6.1 Minimum Wages.

Substituting $a^s(C)$ into equation (7) and re-arranging, it is easy to see that the imposition of a minimum wage rises training if and only if[21]

$$\int_{\underline{w}-\eta}^{2\underline{w}-\eta}[F(y \mid 0,a)-F(y \mid 1,a)]dy-\int_{-\eta}^{\underline{w}-\eta}[F(y \mid 0,a)-F(y \mid 1,a)]dy>0, \tag{13}$$

It follows from this that the imposition of a minimum wage in an otherwise competitive labor market may either increase or decrease training. On the one hand, the imposition of a minimum wage makes general training into de facto specific in the sense that the firm gets the full return to training when the worker is paid the minimum wage. This is captured by the first term in equation (13). On the other hand, a minimum wage increases the likelihood that a working relationship is severed, in which case the firm gets no return to training. This is captured by the second term in equation (13). Thus, the imposition of a minimum wage rises training incidence when the difference between the probability that the marginal worker is paid the minimum wage without and with training is greater than the difference between the probability that the marginal worker leaves the firm without and with training.

Acemoglu and Pischke (2003) predicts that the imposition of a minimum wage rises training incidence. The difference between the prediction of the model here and that of Acemoglu and Pischke (2003) stems from two facts: first, in their model there is no firm-sponsored training in the absence of the minimum wage. Since minimum wages compress the wage structure, Acemoglu and Pischke (2003) predict that minimum wages result in firm-sponsored training relative to the no firm-sponsored training benchmark; second, their model ignores the effect of a minimum wage on separations. It only considers the effect of it on the possibility to become employed. In contrast, here I provide conditions under which the imposition of a minimum wage may result in more or less training relative to a more realistic benchmark in which there is firm-sponsored training, and consider the effect of minimum wages on the probability of separation. Against this benchmark, higher minimum wages result in less training when the difference between the probability that the marginal worker is paid the minimum wage without and with training is greater than the difference between the probability that the marginal worker leaves the firm without and with training. Thus, the prediction that minimum wages result in more training relative to a no firm-provided training could be misleading.

The highest training participation occurs in Sweden with a 60% for workers aged 25-64, while the lowest is Romania with a 10% participation.

[21] The analysis of unemployment assistance benefits is the same as the one presented here and thus omitted.

The empirical literature with regard to the impact of minimum wages on training provides mixed evidence. The earliest efforts focused primarily on wage growth as a proxy for training, producing mixed results. These studies found that age-earnings profiles are significantly flatter for workers whose wages were bound to the minimum (Mincer and Leighton (1980); Hashimoto (1981)).[22] Recent evidence has cast serious doubt on the validity of this entire approach.

Grossberg and Sicilian (2004) find that while minimum wages are indeed associated with reduced wage growth, they appear to have no significant impact on job training. Acemoglu and Pischke (2003) claim that minimum wages eliminate part of the lower tail of the wage distribution, bunching workers around the minimum wage and thereby lowering the age-earnings profile, and that this will be true independent of their impact on training. Thus, it seems clear that a correct test of the relationship between minimum wages and training must be conducted with information on worker training. Acemoglu and Pischke (2003), taking into account their own criticism and using within state variation in minimum wages for an a homogeneous group of workers, find no evidence of a reduction in training for workers with wages near to the minimum wage. Fairris and Pedace (2004), using establishment-level data, find no evidence indicating that minimum wages reduce the average hours of training of trained employees and little to suggest that minimum wages reduce the percentage of workers receiving training.

There is only one study that can provide an empirical answer to the question of how training rises with the imposition of a minimum wage. Arulampalam, Booth, and Bryan (2004a) estimate the impact of the new national minimum wage in the UK on low-wage workers using two 'treatment groups': those workers whose derived 1998 wages were below the minimum and those workers explicitly stating they were affected by the new minimum. Using information on training incidence and intensity, they find no evidence that the minimum wage introduction reduced the training intensity of affected workers and some evidence that it increases the number of workers receiving training. In particular, the training probability increased by 8 to 11 percentage points for affected workers.

Stewart (2004) finds, using the same data and period, that the estimated impact of the introduction of the minimum wage on the probability of remaining in employment is insignifi-

[22] Card and Krueger (1995) compared cross sectional wage profiles in California before and after the 1988 minimum wage increase with a number of comparison states. They also found flatter profiles in California after the minimum wage increase. However, they point out that the Californian profile also shifts up and does not cross the previous age-wage profile. This pattern contradicts the standard theory, but is consistent with the predictions of the model here.

cantly different from zero for all four demographic groups (male and female adults and youths). This evidence is related to the magnitude of the second term in equation (13) and suggests that this term is small if not zero. This provides an explanation for why the imposition of the new national minimum wage in the UK resulted in an increase in training.[23]

6.2 Firm-specific Unions.

The crucial feature of the union model here is the coexistence of a unionized and non-unionized sector. Each sector consists of many firms competing for workers. The difference between the two sectors is that firms in the unionized sector have to pay at least the union wage (a wage floor θ), while firms in the non-unionized sector do not face a wage floor restriction. It follows then that unionized firms behave as spot market firms in the presence of a wage floor and non-unionized firms behave as spot market firms in the absence of a wage floor.

In this model, unionized firms offer a particular type of long-term wage contract: they guarantee to pay at least the union wage in the future. Although firms could offer such a contract without becoming unionized, it is not credible once training is completed; they will have an incentive to renegotiate the wage in certain states. Hence, unions here work as a commitment device. Unionized firms credibly signal to workers that they will pay at least the agreed union wage in the future.

In many countries, the union wage depends on observable worker characteristics such as training. In order to simplify the model, I assume here that the union wage is the same for workers with and without training. In certain countries the union apply to all workers (those in training and those who are not), while in others such as Germany and Italy, it applies only to those that have already received training.

The model here can accommodate both cases without further analysis. In order to see this let the union wage for trainees be w_0 and that for old workers be equal to θ. Then it follows from the analysis in section 5, that only workers with an ability greater than $a(\tau, w_0)$ are hired in the unionized sector and only those with an ability greater than $a^D(C)$ are trained in that sector. In contrast, in the non-unionized sector all workers can find a job, and only those whose ability exceeds $a^s(C)$ will receive training.

[23] This finding does not contradict the one in table 3 since the coefficient there captures the effect of a marginal increase in the minimum wage on training incidence once there is a minimum wage, while here the evidence refers to the case in which initially there is no minimum wage and one is imposed.

Let me assume that the wage for trainees is chosen so that $a(1, w_0) \leq a^D(C)$. This means that in the unionized sector, firms may be willing to hire workers who will not receive training and they are willing to hire all workers that they will be willing to train. Ignoring sorting across sectors issues, it is then clear from the analysis regarding the introduction of a minimum wage that unions may result in more or less training. This results is in contrast to others in the literature, such as Dustmann and Schönberg (2008) and Booth, Francesconi, and Zoega (2003), since they argue that unions increase training. The reason for that it is the use as a benchmark a model that predicts no firm-sponsored training in the absence of unions.

The main difference with minimum wages stands for the sorting of workers across sectors (unionized and non-unionized). A worker chooses to work in the unionized sector if total career wages from working in the unionized sector exceeds that from working in the non-unionized sector.

It is useful to note that a worker who leaves the unionized sector will go on to work in the non-unionized sector, and he will paid his total productivity in that sector; that is, y.

Because there is competition in the unionized sector as well as in the non-unionized sector, the first-period wage must be set so that firms make zero expected profits. This implies, after integrating by parts once, that total career utility for a worker with ability a in a sector with wage floor θ, with $\theta = 0$ in the non-unionized sector, is given by:

$$E(y \mid 0, a) + y_H + \eta - \theta F(\theta - \eta \mid \tau_a, a) - \int_{\theta-\eta} F(y \mid \tau_a, a) dy - \tau_a C$$

Thus, for a worker with ability a, total career utility in the unionized sector is greater than that in the non-unionized sector if and only if

$$\int_{-\eta} F(y \mid \tau_a^s, a) dy - \theta F(\theta - \eta \mid \tau_a^D, a) - \int_{\theta-\eta} F(y \mid \tau_a^D, a) dy + (\tau_a^s - \tau_a^D) C \geq 0.$$

It is clear from this expression that workers receiving training in both sectors and those who do not receive training in both sector are better-off in the non-unionized sector. The reason is simple. In the unionized sector, they will be fired more often when they turn out to have a lower productivity than the unionized wage, and thus they will lose the return to firm-specific training more often and will not benefit from the unionized wage. Workers who receive training in the non-unionized sector, but do not receive training in the unionized sector will choose the non-unionized sector. Only workers who will be trained in the unionized sector, but not in the non-unionized sector will choose the unionized sector when the expected loss due to the fact that firing occurs more often is not too high.

A worker who receives training in the unionized sector, but does not in the non-unionized sector prefers the unionized sector if and only if

$$\int_{-\eta} F(y \mid 0, a)dy - \theta F(\theta - \eta \mid 1, a) - \int_{\theta-\eta} F(y \mid 1, a)dy - C \geq 0$$

This shows that if a unionized sector exists, it is exactly because there are workers who would receive training in that sector but would not receive training in a non-unionized sector. This provides a rationale for why the empirical evidence shows that training incidence is greater among unionized workers (see, for example, Booth (1991); Lynch (1992); Green, Machin, and Wilkinson (1999); Booth *et al.* (2003); and Dustmann and Schönberg (2008)). Cross-country comparisons also reveal that workers in Europe receive more work-related training than their counterparts in the United States (see, for example Bassanini *et al.* (2005)) and that unionization is higher in Europe.

There is one study that asks the equivalent question that was asked in this section but from an empirical point of view, which is Dustmann and Schönberg (2008). Using German data, they find that firms that change from being non-unionized to being unionized increase their training incidence in a significant manner. They report that their estimates suggest that the difference in training probability between being unionized and non-unionized for those firms that choose to be unionized is 6.8 percentage points, and the difference in the proportion of apprentices is 2.7 percent. Thus, again the model here provides a rationale for this evidence different from the one provided in for instance Booth *et al.* (2003) and Dustmann and Schönberg (2008).

6.3 Firing Costs

Substituting $a^s(C)$ into equation (7) and re-arranging, the imposition of firing costs rises training incidence if and only if

$$\int_{-T-\eta}^{-\eta} [F(y \mid 0, a) - F(y \mid 1, a)]dy > 0. \tag{14}$$

This shows that the imposition of firing costs in an otherwise competitive economy rises training incidence. The reason is that the relationship is severed less often, since firing costs lower a firm's outside option and thus the firm and the worker share the return to training more often. This means that the firm fires the worker if and only if $y + \eta - w < -T$, while in a competitive labor market it fires the worker if and only if $y + \eta - w < 0$. Thus, in the presence of firing costs, the firm is willing to keep the worker even if he has negative net productivity.

I will defer the discussion of the empirical evidence to the next sub-section where I study the effect of severance pay on training.

6.4 Mandated Severance Pay

Substituting $a^s(C)$ into equation (7) and re-arranging, the imposition of mandated severance pay rises training if and only if

$$\int_{-\eta}^{2P-\eta}[F(y \mid 0, a) - F(y \mid 1, a)]dy - \int_{\eta-2P}^{\eta}[F(y \mid 0, a) - F(y \mid 1, a)]dy > 0 \tag{15}$$

The imposition of mandated severance pay has a positive and a negative effect relative the competitive benchmark. The positive effect arises because mandated severance payments work as a wage floor when the productivity is low (i.e., $y \leq P$). This means that in those states the firm gets the full return to training since in order to keep the worker the firm must paid him a wage equal to the mandated severance payment. In addition, severance pay does not affect the separation decision, since the worker must be paid P regardless whether he stays or leaves. The negative effect stems from the fact that severance pay increases the likelihood that the worker's outside option binds.[24] Because the firm gets no return to training when the worker must be paid his outside productivity, the firm's incentives to provide general training fall. Thus, the imposition of severance payments rises training incidence when the difference between the probability that the marginal worker is paid severance payments without and with training is greater than the difference between the probability that the marginal worker's outside option binds without and with training.

The evidence with regard to the effect of an employment protection institutions on training is somewhat scarce. Bishop (1991) reports that the likelihood and amount of formal training are higher at firms where firing a worker is more difficult. Acemoglu and Pischke (2000) argue that there are complementarities between regulation regimes and training systems, and that reducing firing costs and increasing employment flexibility could reduce the incentives to train. Their evidence, however, is casual and focuses mainly on Germany. For European countries, Bassanini *et al.* (2005) find that training incidence is lower when the degree of employment protection of both regular and temporary workers is greater, although this effect is statistically different from zero only for the former. In particular, they find that a unit increase in the employment protection index reduces training incidence by 0.034 in the case of regular workers

[24] This assumes that outputs are independently and identically distributed across workers.

and by 0.004 in the case of temporary workers. Given that average training incidence in their sample is close to 0.2, these effects are not negligible.

Almeida and Aterido (2008) analyze the link between stringency of the de facto labor market regulations faced by firms and the incentive to invest in job training. They use a large firm level data set across more than 65 developing countries. Their findings strongly support the idea that a stricter labor code is associated with a higher investment by firms in the human capital of their employees. Training incidence for a firm facing the 90th percentile of the enforcement of labor regulation relative to a firm facing percentile 10th is 2.1 percentage points higher in a country with a rigid labor regulation (that is, in the 90th percentile of the rigidity of employment index) than in a country with a less rigid labor regulation (i.e., in the 10th percentile). Nevertheless, the magnitude of the effect is quantitatively small (average training incidence in their sample is 45.2%).

7 Labor Market Institutions and Training Incidence

In previous sections I derived conditions in which any given institution increases training incidence relative to a benchmark in which there are no LMI. This section discusses two related issues. First, I study how a marginal change in any given institution affects training incidence. Second, I discuss the extent to which our theoretical results are consistent with the stylized facts presented in 2.

Given the results in proposition 3, it is easy to see that the effect of any institution on firm-provided training will depend on whether all hired workers are trained or not. As in the last section, here I will focus on a parametrization under which not all hired workers receive training. Thus, training incidence in country j is given by $T_j^D \equiv 1 - G_j(a_j^D(C))$.[25]

Here, I shall make the following assumption regarding the distribution of output.

- (A2) Let define the likelihood ratio as $\mathcal{L}(y \mid a) \equiv \frac{f(y|1,a)}{f(y|0,a)}$. Then $f(y \mid \tau, a)$ satisfies the Monotone likelihood ratio property if and only if $\mathcal{L}(y \mid a)$ rises with y.[26]

It readily follows from equations (7) that the effect of an increase in the wage floor (i.e, minimum wage and assistance unemployment benefits) on training incidence is positive if and

[25]In this section, I will omit the argument C to decrease the notational clutter.

[26]This property implies strict first-order stochastic dominance.

only if

$$\triangle F(2\theta - \eta \mid a^D) - \triangle F(\theta - P - T - \eta \mid a^D) > 0. \tag{16}$$

A hike in the wage floor may either increase or decrease the number of workers who receive training. For all productivity levels between $2\theta - \eta$ and $\theta - P - T - \eta$, workers are paid the wage floor, which is independent of their productivity. In those states, a wage floor hike reduces firms' profits by the same amount regardless of workers' level of training and firms gets the full return to training. Thus, a wage floor hike rises training incidence when the probability that the marginal worker gets paid the wage floor when he receives training is smaller than that when he does not receive training.

This is consistent with the evidence in table 3. Furthermore, it is easy to see that the marginal effect of an increase in the wage floor on training incidence rises as severance payments and firing costs increase. This is also consistent with the coefficient on the interaction term considering minimum wages and EPL and that for unemployment assistance benefits and EPL reported in table 2.

This leads to the following result.

Prediction 1 *Suppose assumptions (A1) and (A2) hold. Then training incidence may either rise or fall with the wage floor, and the marginal effect of a wage floor on training incidence is more likely to be positive in economies with a stronger employment protection legislation and higher unemployment assistance benefits.*

An increase in firing cost rises training if and only if

$$\triangle F(\theta - P - T - \eta \mid a^D) > 0. \tag{17}$$

An increase in firing costs, increases the number of workers who receive training. The reason is that a marginal increase in firing costs decreases the firm's outside option and thus the relationship is less likely to be severed. Because the firm gets the full return to training in states close to the separation threshold when workers are the paid the wage floor or firms and workers share the return to training in the absence of wage floors, firms have higher incentives to train workers.

This leads to the following result.

Prediction 2 *Suppose assumptions (A1) and (A2) hold. Then regardless of the institucional setting, training incidence rises with firing costs.*

If the EPL index captures mostly firing costs rather than severance payments this prediction is confirmed by the results in table 3, since an increase in EPL increases training incidence regardless of the institutional setting.

An increase in severance payments rise training incidence if and only if

$$\begin{aligned} &-\triangle F(\eta - 2P \mid a^D) + \triangle F(\theta - P - T - \eta \mid a^D) - \\ &[\triangle F(\theta - P - T - \eta \mid a^D) - \triangle F(2\theta - \eta \mid a^D)]\frac{\partial \theta}{\partial P} > 0. \end{aligned} \tag{18}$$

When severance payments do not affect the wage floor; that is, $\underline{w} > \mu + P$, an increase in P rises the worker's outside option and decreases the separation threshold. The former effect reduces firms' incentives to train workers since firms are less likely to get a positive return to training, while the latter effect induces firms to invest more in training since at the separation threshold, firms get the full return to training because wages are independent of productivity. Thus, training incidence rises with severance pay when the difference between the probability that the marginal worker is paid his outside option without training and that with training is greater than the difference between the probability that the marginal worker leaves the firm without training and that with training.

When $\underline{w} \leq \mu + P$, wages rise with P in a one-by-one basis and therefore the separation threshold is independent of P since in this case severance payments are just a transfer from firms to workers.[27] On the one hand, as severance pay rises, firms' incentives to train fall since workers' outside options are more likely to bind and, on the other hand, workers are more likely to be paid a wage that is independent of their productivity. This rises firms' incentives to train since in those states in which workers are paid $\mu + P$, firms get the full return to training. Thus, training incidence rises with severance pay when the probability that firms and workers share the return to training evaluated at the ability level of the marginal worker is smaller when the marginal worker receives training than when he does not.

This leads to the following result.

Prediction 3 *Suppose assumptions (A1) and (A2) hold. Then training incidence may either*

[27] This is in line with Cahuc and Zylberberg (1999) who argue that in the presence of minimum wages, inside wages cannot be adjusted to the severance pay.

rise or fall with severance pay, and the marginal effect of an increase in severance pay on training incidence is more likely to be positive in economies with higher minimum wages and unemployment assistance benefits.

This result is consistent with the evidence reported in section 2 as long as the EPL index captures mostly firing costs rather than severance payments.

Finally I will study the effect of unions on training incidence. Because there is competition in the unionized sector as well as in the non-unionized sector, the first-period wage must be set so that firms make zero expected profits. This implies, after integrating by parts once, that total career utility for a worker with ability a in a sector with wage floor θ is given by:

$$E(y \mid 0, a) + y_H + \eta - (\theta - \mu - P) \int^{\theta - T - P - \eta} f(y \mid \tau_a, a) dy - \int_{\theta - T - P - \eta} F(y \mid \tau_a, a) dy - \tau_a C$$

Because $\theta \geq \mu + P$, total career utility falls as the wage floor θ rises. Thus, ceteris-paribus, less workers choose the unionized sector as θ rises. This implies that as θ rises, marginal workers will choose the unionized sector only if an increase in θ induces unionized firms to provide them with training. Thus, in the data a positive relationship between union density, understood as the fraction of workers who work in the unionized sector, and training incidence should emerge.[28]

Observe also that the marginal effect of θ on participation in the unionized sector rises as unemployment assistance benefits increase. Because unionized workers are more likely to be fired, ceteris-paribus, higher unemployment benefits makes the unionized sector more attractive.

Prediction 4 *Suppose that assumption (A1) and (A2) hold. Then training incidence and union density are positively related.*

These prediction is also confirmed by the estimates presented in table 2.

Thus, if the index of EPL captures mostly firing costs, one can conclude that training incidence should be greater in countries with stronger EPL and higher union density. This effects are more likely to be positive in economies with higher minimum wages and unemployment assistance benefits. The downside of all this is that unemployment should also be greater in these economies.

[28] The causality is however from training to union density; if unionized firms train more, more workers choose the unionized sector.

Thus, empirical studies focusing on single institutional instruments are likely to provide biased estimator on the effect of any given institution on training incidence. They also suggests that the great variation of LMI across countries has the potential to empirically explain the great variation in training incidence across countries. This however requires a more complete and detailed data on training incidence and individual and country level characteristics such as schooling.

8 Workers Training Decisions

So far I have assumed that workers do not invest in training. The evidence however shows that firms and workers contribute to training although in a disimilar way. Figure 8 shows self-reported training incidence by financing source.[29] The figure shows great variation of training incidence by financing source across countries. Furthermore countries where firm-financed training incidence is greater, worker-financed training incidence is lower. While this is just raw data this is somewhat indicative of substitution between firm- and worker-financed training.

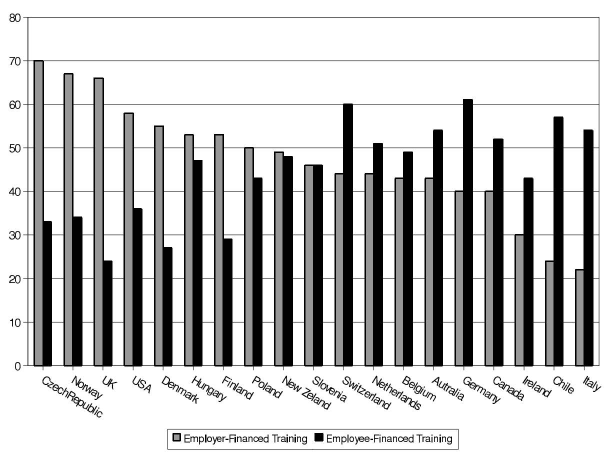


Figure 3: Training Incidence by Financing Source (source: IALS, ALL, and AEPS 1993-1999)

In this section, I consider the case in which both workers and firms are allowed to invest in general training. Let τ be (τ_f, τ_l), where τ_f is the firm investment decision and τ_l is the worker's investment decision.

The output is distributed $F(y \mid \tau_f, \tau_l, a)$, with $F(\cdot)$ sub-modular in (τ_f, τ_l). That is, I

[29]Note that training incidence does not add up to 1 since training costs can be shared between different sources.

assume that the marginal productivity of τ_f (τ_l) is smaller when the worker (the firm) has already invested in training. Formally, submodularity with respect to (τ_f, τ_l) implies that $F(y \mid 1,1,a) + F(y \mid 0,0,a) \geq F(y \mid 1,0,a) + F(y \mid 0,1,a)$ for all $a \in A$. This assumption is intended to capture the idea that for any skill level firm- and worker-provided training are substitutes. Furthermore, I keep the assumption that training and skills improve the distribution in the FOSD sense; that is, for all $y \in Y$, $F(y \mid \tau_f, \tau_l, a) \leq F(y \mid \tau_f', \tau_l', a)$ for any $(\tau_f', \tau_l') \leq (\tau_f, \tau_l)$ and $F_a(y \mid \tau_f, \tau_l, a) < 0$ for all (τ_f, τ_l), and skills and training are complements in the following sense: $F_a(y \mid \tau_f, 1, a) \leq F_a(y \mid \tau_f, 0, a)$ for $\tau_f \in \{0,1\}$ and $F_a(y \mid 1, \tau_l, a)\} \leq F_a(y \mid 0, \tau_l, a)$ for $\tau_l \in \{0,1\}$. Furthermore, to simplify the algebra, I make the following reasonable assumption: $F(y \mid 1,0,a) = F(y \mid 0,1,a)$.

In order to ensure that training rises with skills, I assume that $F_a(y \mid 0,1,a) + F_a(y \mid 1,0,a) \geq F_a(y \mid 1,1,a) + F_a(y \mid 0,0,a)$. This says that the marginal return to one party's investment in training rises with the worker's skill level more when the other party does not invest in training than when it does so.

First, lets consider the case of spot contracting in the absence of LMI.

In this case, for any given $\tau_f \in \{0,1\}$, a worker chooses $\tau_l \in \{0,1\}$ to maximize its total expected wages $U_l(\tau_f, \tau_l \mid a, \mathbf{0}) - \tau_l C$ and, for any given $\tau_l \in \{0,1\}$, the firm chooses $\tau_f \in \{0,1\}$ to maximize its total expected profits $U_f(\tau_f, \tau_l \mid a, \mathbf{0}) - \tau_f C$. Thus, provided that a firm hires a worker with a skill level a, a worker invests in training if and only if

$$U_l(\tau_f, 1 \mid a, \mathbf{0}) - C \geq U_l(\tau_f, 0) \mid a, \mathbf{0}),$$

and the firm invests in training if and only if

$$U_f(1, \tau_l \mid a, \mathbf{0}) - C \geq U_f(0, \tau_l \mid a, \mathbf{0}).$$

Integrating-by-parts once the worker and the firm's incentive constraints, a worker with a skill level $a \in A$ will invest in training if and only if

$$\int_{\eta} [F(y \mid \tau_f, 0, a) - F(y \mid \tau_f, 1, a)]dy + \frac{1}{2}\int_{-\eta}^{\eta} [F(y \mid \tau_f, 0, a) - F(y \mid \tau_f, 1, a)]dy - C \geq 0, \quad (19)$$

while a firm will invest in training if and only if

$$\frac{1}{2}\int_{-\eta}^{\eta} [F(y \mid 0, \tau_l, a) - F(y \mid 1, \tau_l, a)]dy - C \geq 0. \quad (20)$$

These incentive constraints capture the fact that the worker's is paid his productivity outside of the firm when this is high, since the worker's productivity outside of the firm rises by the same amount as it does it within the relationship, and the firm and worker share the return to general training when productivity in the alternative employer is lower than η, since the worker's share of his productivity with the current employer exceeds that with his outside employer.

It follows from equation (19) and submodularity with respect to (τ_f, τ_l) that the worker's best response is non-increasing in the firm's investment decision. Similarly, it follows from equation (20) and submodularity with respect to (τ_f, τ_l) that the firm's best response is non-increasing in the worker's investment decision. In short, (τ_f, τ_l) are strategic substitutes. For the sake of brevity, in what follows, I will focus on pure strategies.

Because training and skills are complements in the sense defined above, there exists a skill level, denoted by $a^l(\tau_f, C)$, such that a worker's best response to $\tau_f \in \{0,1\}$ is to invest if and only if his skill level is greater than $a^l(\tau_f, C)$. Similarly for the firm. That is, the firm's best response to the worker's decision $\tau_l \in \{0,1\}$ is to invest if and only if the worker's skill level is greater than $a^f(\tau_l, C)$.

Lemma 1 *(i) $a^l(0,C) \leq a^l(1,C)$ and $a^f(0,C) \leq a^f(1,C)$; and (ii) if $\tau_l \geq \tau_f$, then $a^f(\tau_l, C) > a^l(\tau_f, C)$*

Proof. Observe that submodularity implies that

$$\int_{\eta} [F(y \mid 0,0,a) - F(y \mid 0,1,a)]dy + \frac{1}{2}\int_{-\eta}^{\eta} [F(y \mid 0,0,a) - F(y \mid 0,1,a)]dy - C \geq$$
$$\int_{\eta} [F(y \mid 1,0,a) - F(y \mid 1,1,a)]dy + \frac{1}{2}\int_{-\eta}^{\eta} [F(y \mid 1,0,a) - F(y \mid 1,1,a)]dy - C.$$

This together with the fact that for $\tau_f \in \{0,1\}$

$$\int_{\eta} [F_a(y \mid \tau_f,0,a) - F_a(y \mid \tau_f,1,a)]dy + \frac{1}{2}\int_{-\eta}^{\eta} [F_a(y \mid \tau_f,0,a) - F_a(y \mid \tau_f,1,a)]dy \geq 0$$

implies the result.

The proof for the $a^f(\tau_l, C)$ is identical and thus omitted.

Part (ii) readily follow from comparing payoffs and noting that $F(y \mid 1,0,a) = F(y \mid 0,1,a)$.

■

This lemma establishes that the skill threshold above which the worker invests in training is greater when the firm invests in training than when it does not. Similarly for the firm. This is due to the fact that there is substitution between the two types of training and training and skills are complements. The second part says that for any given skill level the worker is more likely to invest in training.

Let $\tau_a^s = (\tau_{af}^s, \tau_{al}^s)$ be the pure-strategy equilibrium choice of training for a worker with skill level a.

The lemma above and the discussion so far leads to the following result.

Proposition 4 *(1) Suppose that $\eta > 0$ and $a^f(0, C) > a^l(1, C)$. Then if (i) $a > a^f(1, C)$, both the firm and the worker invests in training; (ii) if $a^f(1, C) \leq a > a^l(0, C)$, the firm does not invest in training, while the worker does it; and (iii) if $a \leq a^l(0, C)$, neither the firm nor the worker invests in training; and (2) Suppose that $\eta > 0$ and $a^f(0, C) \leq a^l(1, C)$. Then if (i) $a \geq a^f(1, C)$, both the firm and the worker invests in training; (ii) if $a^f(1, C) > a \geq \max\{a^l(1, C), a^f(0, C)\}$, the firm does not invest in training, while the worker does it; (iii) if $a^l(1, C) > a \geq a^f(0, C)$, either the firm or the worker invests in training; (iv) if $a^f(0, C) > a \geq a^l(0, C)$, the worker invests in training, while the firm does not; and (v) if $a \leq a^l(0, C)$, neither the firm nor the worker invests in training.*

Because workers are never paid more than his productivity, all workers are employed regardless of their training. When a worker's skills are low, he does not receive and does not invest in training, while when his skills are high, both the firm and the worker himself invest in training. A worker whose skill level is neither high nor low, either receives training or invests in training. When only the worker invests in training, he pays for his training directly and thus have a lower first-period income, but a larger wage than when only the firm invests in training. This follows from noting that the first-period wage when only the firm invests in training is: $w_1 = E(y \mid 0, a) + U_f(1, 0 \mid a, \mathbf{0}) - C$, while when only the worker invests in training, the first-period wage is $w_1 = E(y \mid 0, a) + U_f(0, 1 \mid a, \mathbf{0})$, and $U_f(1, 0 \mid a, \mathbf{0}) = U_f(0, 1 \mid a, \mathbf{0})$.

Note that compensation is more front-loaded when the worker undertakes training and thus the wage profile is steeper when the firm pays for training.

Essentially there are two things that come out of this model. First, workers' incentives to invest in training are greater than firms' incentives, and second, there is a parametrization under which multiple equilibria exists that result in two different regimes, one in which only workers are willing to invest in training, and one in which only firms provide training.

This leads me to ask whether LMI may change firms and workers' incentives in a way that now firms are more likely to invest in training than workers are. If so, this provides another answer to the question of how LMI affect firm-sponsored training.

Now, lets consider training investment decisions in the presence of LMI.

Provided that a firm hires a worker with a skill level $a \in A$, for any training level $\tau_f \in \{0,1\}$, the worker invests in training if and only if

$$U_l(\tau_f, 1 \mid a, D) - C \geq U_l(\tau_f, 0 \mid a, D),$$

and, for any given any $\tau_l \in \{0,1\}$, the firm invests in training if and only if

$$U_f(1, \tau_l \mid a, D) - C \geq U_f(0, \tau_l \mid a, D),$$

Integrating-by-parts the worker's incentive constraint, a worker with a skill level $a \in A$ invests in training if and only if

$$\begin{aligned}&\int_{\eta-2P}[F(y \mid \tau_f, 0, a) - F(y \mid \tau_f, 1, a)]dy + \\ &\frac{1}{2}\int_{2\theta-\eta}^{\eta-2P}[F(y \mid \tau_f, 0, a) - F(y \mid \tau_f, 1, a)]dy + \\ &(\theta-\mu-P)[F(\theta-P-T-\eta \mid \tau_f, 0, a) - F(\theta-P-T-\eta \mid \tau_f, 1, a)] - C \geq 0.\end{aligned} \tag{21}$$

while a firm will invest in training if and only if

$$\begin{aligned}&\frac{1}{2}\int_{2\theta-\eta}^{\eta-2P}[F(y \mid 0, \tau_l, a) - F(y \mid 1, \tau_l, a)]dy + \\ &\int_{\theta-P-T-\eta}^{2\theta-\eta}[F(y \mid 0, \tau_l, a) - F(y \mid 1, \tau_l, a)]dy - C \geq 0.\end{aligned} \tag{22}$$

It follows from equation (21) and submodularity with respect to (τ_f, τ_l) that the worker's best response is non-increasing in the firm's investment decision. Similarly, for the firm. As before because training and skills are complements in the sense defined above, there exists a skill level, denoted by $a^l(\tau_f, C, D)$, such that a worker's best response to $\tau_f \in \{0,1\}$ is to invest if and only if his skill level is greater than $a^l(\tau_f, C, D)$. Similarly for the firm. That is, the firm's best response to the worker's decision $\tau_l \in \{0,1\}$ is to invest if and only if the worker's skill level is greater than $a^f(\tau_l, C, D)$.

Using the same arguments as above, it is easy to show that

Lemma 2 *$a^l(0, C, D) \leq a^l(1, C, D)$ and $a^f(0, C, D) \leq a^f(1, C, D)$.*

In contrast to the case in which there is no LMI, in the presence of them it is no longer possible to rank the skill thresholds as done before.

The next proposition follows from the lemma above and submodularity.

Proposition 5 *Suppose that $\eta > 0$ and a worker with skill level a finds employment. Then if (i) $a \geq \max\{a^f(1,C,D), a^l(1,C,D)\}$, both the firm and the worker invests in training; (ii) if $\max\{a^f(1,C,D), a^l(1,C,D)\} > a \geq \min\{a^f(0,C,D), a^l(0,C,D)\}$, either the firm or the worker invests in training; and (v) if $a < \min\{a^f(0,C,D), a^l(0,C,D)\}$, neither the firm nor the worker invests in training.*

Let τ_a^{DB} be the optimal investments in training in the presence of LMI.

Integrating-by-parts once equation (1), the necessary condition for a worker with skill level a and training τ_a^{DB} to be hired is

$$E(y \mid 0, a) + \eta - P - \frac{1}{2}\int_{2\theta-\eta}^{\eta-2P} F(y \mid \tau_a^{DB}, a)dy - \int_{\theta-P-T-\eta}^{2\theta-\eta} F(y \mid \tau_a^{DB}, a)dy - \tau_a^f C \geq \underline{w}. \tag{23}$$

where τ_a^f is the firm-provided training to a worker with skill level a.

Because an increase in skills improves the output in the FOSD sense and $F(y \mid 1, 0, a) = F(y \mid 0, 1, a)$, the LHS of equation (23) rises with skills.[30] Thus, I can define the skill threshold $a(\tau_a^{DB}, \underline{w})$ as the lowest skill level at which the inequality in equation (23) is satisfied. It follows from this that any worker with training τ_a^{DB} and skills greater than or equal to $a(\tau_a^{DB}, \underline{w})$ will be hired. Thus, a worker whose skill level exceeds $a(\tau_a^{DB}, \underline{w})$, will invest in training or will be trained or both according to the result in proposition 5.

There are several interesting remarks here. First, observe that ceteris-paribus a firm is willing to hire a worker with lower skills when the equilibrium is such that only the worker undertakes training relative to the case in which training is firm sponsored. The reason is that firm's expected profits at the time the hiring decision is made are higher. Second, LMI may lead to a regime switching from a worker-financed training regime to a firm-provided training regime. This occurs when LMI are such that the following holds $a^l(\tau_a^{DB}, C, D) > a^f(\tau_a^{DB}, C, D)$. Third, in an equilibrium in which only firm-provided training arises, the mass of workers who are not able to find employment is greater than that in a worker-financed training equilibrium. Fourth, wages are more front-loaded when workers undertake training and thus wage profiles are steeper when firms pay for training. This implies that wage returns are greater when training is firm-provided than worker-provided. Fifth, there are circumstances

[30] Here, I am assuming that in the case of multiple pure-strategy equilibria, the firm and the worker coordinate in one equilibrium for all skill levels in the range in which multiplicity occurs.

in which the presence of LMI favor firm-sponsored training, but crowds out worker-financed training. However, total training incidence may increase or decrease.

With regard to the fourth result most research points towards substantially larger returns to training financed by the employer. In fact, few studies have been able to document any returns to individual financed (self-sponsored) training. For instance the study by Booth and Bryan (2002) on British data finds no effects on wages from individual financed training. Similarly, Loewenstein and Spletzer (1998) study of NLSY indicates that non-employer financed training does not yield a positive wage return. Blundell, Dearden, Meghir, and Sianesi (1999) also note that employer provided training has a positive impact on wages whereas training not provided by the employer has an insignificant effect on wages.

9 Conclusions

This paper considers several institutions at once, emphasizes the different effects of LMI on firm-provided training, and provides a more natural benchmark against to which to compare the effects of any institution on firm-provided training. The paper's contribution is threefold. On one hand, it shows that using a model that predicts no-firm sponsored training in the absence of LMI as benchmark against to which to compare the effect of any institution on firm-provided training leads to either wrong predictions or incomplete description of how firms' incentives are affected by LMI. On the other hand, the model results show that the effects of LMI on training depends mainly on the institutional setting, and the interactions between different institutions are highly complex. Thus, empirical studies of the impact of different LMI on firm-provided training require to control for the whole institutional mix, needs to control for workers' characteristics and must take into account the effect of LMI on labor turnover; anything short of this is bound to produce biased coefficients of the effect of LMI on firm-provided training in ways that, even at theoretical level, are difficult to devise. Third, the model, in conjunction with the large cross-country heterogeneity in LMI puts forth a plausible rationale for the large variation in firm-provided training incidence across countries, and argues that empirical studies focusing on any single institution appear to miss some potentially important effects.

In spite of the complex relationship between LMI and training incidence, some conclusions can be made. Most LMI reduce employment and this is even more so when training is financed by firms. In general terms, it can be concluded that training incidence should be greater in countries with stronger EPL and higher union density, and this is more likely to be the case in economies with higher minimum wages and unemployment assistance benefits. However, it is extremely delicate to make policy recommendations without a detailed empirical analysis taking into account the complexities in the relationship between training, employment and LMI that this paper highlights.

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