Barriers to Entry, Deregulation and Workplace Training:
A Theoretical Model with Evidence from Europe

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Abstract

We study the impact of barriers to entry on workplace training. Our theoretical model indicates that there are two contrasting effects of deregulation on training. With a given number of firms, deregulation reduces the size of rents per unit of output that firms can reap by training their employees. Yet, the number of firms increases, thereby raising output and profit gains from training and improving investment incentives. The latter effect always prevails. Our empirical analysis, based on repeated cross-section data from 15 European countries and 12 industries, confirms the predictions of the model and shows that deregulation increases training incidence.

JEL-Code: J24, L11, O43.

Keywords: training, product market competition, Europe.

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Introduction

Product and labour market deregulation have attracted considerable attention by economists and policy makers, and there is a broad concern that these regulations can hamper growth and increase unemployment (see e.g. Aghion and Howitt, 1998, Blanchard and Giavazzi, 2003, Alesina et al, 2005). Empirical research on the economic effects of product market regulation and deregulation has focused so far on employment (Kugler and Pica, 2004), productivity growth (Nicoletti and Scarpetta, 2003, Aghion et al. 2009), investment in capital stock (Alesina et al, 2005), innovation (Aghion et al., 2005), and easiness to start a business (Aghion et al, 2008).

This paper develops a theoretical and empirical analysis of the relationship between product market regulation / deregulation and workplace training, which we define as the accumulation of human capital taking place while in employment and after school completion. We believe that looking at training is important because the production of skills is considered as one of the main factors affecting productivity growth (see e.g. OECD, 2007). A casual look at available industry-level cross-country data reveals that the degree of stringency of product market regulation and the training participation rate are negatively correlated. Using data from the European Labour Force Survey and the OECD regulatory database which cover the years 1995-2002, Figure 1 illustrates this for 15 European countries and 3 non-manufacturing sectors (energy, transports and communication), for which data are available. Yet the prevailing view in the labour economics literature is that product market competition depresses training because it compresses the size of the rents that can be appropriated by firms which invest in human capital and pay for most of job-related training (see e.g. Acemoglu and Pischke, 1999, Gersbach and Schmutzler, 2001, 2006)[1].

This view appears to overlook a standard finding in the theory of industrial organization: a firm's incentives to reduce unit costs - for instance by training more workers - do not depend on the size of rents *per se* but on the sensitivity of rents to unit cost reductions (see e.g. Boone, 2000, and Aghion et al., 1997). In the case of price competition (that is when firms set prices rather than quantities), if firms have similar production costs, it is well known that greater competition increases incentives to reduce unit costs even if rents – defined in terms of profits per unit of output – fall (see e.g. Aghion et al., 2001). This occurs because reducing costs allows reducing prices and the sensitivity of product demand to relative prices is greater, the greater the degree of competition.

In this paper we argue that a similar mechanism applies to the investment in human capital by firms, insofar as firms pay for training as a mean to reduce unit costs (see e.g. Stevens, 1996, Acemoglu and Pischke, 1999). We develop a model which casts the training decision in an economy characterized by imperfectly competitive product and labour markets where firms are ex-ante identical and compete in the product market by setting prices, as in Blanchard and Giavazzi (2003). We show that in equilibrium deregulation has two contrasting effects on training. On the one hand, a reduction in the barriers to entry for a given number of firms compresses profits per unit of output, and therefore tends to depress training (we will call this "rent effect" hereafter). This is the mechanism usually stressed in the literature. On the other hand, there is an "elasticity" or "business stealing" effect: conditional on profits per unit of output, additional firm entry due to deregulation increases the output (and therefore profit) gains from training and raises the employer's incentive to invest in human capital. Output gains increase because additional training reduces the relative product price and the response of output to prices is greater, the greater the degree of competition in the product market[2]. We show that the latter effect prevails on the former and conclude that deregulation increases training.

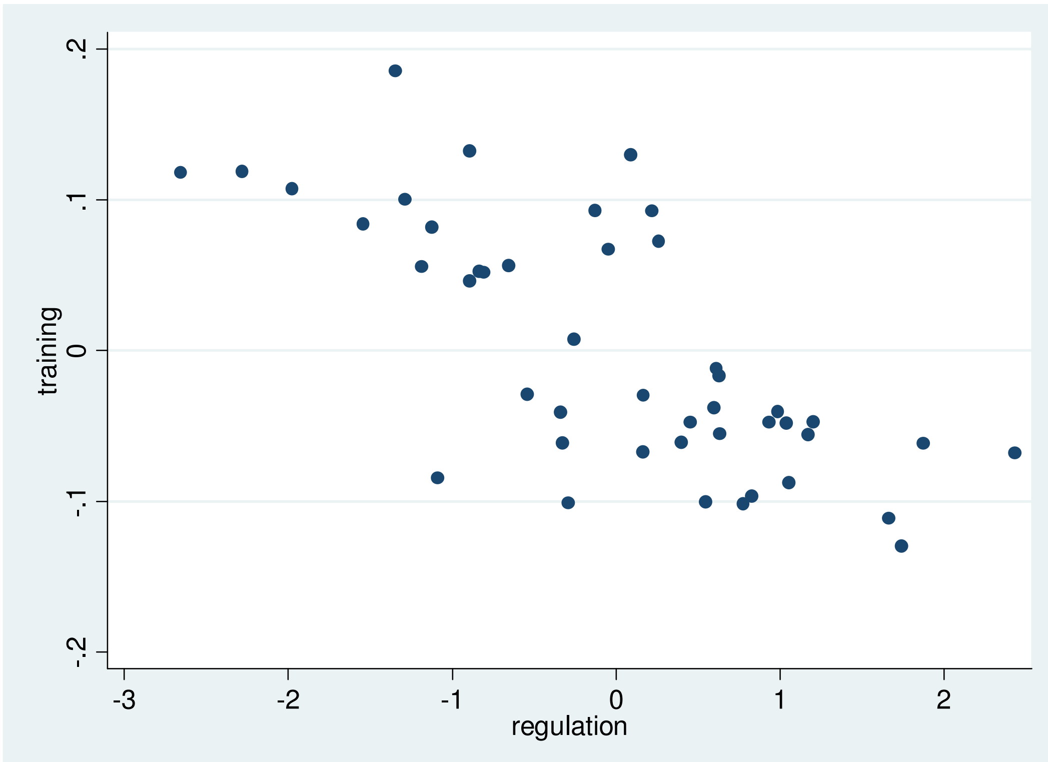
We first derive the equilibrium and describe the comparative statics when: a) training is firm – specific and paid by firms; and b) wages are the outcome of the bargain between employers and workers. We focus on training paid and organized by firms because this is the bulk of workplace training (see Bassanini et al., 2007, and the references therein), and on bargaining in line with the importance of collective wage determination in

[1] The only exception is Autor (2001) who studies firm-sponsored training in the Temporary Help Sevice (THS) industry. In his model training is provided at the time of hiring and is essentially used by THS firms as a screening and selection device. Greater product market competition increases the pressure to secure high-ability workers and the need to use training as a way to attract and select them. His model therefore appears to be specific to the THS industry.

[2] A similar effect is stressed also by Vives (2006), who investigates the relationship between competition and innovation, and Raith (2001), who looks at how competition affects managerial incentives.

Europe, to which our empirical analysis applies. Our emphasis on firm – specific training is also motivated by the European perspective. In his comparative analysis of labour markets, Wasmer (2006) argues that in Europe high employment protection facilitates the investment in firm - specific skills and reduces labour mobility. In the US, instead, limited protection favours both the accumulation of more general skills and higher mobility of workers.

Figure 1. The correlation between training and regulation



Note: The training participation rate refers to training taken in the 4 weeks preceding the survey of full-time employees aged between 25 and 54 years and with at least 4 weeks of tenure. The regulation indicator covers all aspects of anti-competitive regulation (excluding public ownership) and ranges between 0 – no regulation – to 6 – maximum regulation. The sector average of each variable has been subtracted to make comparable in a single charts figures from different industries. Data refer to averages for 1995-2002 for 3 2-digit (letter) sectors (Energy, Transport and Communications) and 15 countries (Norway and pre-enlargement EU excluding Luxembourg). *Sources*: OECD regulatory database and Eurostat's European Labour Force Surveys.

Our key results, however, apply also when training is general and the marginal cost of training is lower than the marginal cost of hiring for any value of training, because labour market frictions substantially reduce the transferability of general skills, making them *de facto* specific, as discussed by Acemoglu and Pischke (1999). Moreover, we show that the positive relationship between deregulation and training holds also when training is fully general, hiring costs are low, the employee invests and bears the training costs and there is no wage bargaining. The reason is that, with additional firm entry due to deregulation, the output gains from employing trained workers increase, the demand for training improves, and so does its supply.

The findings of the theoretical model are a useful guide to our empirical research. Empirical work on product market competition and training is scarce. We are aware of only two studies on the issue and both point to a positive relationship between competition and training. Autor (2001), shows that the Herfindhal index and training are negatively correlated in US temporary help firms, which suggests that less competition reduces training. In a multi-country study of Europe, Bassanini et al (2007), find evidence of a negative and statistically significant correlation between the index of product market regulation developed by the OECD and training intensity, thereby supporting and generalizing Autor's findings.

One potential drawback of multi-country aggregate studies is that, by exploiting only the country and time dimensions, they do not allow to control for many confounding factors that might affect training and vary across country and over time. One way to overcome this limit is to add at least one additional dimension to the data, the sector, as we do in the current paper. With data which vary by country, year and sector, we can compare a treatment group, which consists of the sectors directly affected by our measure of deregulation, with a control group, composed of those sectors which are not affected *directly* by such measure, while at the same time controlling for country and country by time specific effects. The assignment to sectors is random insofar as we can safely rule out the possibility that firms anticipating policy reform can switch sector of production. Given the costs of switching sector, we believe that this source of endogeneity is of second order of relevance.

We use the OECD database on product market regulation which has been designed to pick up regulatory reforms in traditionally heavily regulated sectors, such as transport, communication and public utilities. We consider these sectors as our treatment group, and contrast their behaviour with respect to training with the control group, which consists of the manufacturing sector, limiting our analysis to European countries. After the implementation of the European Single Market Programme (SMP hereafter) in the early 1990s, we can assume that no country/sector-specific regulatory reform affected the manufacturing sector, which therefore qualifies as a genuine control.[3] By comparing training incidence in these sectors, we try to disentangle the effects of deregulation on training from other confounding factors, which affect both groups. To this purpose we match regulation data with training data from the European Labour Force Survey (ELFS) as well as several other sector-level databases and obtain a rich sector-level database of training covariates.

Our econometric analysis shows that reducing product market regulation increases training incidence, in line with the predictions of the theoretical model[4]. The estimated effects are not small: depending on the selected measure of regulation and on the empirical specification, a 10 percent reduction of regulation increases training incidence in the exposed industries by 2.8 to 5 percent.

One might question whether the OECD indicators can adequately capture the regulation and deregulation processes taking place in the treated industries. If yes, we would expect these indicators to positively affect industry–specific profitability. We show that this is the case when profitability is measured by the observed Lerner index (defined as the average share of the value of output that exceeds variable costs, see e.g. Klette, 1999). We also decompose the marginal effect of deregulation on training incidence into its negative effect on the Lerner index and the marginal effect of a lower Lerner index on training, and show that the former is negative and the latter is positive – lower profits are associated to lower rents but also to a higher number of firms, and the overall effect on deregulation on training is positive.

The paper is organized as follows. In the first section we develop the theoretical model. The subsequent sections introduce the empirical strategy and the data and present our estimates of the relationship between training and product market regulation. Conclusions follow.

1. The Model

1.1 Firm-specific training and wage bargaining

Following Blanchard and Giavazzi (2003) and Stevens (1996), consider a three–stage model economy where each firm produces a differentiated product using labour. The number of firms m is determined by an entry condition, which is affected by product market regulation. The logical sequence of the model is as follows: first, firms decide entry (let us call this stage zero); second, each firm hires a number of (unskilled) workers and provides them with a given amount of training, paying the related training costs (call this first stage); third, and

[3] The manufacturing sector, however, could be affected indirectly, because of the close linkage among sectors typical of modern economies.

[4] Needless to say, our empirical results can be consistent with alternative theoretical constructs. In this paper, we do not attempt to discriminate our theory against alternative hypotheses. More modestly, we develop a theoretical model which is consistent with the empirical findings.

conditional on training, firms and workers bargain over wages and employment – or over wages only if the employer (credibly) commits to employ all trainees in final production – (call it second or final stage).[5] Conditional on the amount of training, prices are set when employment is determined. Production occurs at the end of the sequence.

As standard in the training literature (see e.g. Acemoglu and Pischke, 1999, Stevens (1996) or Bassanini et al., 2007), we assume that no training can occur after the bargaining. In both the decision to enter and in the choice of how many workers to train, each employer has full information and can perfectly foresee the wages she will pay, the level of employment and the prices at which she will be able to sell her goods.

Firms in this economy share the same production and training technology, and the same elasticity of product demand. Risk neutral homogeneous workers have the same reservation wage, and there are no exogenous separations of workers from firms. Furthermore, imparted skills are firm–specific (an assumption that we relax in sub-section 1.2).[6] Each firm operates the technology $Y_i = AL^e{}_i$, where Y_i is output of firm *i*, A is a productivity parameter and $L^e{}_i$ is employment in efficiency units, which depends on the amount of training given to each employee $\tau_i \geq 0$. Hereafter, we shall call this amount "training intensity". We assume that the (real) cost of training per employee be a convex function of training intensity τ

$$c(\tau_i) = \frac{\mu \tau_i^{\,2}}{2} \qquad [1]$$

where μ is a scale parameter. This assumption captures decreasing returns in the production of human capital and rules out corner solutions for optimal training.[7] Training affects productivity and labour in efficiency units is given by $L^e{}_i = (1+\tau_i)L_i$ where L is employment. Hence, the production function can be written as $Y_i = A(1+\tau_i)L_i$.[8] Since the number of employees cannot be greater than the number of workers recruited and trained in the first stage T_i, it must be that $L_i \leq T_i$.

Following Blanchard and Giavazzi (2003), we assume that each firm faces the following product demand function

$$Y_i = \frac{Y}{m}\left(\frac{P_i}{P}\right)^{-\theta} \qquad [2]$$

where $\theta = \sigma g(m) > 1$ is the absolute value of the elasticity of demand with respect to the relative price, which increases in the number of firms ($\frac{\partial g}{\partial m} > 0$)[9], σ is a suitable constant, Y is aggregate output, and P_i and P are the price set by firm *i* and the average price respectively.

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[5] Our results can be easily generalised to the case where workers have no bargaining power and are paid their reservation wage.

[6] The assumption is less restrictive than one might think insofar as each firm might have an idiosyncratic combination of general skills (see e.g. Lazear, 2003).

[7] Decreasing returns can arise for instance because the marginal productivity of trainers is decreasing in training intensity.

[8] We implicitly assume that the employees of firm i have the same level of skills, and that the employer cannot gain by recruiting both trained and untrained workers. We also assume that each unit of training increases the efficiency of labour by one unit. This is just a normalisation that simplifies the analysis with no qualitative impact on results.

[9] This follows from the fact that an increase in the number of products associated to firm entry raises the elasticity of substitution between products. As standard in this type of models, we also assume that the number of firms is sufficiently large that the firm cannot affect aggregate variables with its own decisions. This is one of the key differences between our model and Gersbach and Schmutzler (2001, 2006) who consider strategic interactions in a duopoly (with no entry).

Define net and gross profits as net and gross of training costs. The characterization of the equilibrium proceeds by backward induction and starts with the bargain in the second and final stage. Ex-post wage bargaining is justified by the fact that, when firms invest in firm–specific training, workers cannot commit to ex-ante wages but re-contract after the training investment has taken place (Malcolmson, 1997). It is also a plausible characterization of European labour markets, where wages are often set by collective bargaining between employers and trade unions (see Nickell, Nunziata and Ochel, 2005).

In the event of settlement, employed workers earn $W \geq V$, where V is the reservation wage. Failure to settle disrupts the production process to the point that no production occurs and the parties agree to separate. In this event the firm makes zero profits and workers earn their reservation wage V. We characterize the bargaining as a cooperative Nash game, and define the Nash maximand as

$$\Omega_i = \delta \ln\left[(W_i - V)L_i\right] + (1-\delta)\ln\left[P_i Y_i - L_i W_i\right] \qquad [3]$$

where $\delta \leq 1$ is the relative bargaining power of labour and the second element on the right hand side of [3] is the gross nominal profit from a positive settlement accruing to the employer[10].

Consider two alternative settings: in one setting, each firm either can credibly commit to employ in the second stage all the workers who were trained in the first stage – or is forced to do that by strict dismissal regulations. In these circumstances, second–stage employment is fixed and the parties bargain only over wages. In the other setting, there is no strict regulation and the employer does not commit to employ all trainees. As a consequence, in the second stage both wages and employment are bargained over, subject to the constraint that the number of employees cannot exceed the number of trainees set in the first stage[11]. We start with describing the equilibrium under the former setting (call it the "commitment equilibrium"). We do so for expositional reasons, since the derivation of the equilibrium is simple and more intuitive in this setting. We then show that the same equilibrium also holds and is unique in the absence of commitment. We conclude this sub-section by stating the key testable implication on the relationship between product market deregulation and firm-specific training. In the next sub-section we show that the same key implication holds also in the case of general training.

1.1.1 The commitment case

With employment equal to the number of trainees, the parties in the second stage bargain over wages to maximise equation [3]. The outcome of the bargain in firm i is

$$W_i = \delta P_i \frac{Y_i}{L_i} + (1-\delta)V = V + \delta(P_i A(1+\tau_i) - V) \qquad [4]$$

Each employee is paid the outside option plus a share of total rents per worker, a standard result. Employer i in the first stage internalises the wage rule [4] and chooses training intensity and the number of trainees (and therefore employment and prices) to maximize her net real profits[12]

$$\Pi_i = \left\{(1-\delta)\frac{P_i}{P} - (1-\delta)\frac{V}{PA(1+\tau_i)} - \frac{\mu\tau_i^{\,2}}{2A(1+\tau_i)}\right\}\frac{Y}{m}\left(\frac{P_i}{P}\right)^{-\theta} \qquad [5]$$

[10] Profits are gross because training costs in the second stage are bygones.

[11] We assume that in this case the parties are involved in efficient bargaining. An alternative characterization would be the "right to manage" model, where the employer retains authority over employment determination. We follow Blanchard and Giavazzi in the preference for efficient bargaining, which they argue has the advantage of capturing the possibility that firms are not operating on their demand for labour.

[12] That is, nominal profits divided by the average price.

The terms within and outside the braces on the right-hand side are net real profits per unit of output π_i and output Y_i respectively. Since $L_i = T_i$ under commitment, equation [5] can also be written as:

$$\Pi_i = (1-\delta)\left(\frac{m}{Y}\right)^{-\frac{1}{\theta}} \left(A(1+\tau_i)T_i\right)^{1-\frac{1}{\theta}} - (1-\delta)\frac{V}{P}T_i - \frac{\mu\tau_i^2}{2}T_i$$

For $\theta < +\infty$, profit maximisation with respect to the number of trainees yields

$$\frac{P_i}{P} = \frac{\theta}{(\theta-1)}\left(\frac{V}{PA(1+\tau_i)} + \frac{\mu\tau_i^2}{2(1-\delta)A(1+\tau_i)}\right) \qquad [6]$$

The relative product price of firm *i* is a mark-up on the sum of unit labour costs $\frac{V}{PA(1+\tau_i)}$ - net of the share of rents accruing to workers - and unit training costs $\frac{\mu\tau_i^2}{2A(1+\tau_i)}$, with the latter component increased by the factor $(1/(1-\delta))$.[13]

The maximisation of profits with respect to training intensity τ_i yields

$$\left(1-\frac{1}{\theta}\right)(1-\delta)\frac{P_i}{P}A = \mu\tau_i \qquad [7]$$

Substituting [6] into [7] and simplifying gives the following second order equation in training intensity

$$\frac{\mu\tau_i^2}{2} + \mu\tau_i - (1-\delta)\frac{V}{P} = 0$$

which can be solved to yield

$$\tau_i = \frac{-\mu \pm \sqrt{\mu^2 + 2\mu\frac{V}{P}(1-\delta)}}{\mu} > 0 \qquad [8]$$

Since both V and the parameters μ and δ do not vary across firms, it must be that $\tau_i = \tau$, implying that all firms select the same training intensity for their employees. It follows from this and equation [6] that, at the optimal level of training, relative prices are the same across firms. Since in general equilibrium we cannot have that all firms have a relative price above or below 1 (see Blanchard and Giavazzi, 2003), it must be that $\frac{P_i}{P}$ is equal to 1. Using this result into [7] we obtain the key expression

[13] This is due to the fact that training benefits are shared but training costs are borne only by the firm. If workers have no bargaining power, relative prices in equation [6] are a mark-up on labour and training unit costs.

$$\tau = \frac{A}{\mu}(1-\delta)\frac{(\theta-1)}{\theta} \qquad [9]$$

which shows that training intensity in equilibrium is an increasing function of the elasticity of demand θ and, therefore, the number of firms *m*. To better explain this result, we use equation [6] and the fact that relative prices in equilibrium are equal to 1 in the definition of profits per unit of output π to obtain

$$\pi = \frac{1-\delta}{\theta} \qquad [10]$$

which plugged into [9] yields

$$\tau = \frac{A}{\mu}\pi(\theta-1) \qquad [11]$$

Training intensity is increasing in net real profits per unit of output π and, conditional on π, is decreasing in the training cost parameter μ and increasing in the productivity parameter *A* as well as in the elasticity θ. The relationship between training intensity and θ reflects both a "rent" and a "business stealing" effect. The former effect has negative sign and occurs because an increase in θ reduces profits per unit of output π and the benefits of training. The latter effect has positive sign and comes from the fact that the output (and profit) gains from training are increasing in θ: training increases productivity, relative prices are decreasing in productivity and the response of output to relative prices is greater, the higher is θ. It turns out that the latter effect always dominates the former. Therefore, more product market competition that increases the number of firms and elasticity θ unambiguously increases training intensity in equilibrium, as shown by equation [9].

In the long-run, the equilibrium number of firms is determined by the condition that net profits per unit of output π must be equal to the cost of entry per unit of output ρ:

$$\pi = \frac{1-\delta}{\theta} = \rho \qquad [12]$$

The assumption that ρ is proportional to output is convenient and used also by Blanchard and Giavazzi (2003). We show in the Appendix that our results still hold when we specify the entry cost more conventionally as a fixed cost. Equation [12] implies that a fall in the costs of entry increases the number of firms and θ. As a consequence, profits per unit of output are reduced until the arbitrage condition [12] is satisfied. We assume that ρ can be taken as exogenous or determined by public policy. A reduction in ρ can be brought about by liberalisation reforms lowering regulatory barriers in the product market. For instance, we can assume that $\rho = f(R)$, where *R* measures the stringency of regulatory barriers and $\partial f / \partial R > 0$.

Plugging [12] into [11] we obtain

$$\tau = \frac{A}{\mu}(\theta-1)\rho \qquad [13]$$

which, taking into account the relationship between θ and ρ described by equation [12], yields:

$$\tau = \frac{A}{\mu}(1-\delta-\rho) \qquad [14]$$

where $\rho < 1-\delta$ because $\theta > 1$. We summarise our results in the following proposition:

Proposition 1. In the commitment case, the long run equilibrium in the presence of positive entry costs ρ exists and is unique. A reduction in entry barriers – which corresponds to a reduction in the parameter ρ – increases training intensity.

In comparative statics terms, the effect of product market deregulation on training intensity is illustrated in Figure 2, where continuous lines in the (θ, τ) plane refer to the initial equilibrium and dashed lines to the new equilibrium. Training intensity along the schedule TT – associated to equation [13] – tends to zero when $\theta \to 1$ and increases with θ and the number of firms[14]. The schedule MM associated to equation [12] is a vertical line, which simply describes the relationship between entry costs and the number of firms. This line cuts the horizontal axis at $\theta = \frac{1-\delta}{\rho}$ >1. Therefore, the two schedules certainly intersect (existence of equilibrium) and do so only once in the relevant domain (uniqueness).

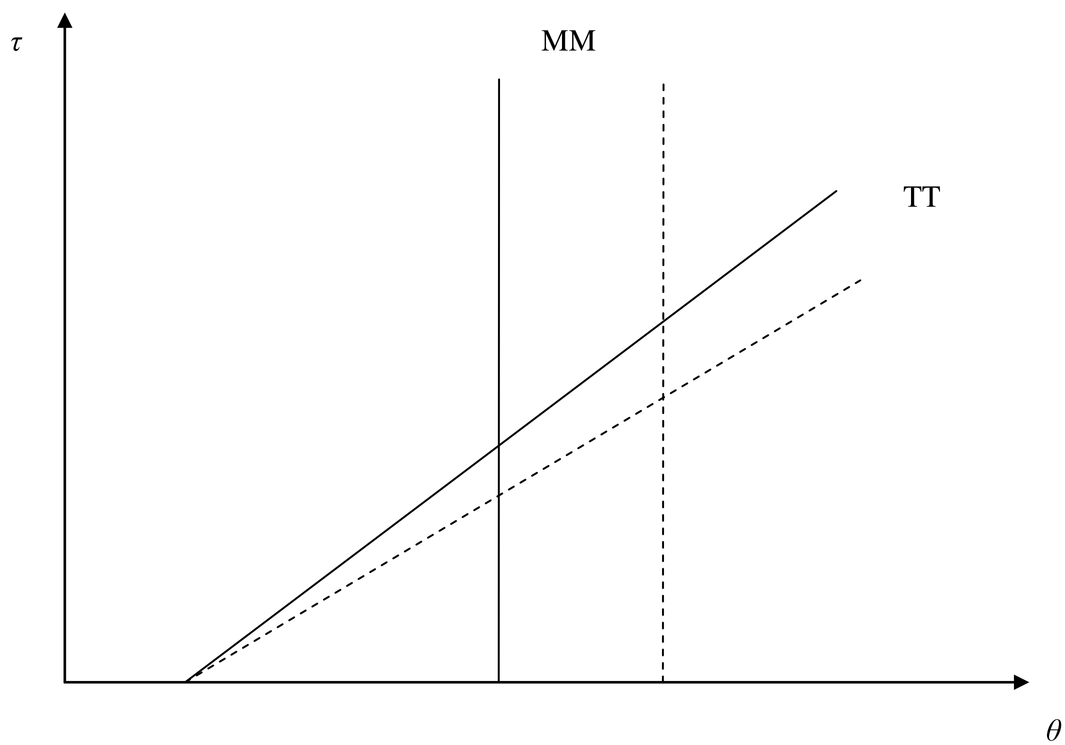

Figure 2: *The effect of reducing barriers to entry in the commitment case*

A product market deregulation which reduces entry barriers and the value of ρ shifts the MM curve outwards and the TT curve downwards. The overall effect is to increase the number of firms unambiguously. There are two effects on training intensity: first, and for a given number of firms, lower entry barriers rotate the

[14] Recall that $\frac{\partial \theta}{\partial m} = \sigma \frac{\partial g}{\partial m} > 0$.

TT schedule downwards,[15] because they imply lower net profits per unit of output, thereby dampening training intensity. This is the "rent" effect usually stressed in the literature. Second, the number of firms in equilibrium is higher and the MM shifts outwards. Training increases along the new TT schedule, because the output gains from training are greater (the "business stealing" effect). Since the latter effect is larger than the former, equilibrium training intensity increases.

1.1.2 The no-commitment case

In this sub-section we argue that the commitment equilibrium described above is an equilibrium even in the absence of commitment. Our argument here is only verbal, but the formal proofs are available in the Appendix. We proceed in two steps, which correspond to the two lemmas presented in the Appendix. First we show that, starting from the commitment equilibrium, bargaining outcomes involving any employer and her workers cannot produce a level of employment L_i that differs from the equilibrium number of trainees T_i. On the one hand, $L_i < T_i$ is not a profitable deviation from the equilibrium: if the bargaining pair were free to deviate, it would bargain for $L_i > T_i$. The intuitive reason is that, in the second stage, the employer and her workers bargain over employment without internalising training costs, which are bygones and do not affect the Nash maximand (cf. equation [3]). By contrast, as shown in the previous subsection, T_i is set in the first stage by taking into account those costs – that are increasing in T_i. On the other hand, $L_i > T_i$ is not feasible because training is only possible in the first stage, and there is no available skilled worker who can be hired in the labour market. Therefore, training in the first stage acts as an effective commitment device.

Second, let us define an "accommodating strategy" as a strategy that selects in the first stage a training intensity τ_i and a number of trainees T_i which accommodates the level of employment that each firm *i* expects to be chosen by the bargaining parties in the second stage if they could bargain over wages and employment without any constraint. We show that this strategy is always less profitable than a non accommodating strategy, which sets a relatively low number of trainees in the first stage and by so doing binds employment in the second stage to the constraint $L_i = T_i$. The intuition here is that, in the absence of commitment, the level of employment set by bargaining parties in the second stage tends to be "too high" because, as discussed above, the employer and her workers bargain over employment in the second stage without internalising training costs. By accommodating this employment level in the first stage, the employer is forced to bear the associated training costs. A natural way to reduce these costs is to tie her own hands and train a smaller number of workers in the first stage, thereby constraining employment in the second stage.

Since the bargaining parties cannot profitably deviate in the second stage from the commitment equilibrium, and no single firm can profitably pursue an accommodating strategy that allows employment to be freely chosen in the second stage, employment is effectively constrained to be equal to the ex-ante number of trainees even in the absence of commitment, and the following proposition holds:

Proposition 2. In the presence of positive entry costs ρ, and given the workers' bargaining power δ, the cost parameter μ and the productivity parameter A, a combination of training intensity τ, number of trainees T, wages W and employment L that is an equilibrium in the commitment case is also the unique equilibrium in the no-commitment case.

Proof: see the Appendix.

In the extreme case when $\rho = 0$ and the number of firms goes to infinity, there are no rents, which implies no scope for business stealing effects because firms cannot trade off lower profits per unit of output for

[15] The barycentre of the rotation is the point (1,0).

greater output. Therefore, equilibrium training is zero. The case of no entry costs looks, however, implausible and, at best, applies to a relatively small number of specific markets.[16] Hence, we can establish the following corollary, which yields a testable implication and provides an explanation for the empirical pattern shown in Figure 1:

Corollary 1. A reduction in entry barriers – corresponding to a reduction in the parameter ρ – that does not lead to perfect competition in the product markets increases firm-specific training incidence independently of whether employers can or cannot commit to a given employment level.

1.2 General training

In the economy described so far, each firm invests in firm – specific training and is willing to pay the necessary training costs. Moreover, workers and employers bargain over wages and employment. As already stressed, we believe that the emphasis on bargaining and specific training is justified by the fact that our data come from European countries. However, we would like to know whether our results are more general and apply also to other economies where collective bargaining plays a minor role and/or training tends to be more general. In this sub-section, we consider an alternative specification of the model where firm-specific training is replaced by general training, and the wage of trained workers is also determined by the interaction of demand and supply.

Assume that skills are general and that firms have the option of hiring skilled labour from the labour market or from other firms (*poaching*). With firm-specific skills, no trained worker is available in the market. If training is general, however, workers can be trained by one firm and switch employer in the second-stage if there are employers willing to offer them a higher wage. If hiring were costless and hired workers were as productive as workers trained in-house, no firm would be willing to train and bear the training costs.[17] However, hiring skilled labour in an imperfectly competitive labour market is costly, either because skills are not fully transferable or because of the presence of frictions and information asymmetries. For example, the recruitment of skilled labour requires a costly screening activity – both in terms of time and resources – to distinguish between skilled and unskilled applicants and to measure the skills of potential hires. Since the cost of screening is likely to rise with the level of skills, we make the convenient assumption that hiring costs h per employee are given by $h(\tau_i) = \frac{\eta \tau_i^2}{2}$, where η is a non-negative scale parameter.

When the marginal cost of training is lower than the marginal cost of hiring, the analysis in Section 1.1 applies. In this case, the employer's willingness to pay for training is justified because labour market frictions – including search and informational asymmetries – substantially reduce the transferability of general skills from a firm to another, as discussed by Acemoglu and Pischke (1999).

Consider next the case when hiring is less costly than training. With no heterogeneity in the technology and in the costs of hiring and training, all firms prefer to hire skilled labour than train unskilled labour. But with

[16] For example, when we use the time-varying data on which Figure 1 is based, in only 3% of the available observations the indicator of industry-specific regulatory barriers to competition is equal to zero. This would imply that, in our data, competition was not perfect in at least 97% of the observations (and probably in fewer of them, since absence of anti-competitive regulation is only a necessary condition for perfect competition).

[17] As shown by Gersbach and Schmutzler (2001), this statement may not hold if the number of firms in the market is small (and fixed), so that aggregate variables cannot be taken as given by the firm – as it happens in our model - because they are affected by its own behaviour. In their model, the marginal productivity of training is a decreasing function of training, the number of firms is small and entry is not possible. Therefore, even with no hiring costs, each firm is able to keep at least a fraction of its own trained workers, even if all other firms do not train and prefer to poach. This occurs because the firm's marginal benefit from employing skilled workers is decreasing in the employment level, which implies that each firm will employ an equal number of skilled workers. The share of workers trained in-house that the firm will be able to keep will be therefore at least $1/m$, where m is small and fixed. As competition dampens the sensitivity of the firm's marginal benefit from employing skilled workers to employment, this type of model implies that competition reduces training investment by firms. By contrast, in a standard model of monopolistic competition, such as ours, in which the number of firms is assumed to be large, essentially all workers can be poached, and this effect is always neutralised.

no training by firms there can be no hiring of skilled labour, unless workers themselves are willing to bear the training costs. For each worker, let the cost of training be $\frac{\xi\tau^2}{2}$ and assume that wages are a function of training intensity, $W = W(\tau)$[18]. Then homogeneous workers will invest until the marginal benefit of the investment is equal to the marginal cost

$$W^{'}(\tau) = \xi\tau \qquad [15]$$

where the prime is for the first derivative.

The demand for training intensity by firms is obtained by maximising profits per employee[19]

$$\frac{\Pi}{L} = \{AL(1+\tau)\}^{1-\frac{1}{\theta}} \frac{1}{L}\left(\frac{Y}{m}\right)^{\frac{1}{\theta}} - \frac{W(\tau)}{P} - \frac{\eta}{2}\tau^2$$

The first order condition with respect to τ is

$$\left(1-\frac{1}{\theta}\right)A = W^{'}(\tau) + \eta\tau \qquad [16]$$

where we have imposed the equilibrium condition $\frac{P_i}{P} = 1$. Using [15] in [16] we obtain that training is given by

$$\tau = \left(1-\frac{1}{\theta(\rho)}\right)\frac{A}{\xi+\eta} \qquad [17]$$

where θ is a negative function of entry costs per unit of output ρ. The above equation indicates that, when workers invest in general skills, a deregulation of the product market which raises the number of firms and the elasticity of product demand θ generates higher training intensity because it increases the marginal benefits of training per worker $\left(1-\frac{1}{\theta(\rho)}\right)A$ accruing to firms and, therefore, the demand for better trained workers. As in the previous subsection, this occurs because more training reduces relative prices and the sensitivity of output (and profits) to prices is greater, the greater the elasticity of product demand. Higher demand for training generates in turn higher wages for trained labour, and a higher supply of skills.[20] Proceeding as in the section 1.1 – that is, taking into account the entry condition, the first-order conditions with respect to employment and the symmetry of prices – we obtain that $\theta = 1/\rho$, which used in [17] yields:

$$\tau = \frac{A}{\xi+\eta}(1-\rho) \qquad [18]$$

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[18] In the symmetric equilibrium, employment in each firm is given by $L = \frac{Y}{mA(1+\tau)}$. Notice that the marginal cost of training for the worker should not be confused with equation [1], which refers to the employer.

[19] Since firms are homogeneous, we drop the subscript *i.*

[20] Subject to the assumption of small hiring costs, our model is close to the model developed by Gaudalupe (2007) to explain the effect of product market deregulation on skill premia in the United Kingdom.

We conclude from this that Corollary 1 holds independently of the fact that training is specific or general. Therefore, any empirical evidence showing that anti-competitive regulation reduces training is consistent both with the situation described in sub-section 1.1, where firms train and bear the training costs and wages are set by bargaining,[21] and with an alternative setting with no bargaining where workers bear the training costs and firms hire skilled labour from the market.

2. The Empirical Model

In the empirical application, we investigate whether changes in regulation affect training, measured in our data as the proportion *TP* of workers receiving training during a defined period of time. This measure gives us an indication of the proportion of time an average worker spends being trained.[22] If the quantity of training depends solely on the time spent on it, and workers are homogeneous, the measure *TP* is also proportional to the amount of training given to every worker, the variable used in the theoretical model.[23] Equations [14] in the case of firm specific training and [18] in the case of general training generate a map from entry costs ρ to training intensity τ, and therefore *TP*. To the extent that the relationship between entry costs ρ and the degree of stringency of regulatory barriers is monotonic, this map is also from regulatory barriers *R* to training *TP,* and in the absence of data on entry costs but with information on regulation we can estimate the relationship between *R* and *TP*.

Alternatively, since in the long-run equilibrium entry costs are equal to (net) real profits per unit of output, we can use a measure of profitability, such as the Lerner index, to proxy entry costs. In this case, the relationship between deregulation and training consists of two components: the effect of profitability on training and the effect of product market regulation on profitability (entry costs). However, the problem with any measure of profitability is that it is endogenous, as productivity shocks which affect training also influence profits. Fortunately, and letting aside political economy considerations, entry regulation can be assumed to be exogenous and to affect training only through profitability so that the degree of stringency of regulatory barriers can be used as an instrument for the measure of profitability.[24]

Our regulatory indicators and profitability measures vary by sector, country and over time. Therefore, we collapse our data on training and additional controls at the same level of aggregation and estimate the following empirical counterpart of the theoretical model:

$$TP_{ict} = \lambda_0 + \lambda_1 X_{ict} + \lambda_2 Y_{ict} + \varepsilon_{ict} \qquad [19]$$

where X is a vector of controls, which includes average age, education and firm size, Y is the selected measure of regulation or profitability, the subscript i is for the industry, c is for the country and t is for time.

The linear specification in [19] can be problematic when the dependent variable is fractional (see Wooldridge, 2001). Following Papke and Wooldridge (1996), we assume that the conditional mean is an inverse logit function *G* of the independent variables and consider the following transformed generalized linear model

[21] Or, with no bargaining power, workers are paid their outside option.

[22] Bassanini et al. (2007), for example, show that there is a very strong correlation between the proportion of employees that are trained in a given year and average hours of training per employee.

[23] In a previous version of this paper (Bassanini and Brunello, 2007), we explicitly distinguish between trained and untrained workers in the theoretical model. In that case, training is defined as a 0-1 event both in the theoretical and in the empirical application, and its intensity is measured by the participation rate. Theoretical results are similar to those discussed in the current version, at the price of greater complexity.

[24] Regulation might be endogenous if deregulation tends to occur where productivity growth or innovation are greater and training is correlated with these variables (see e.g. Duso and Röller, 2003). Although we believe that this is unlikely to seriously affect estimates, we partially control for this channel by adding to some of our specifications, as additional covariates, R&D intensity, productivity levels and growth and the investment rate.

(GLM) as an alternative to [19]:

$$TP_{ict} = G(\lambda_0 + \lambda_1 X_{ict} + \lambda_2 Y_{ict} + \varepsilon_{ict}) \qquad [20]$$

that we estimate using a quasi-maximum likelihood estimator (QMLE), where the quasi-likelihood function is the binary choice log likelihood.[25] We postulate that the error term is as follows

$$\varepsilon_{ict} = \xi_{ic} + \xi_{it} + \xi_{ct} + \omega_{ict}$$

where ξ_{ic} is a country by industry effect, ξ_{it} is an industry by time effect, ξ_{ct} is a country by time effect, and ω_{ict} is a standard disturbance. We control for these unobserved effects by including in the specification country by sector, country by year, and sector by year dummies. The country by sector dummies capture cross country differences in the structure of each industry, including differences in the parameters σ, δ and A; the sector by year effects capture the time varying differences in trend growth between affected industries (treated group) and industries not affected directly by deregulation (control group); the country by year dummies absorb country-specific macroeconomic effects, country-wide changes in policy (notably training policy and nation-wide regulation, on which we have no data - see below) as well as changes in the routing of the questionnaire and/or the exact formulation of the training question.

Our key interest lies in estimating the coefficient λ_2, which measures the relationship between product market regulation and training. A negative estimate of λ_2 would suggest that a negative relationship between regulation and training prevails, consistent with the theoretical model of section 1. One might argue, however, that the training concept developed in the model corresponds to steady state training stocks, while we have specified our empirical model in terms of training flows. Although this argument is questionable, we can observe that, given that training stocks and training flows are likely to be positively correlated, the model can be re-specified in terms of the training stock *TS* by simply substituting it for *TP* in equation [19]. In a sensitivity analysis, we construct training stocks from training flows by following a methodology similar to Conti (2005) and Dearden et al. (2006). In particular, we assume a common depreciation rate ($\beta = 0.15$) and a steady state rate of training growth g equal to the sample average growth rate of training flows,[26] and reconstruct initial conditions under the assumption that steady state growth occurs at the beginning of the sample, which implies $TP_1/(\beta + g) = TS_0$, where TP_1 is the training flow in the first period and TS_0 the training stock in the initial period. Finally, training stocks after missing years are constructed by assuming steady state growth in those years.

Specifications [19] and [20] assume that, conditional on the vector *X*, product market regulation variables are the only institutional variables that can vary by country, year and sector, and that institutional confounding factors are fully accounted for by the combination of country by year, country by sector and sector by year dummies. While this is plausible, we cannot rule out the possibility that variables measuring labour market institutions at the same level of detail as regulation variables do affect training. If this is so, failure to account for these effects could erroneously attribute them to changes in product market regulation. Therefore, we

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[25] Papke and Wooldridge (1996) show that QMLE estimators of this kind yield consistent estimates of equation [20] independently of any assumption on the error term, for which a robust variance estimator can be easily devised. In addition, in contrast to the more classical WLS estimation of a linear model with log-odds transformation of the dependent variable, the GLM specification does not require adjustment for boundary values (such as zeros) and can be estimated when fractional data are obtained by sample averages in samples of unknown size that cannot therefore be used to construct weights, as is our case.

[26] In the steady state, flows and stocks grow at the same rate. In country/sector units where a decrease of training flows is observed, the steady state growth rate is set to zero. Alternative measures of training stocks are discussed in Section 4.

also experiment with specifications that augment the vector X with available measures of labour market institutions.

3. Data

We use three main sources of data: a) an OECD database on training and other labour market variables; b) OECD regulatory indicators for seven non-manufacturing industries (electricity, gas, air transport, road transport, railways, post and telecommunications); c) additional sector-level information on output, physical capital and other controls available in the OECD STAN Family databases and the companion 60-industry database of the Groningen Growth and Development Centre.

The OECD database on training is drawn from the EU Labour Force Surveys. It contains information on training and a number labour market variables (namely age, gender, education, part-time/full-time status, occupation, industry, firm-size, tenure, whether the contract is temporary or permanent, whether the activity is in the country of residence, participation in training, type of training and training duration) for employed workers of 23 European countries from 1995 to 2002 (with many missing values, corresponding to countries and years where questions on training were not administered or data on training are unreliable). Data have been collected in the second quarter of each year (March in most countries). Quantitative variables (such as tenure or firm size) are divided into categories (see the appendix for more details). As regards to age, we dispose of categories covering five-year intervals, but reconstruct an ordinal variable by applying to all observations in each category the mean age of the category. Data are semi-aggregated insofar as organized by cells. Each cell corresponds to a combination of categories. Available cells cover all non-empty combinations with one category for each variable. Population weights are reported for each cell.

Training data refer to participation in any education or training course in the 4 weeks preceding the interview (1 week for France). Information on the type of training and its length is available but often missing. For this reason, we do not use it. In order to avoid that initial and close-to-retirement education confound the information on workplace training, we limit our analysis to full-time employees with at least 1 month of tenure, aged between 25 and 54 years, and working in their country of residence. Descriptive statistics on training are available in the Appendix.

We collapse our data on training and selected other labour market variables (education, age, gender and firm size) at the level of sectors. Industries are available at the 2 digit level of the NACE rev.1 classification[27] for most countries and years in manufacturing. In services, they are available at a slightly more disaggregated level than 1 digit of NACE rev. 1. However, since only NACE 1970 is available for certain country-year pairs, we are obliged to aggregate a few industries in order to construct our sector-level database. The final list of industries is available in the Appendix.

We have access to detailed OECD indicators of anti-competitive product market regulation in seven 2 or 3 digit non-manufacturing industries. Data are available for 21 OECD countries on an annual basis and span from 1975 to 2003. These indicators refer to sector-specific entry barriers, public ownership, the market share of the dominant player(s) when relevant (in the telephone, gas and railroad sectors), vertical integration in network industries and price controls when relevant (in the road freight industry). Outside the scope of these indicators are nation-wide aspects of regulations applying to all industries, such as administrative barriers to entrepreneurship (administrative barriers on start-ups, general features of the licensing and permit system, etc...), since these data are not available in time-series in the OECD database.

Available indicators vary between 0 and 6 from the least to the most regulated. Entry barriers cover legal limitations on the number of companies and rules on vertical integration of network industries. A value of 0 corresponds to free entry. By contrast, a value of 6 applies when entry is severely restricted. Public ownership measures the share of equity owned by central or municipal governments, and takes a value of 0 in the case of no equity and a value of 6 in the case of full ownership. All other indicators are similarly defined[28].

Following Alesina et al. (2005) we use the available information to construct time-series indicators of

[27] At the 2 digit level, this classification corresponds to the ISIC rev. 3, with extremely few exceptions.

[28] More details on these indicators are available from Nicoletti et al. (2001), Alesina et al. (2005) and Conway and Nicoletti (2006).

regulatory barriers for three aggregate industries (utilities, transport, and communication services), for which we have training data. This method involves two steps. First, separate indicators of barriers to entry, public ownership, market structure, vertical integration and price controls for each of the seven industries are averaged to obtain two coarser (and partially alternative) indicators: BEVI, which summarizes barriers to entry (comprising legal restrictions and vertical integration) and REGNO, which includes all dimensions except public ownership. As our model applies explicitly to barriers to entry we expect BEVI to be related to training. The same might apply to REGNO insofar as the presence of price controls and the absence of barriers to concentration can, to a certain extent, be seen as additional barriers to start-ups. Second, the same indicators for the three more aggregated industries are obtained by simple averaging the values of the corresponding sub-industries.

Once the two indicators of regulation are matched to our training data we obtain 309 country by sector by time non-missing observations concerning three (typically regulated) service industries for 15 European countries and a maximum of 8 years.[29] Yet, these industries account for a small share of total employment (about 7.5% in 2002). Moreover, in the event that reforms in these three sectors have occurred almost simultaneously, the effect of the variation in regulation on training incidence risks to be swept away once country per year dummies are included in the empirical analysis.

To circumvent this problem, we add manufacturing industries to our dataset. For these industries, regulation concerns essentially administrative burdens, limitations to foreign direct investment as well as barriers to trade, at least in European countries. Now, only the last two barriers can be considered to be sector-specific. But for them, due to the coming into action of the Single Market Programme (SMP) in 1992, it can be assumed that their time profile is flat since at least 1994 for the 12 countries that were EU members in 1992 (see e.g. Bottasso and Sembenelli, 2001).[30] The same argument can be applied to Austria, Finland, Norway and Sweden from 1995 (see e.g. Baldwin et al., 1996, and Gullstrand and Johansson, 2005).[31] This is equivalent to assume that – since 1994 for the majority of countries and since 1995 for a few countries - regulation in manufacturing has been equal to an arbitrary constant, which we control for with country by industry dummies. In sum, we construct an extended dataset starting from the three non-manufacturing industries by adding manufacturing and including only post-SMP years. In practice, this is equivalent to using a difference in difference estimator, where manufacturing sectors are used as the control group and services are the treated group. We end up with a sample composed of 15 countries and 12 industries for a maximum of 8 years for each country-industry pair, and for a total of 1236 observations once observations with missing information on training is excluded.

We consider also the observed Lerner index as a measure of unit profitability in real terms. In our data the Lerner index L is defined as the difference between the value of output and total intermediate, labour and capital costs, normalised by the value of output.[32] All the relevant data, except interest rates, are from the OECD STAN database (current and previous versions).[33] Following Griffith et al. (2006), we calculate the cost of capital by assuming that capital flows freely across borders so that all countries face a world interest rate, for

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[29] Since the exact month of each regulatory reform is not known and might well be subsequent to the second quarter of the corresponding year, each regulatory indicator is lagged one year.

[30] Bottasso and Sembenelli (2001) report that, on average, 75% of the measures implied by the SMP agreement were already transposed into national legal systems at the time when the SMP came into action, and that virtually all measures were transposed shortly after.

[31] According to the first editions of the Single Market Scoreboard (EC, 1997, 1998), by 1997 Finland, Norway and Sweden were among the best performing countries as far as transposition of EC directives is concerned. Only Austria appeared to lag behind, but its gap with other EU countries was closed in 1998. For this reason we check that our results are robust to exclusion of Austria prior to 1998.

[32] This computed index is equivalent to the price-cost margin under the assumption of perfect competition and constant returns to scale (see Klette, 1999, for a discussion). In principle, violation of these assumptions might induce biases, and estimations from production or cost functions would be desirable. Yet, estimated mark-up cannot vary simultaneously by country, industry and year. In addition, our Lerner index will be treated as an endogenous variable and instrumental variables will deal with the possibility of systematic measurement error. For these reasons we prefer to follow Aghion et al. (2005) and use a computed Lerner index.

[33] Capital stocks in nominal terms are obtained by multiplying nominal value added by the ratio of capital stock in volume terms obtained through perpetual inventory method and value added in volume terms.

which we use the US long-term interest rate taken from the OECD EO Database[34].

The other additional relevant covariates are taken from the OECD STAN and related databases. First, one can imagine that growing businesses will have a greater propensity to train than downsizing businesses, insofar as in the former the proportion of new hires in need of induction training is likely to be greater,[35] and in the latter the proportion of dismissals, upon which employers will be unable to recoup the cost of training, is higher. To control for this we include the logarithm of employment growth. Second, there are good reasons to think that training might vary over the business-cycle. For instance, according to Hall (2000), re-organisations take place during slack periods when the cost of foregoing production to re-allocate resources is smaller. The case studied by Hall concerns creation/destruction of job matches and search. However, it can well apply to internal re-organization, which usually requires long periods of adaptation, learning and training before becoming again fully efficient (see also Jovanovic, 2006). In support of such a view, Sepulveda (2002) finds that on-the-job training is counter-cyclical using data from the US National Longitudinal Survey of Youth. To control for sector-specific business cycles we construct log worked hours gaps by subtracting to this variable its filtered time-series obtained applying an Hodrick-Prescott filter with standard parameters. Third, we include the logarithm of R&D intensity, which we expect to affect the incentives to train.[36] Finally, one might expect that, particularly in certain manufacturing industries, globalisation is increasing the competitive pressure on businesses, particularly to improve production quality, independently of regulation. To account for this possibility, we include in [19] and [20] the logarithm of the import-weighted industry-specific real exchange rate, taken from OECD (2007). [37]

The impact of nation-wide institutions, when homogeneous across sectors, is controlled for in equations [19] and [20] by country per year dummies. However, certain labour market institutions might not have the same impact on training in all sectors. More specifically, Haltiwanger et al. (2006) and Micco and Pages (2006), convincingly suggest that the impact of lay-off regulations on job turnover varies according to the natural propensity of industries to adjust their labour input. They show that almost all the variation in the cross-country/cross-sector distribution of job turnover can be explained by the distribution of job turnover in the United States (that is the OECD country with the least regulated labour market) and country dummies, and that the remaining variation can be explained by an interaction between a country-specific indicator of regulatory stringency and US job turnover rates by sector. Bassanini et al. (2009) use the same methodology to explore the impact of lay-off regulations on productivity growth. We use the industry-level job turnover rate in the US (TURN) from Haltiwanger et al. (2006) and interact it with the OECD aggregate measure of employment protection legislation (EPL), so as to obtain an indicator of EPL impact that varies by country, sector and time. Union power might also vary along these three dimensions. In order to capture this effect we use data on union density from Ebbinghaus and Visser (2000). However, these data are available only for macro-sectors. Therefore we cannot do anything better than attributing their macro-sector averages to each sub-sectors.

Exact variable definitions, sources and sample statistics are provided in the Appendix and in Bassanini and Brunello (2007). Since ELFS data are collected early in the calendar year, all non-ELFS data, which usually refer to yearly averages or unknown months, are lagged one year.

4. Empirical results

We start our analysis by examining the association between regulation and training participation at the

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[34] The computed cost of capital is available only for fewer observations (1120) and completely missing in one country (Ireland).

[35] Yet, given that induction training is likely to occur in the very few weeks after hiring and we exclude workers with less than one month of tenure, we probably already control for part of this effect.

[36] We have experimented also the investment rate, drawn from the OECD STAN database, and the level and growth of productivity, drawn from the GGDC 60-industry database, to control for possible endogeneity of regulation with respect to productivity. However, none of these controls turns out significant and they have no impact on estimated coefficients.

[37] We also experiment with import penetration with virtually identical results. Yet, while industry-specific exchange rates, by depending only on imports at a specific date preceding the sample, can be assumed as exogenous, given that double-dimension dummies are added to the specification, import penetration ratios are clearly endogenous.

industry level. We estimate linear specifications (eq. [19]) with the dependent variable expressed in terms of training flows by OLS (Table 1, Panel A) and the corresponding GLM specifications (eq. [20]) by QMLE (Table 1, Panel B). Each Panel in Table 1 is organized in five columns: the first column includes only the product market regulation indicator and (bi-dimensional) fixed effects, which appear in all the columns; column (2) also includes gender, education, the log worked hours gap and the import weighted real exchange rate;[38] column (3) adds age, firm size, and employment growth; column (4) the logarithm of R&D intensity; and column (5) labour market institutions. Similar results (available from authors upon request) are obtained using BEVI in alternative to REGNO.

Table 1. *Estimates of training as function of the index of product market regulation REGNO, which excludes public ownership.*

Panel A: Linear specification estimated by OLS

	(1)	(2)	(3)	(4)	(5)
Regulation, excluding public own. (REGNO)	-0.014 [3.24]***	-0.015 [3.29]***	-0.014 [3.00]***	-0.017 [3.47]***	-0.015 [3.29]***
Percentage with low education		-0.141 [3.11]***	-0.129 [2.73]***	-0.147 [3.06]***	-0.141 [3.10]***
Percentage with intermediate education		-0.065 [1.51]	-0.069 [1.37]	-0.073 [1.64]	-0.064 [1.48]
Percentage females		0.070 [1.82]*	0.068 [1.71]*	0.076 [1.82]*	0.075 [1.90]*
Import-weighted real exchange rate		-0.025 [1.02]	-0.021 [0.82]	-0.025 [1.03]	-0.025 [1.03]
Log worked hours gap		-0.207 [1.94]*	-0.268 [2.42]**	-0.213 [1.81]*	-0.208 [1.94]*
Percentage large firms			0.005 [0.29]		
Age			-0.000 [0.12]		
Employment growth			0.012 [0.41]		
Logarithm of R&D intensity				-0.004 [1.33]	
Union density					0.000 [0.55]
EPL times US job turnover					-0.007 [0.11]
Estimated elasticity of training wrt regulation	-0.472	-0.494	-0.490	-0.500	-0.492
Country by sector dummies	*yes*	*yes*	*yes*	*yes*	*Yes*
Country by year dummies	*yes*	*yes*	*yes*	*yes*	*Yes*
Sector by year dummies	*yes*	*yes*	*yes*	*yes*	*Yes*
Number of observations	1236	1224	1188	1061	1224

[38] As short- and long-run effects of the exchange rate on trade usually differ, import weighted real exchange rates are lagged one extra time. We also experimented with a 3-year moving average with virtually the same results.

Table 1 (continued).
Panel B: GLM specification estimated by QMLE

	(1)	(2)	(3)	(4)	(5)
Regulation, excluding public own. (REGNO)	-0.141 [3.84]***	-0.161 [4.40]***	-0.175 [4.22]***	-0.151 [4.25]***	-0.167 [4.51]***
Percentage with low education		-2.005 [4.38]***	-1.938 [4.03]***	-2.045 [4.38]***	-1.988 [4.36]***
Percentage with intermediate education		-0.679 [1.93]*	-0.646 [1.76]*	-0.737 [2.12]*	-0.638 [1.80]*
Percentage females		0.737 [1.91]*	0.672 [1.71]*	0.643 [1.69]*	0.713 [1.84]*
Import-weighted real exchange rate		-0.275 [1.78]*	-0.263 [1.67]*	-0.382 [2.44]**	-0.276 [1.80]*
Log worked hours gap		-2.269 [2.13]***	-3.186 [2.79]***	-1.939 [1.85]*	-2.229 [2.09]**
Percentage large firms			0.203 [0.66]		
Age			0.012 [0.64]		
Employment growth			0.364 [0.95]		
Logarithm of R&D intensity				-0.069 [1.83]*	
Union density					0.001 [0.18]
EPL times US job turnover					-1.828 [1.57]
Estimated elasticity of training wrt regulation	-0.279	-0.316	-0.345	-0.319	-0.329
Country by sector dummies	*yes*	*yes*	*yes*	*yes*	*Yes*
Country by year dummies	*yes*	*yes*	*yes*	*yes*	*Yes*
Sector by year dummies	*yes*	*yes*	*yes*	*yes*	*Yes*
Number of observations	1236	1224	1188	1061	1224

Notes: Dependent variable: training participation rates. Elasticities are estimated at the sample means computed only for exposed industries. Robust t-or z-values within brackets. *, **, ***: significant at the 10%, 5% and 1% level, respectively.

In the two panels the association between regulation and training is always negative and statistically significant. Training incidence is significantly lower when the share of low educated individuals – with ISCED less than 3 – is higher, a standard result in the training literature (see Bassanini et al, 2007). Consistently with the finding of Sepulveda (2002) we also find that training incidence is countercyclical. Employment growth is positively associated to training but its coefficient is very imprecisely estimated. Furthermore, the import-weighted real exchange rate is negatively related to training in a (weakly) significant way, yielding some support to the idea that, for the tradeable sector, globalisation can have an additional effect on training independently of deregulation.

There is some evidence that training incidence is higher in industries employing more women, a result in line with the literature as regards to Europe (see Bassanini et al., 2007 for a survey), and no evidence that age, the industry's firm size distribution and employment growth matter for training. When log R&D intensity is included to control for investment in intangibles, regulation remains significant, while log R&D intensity appear to attract a negative coefficient, although only weakly significant.[39] Finally, union density is unrelated to training while EPL does not appear to have a significantly greater effect in high turnover industries.

In the exposed industries the estimated elasticity of training with respect to changes in product market regulation varies with the selected indicator and with the estimation method. Focusing on the indicator REGNO and evaluating elasticities at the sample means in the exposed industries, we find that a 10% decrease in REGNO would increase training incidence by 4.7% to 5.0% percent in the linear model – depending on the specification used – and by 2.8% to 3.4% percent in the GLM specification[40]. These are economically significant effects, taking into account the fact that regulation indicators slumped by almost 50% in the sample period in the exposed industries.

Since there are only 15 countries in our sample, we ask whether our results are driven by one specific country. Figure 3 plots the estimates of the parameter of interest, which captures the impact of REGNO on training, obtained by excluding one country at a time for our preferred specification (Table 1, Panel B, Column 2). Estimates appear to be relatively stable and always significant at the 1% level.[41]

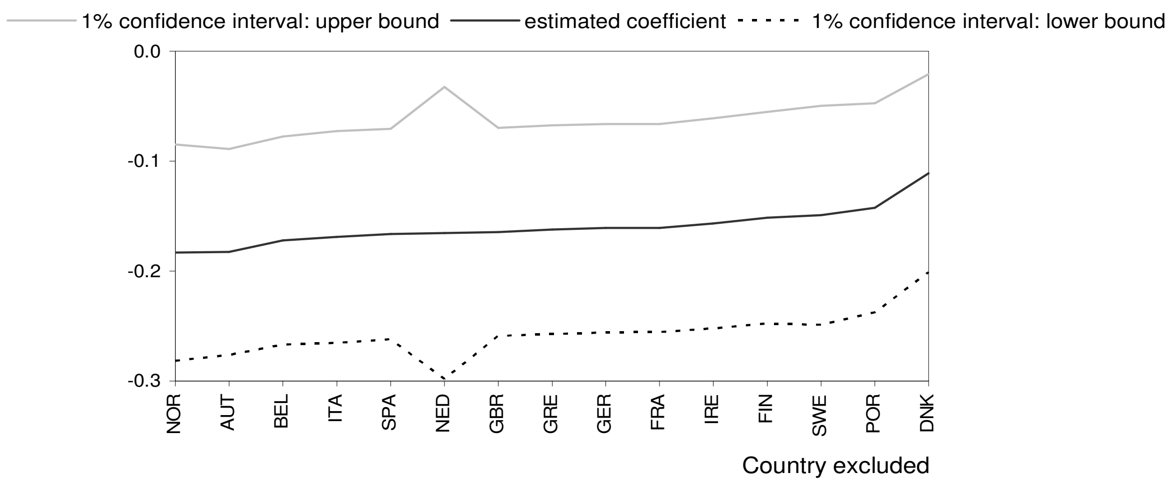

Figure 3. *Sensitivity to country coverage*

Note: The figure shows central estimates and confidence intervals obtained by re-estimating the model of Column 2 in Panel B of Table 1 excluding one country at a time.

Next, we check the robustness of our findings to changes in the dependent variable, and report our results in the four rows of Table 2 below. In particular, we replace our measure of training flows with alternative

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[39] The negative sign of the coefficient on R&D intensity might look surprising. Yet this is consistent with the evidence of lack of complementarity between R&D and training expenditures provided by Ballot, Fakhfakh and Taymaz (2001).

[40] If $E(y \mid x) = G(z)$, with $z = xb$, is the logistic specification, the marginal effect is $E(y \mid x) = \frac{\partial G}{\partial z} b$.

[41] In particular, it is reassuring that our results are not driven by the presence of Norway in the sample. It can be argued that, although intra-European trade barriers were lifted by the implementation of the SMP, trade barriers still exist with respect to non-European countries and these barriers are not captured by real industry-specific exchange rates. A further refinement of our strategy consists therefore in restricting the sample to EU members only (thus excluding Norway). Since EU trade policy is common to all EU member countries, there is no cross-country variation in sector-specific tariff and non-tariff barriers, which are therefore entirely controlled for by industry-by-time dummies.

measures of training stocks, as described above. We find that in all cases that the negative relationship between training and product market regulation is confirmed by the data. Moreover, the estimated elasticities suggest that a 10 percent reduction of regulation increases training stocks by 1.2 % to 4.3 %, depending on the selected definition of the stock.[42]

Table 2. *Estimates of training stock as a function of REGNO. Alternative measures*

	Coefficient	Elasticity
Training stock – base measure	-0.062 [2.62]***	-0.204
Training stock – alternative measure based on observed growth rates	-0.130 [4.51]***	-0.426
Training stock – alternative measure assuming 2% steady state growth	-0.037 [2.15]**	-0.122
Training stock – alternative measure assuming 2.5% steady state growth	-0.037 [2.16]**	-0.123

Notes: Dependent variable: log of training stocks. Each row corresponds to a different measure. Base measure computed by assuming that industry-specific steady state growth rates of training stocks are equal to observed mean growth rates of training participation rates in industries where this is positive and 0 elsewhere. In row 2, the observed mean growth rates of training participation are used for all industries. In row 3, a constant 2% steady state growth rate of training stock is assumed. In row 4, a constant 2.5% steady state growth rate of training stock is assumed. Elasticities are estimated at the sample means computed only for exposed industries. Robust t-values within brackets. *, **, ***: significant at the 10%, 5% and 1% level, respectively.

An alternative to the direct estimation of the relationship between regulation and training is to estimate how training is affected by profitability, measured by the observed Lerner index, and to instrument the latter with a measure of product market regulation. The advantage of this approach is that it allows us to disentangle the effect of regulation on profitability from the effect of profitability on training. The disadvantages are greater measurement errors and the fact that profitability needs to be treated as endogenous in training regressions. We estimate the linear model by two-stage least squares and the GLM model using the control function approach suggested by Smith and Blundell (1986), using regulatory indicators as instruments. The latter approach consists of two steps: in the first step, we regress the Lerner index on regulation and other controls; in the second step, we augment the GLM specification with the residual from the first stage regression, and obtain confidence intervals by bootstrapping (see Efron, 1987).

The results from this exercise are presented in the two panels of Table 3 (as above, panel A for the linear model and panel B for the GLM model). As expected, we find that an increase in the Lerner index reduces training incidence and that regulation has a statistically significant positive correlation with the Lerner index (see bottom of the table). In addition, standard tests suggest that the Lerner index is endogenous.[43]

Depending on the specification of the linear model, a 1% increase in profitability is expected to reduce training by 1.38% to 1.79% percent, a large effect. These elasticities are smaller but still substantial when we consider the GLM logistic specification. In this case a 1% increase in profitability is associated to a 0.59% to

[42] We consider four different measured of the training stock. They are all based on the perpetual inventory method described in section 2 above, but differ with respect to assumption concerning the steady state growth rate. Our preferred measure is computed by assuming that industry-specific steady state growth rates of training stocks are equal to observed mean growth rates of training participation rates in industries where this is positive and 0 elsewhere. As regards alternative measures, in the first, the observed mean growth rates of training participation are used for all industries; in the second, a constant 2% steady state growth rate of training stock is assumed (as assumed by Dearden, Reed and van Reenen, 2006); and in the third, a constant 2.5% steady state growth rate of training stock is assumed, which does not appear to be inconsistent with our data. Using the latter measure, in fact, we cannot reject 2.5% as the average growth rate of the training stock in all industries.

[43] In linear models, the Durbin-Wu-Hausman test of endogeneity always reject the null of exogeneity of the Lerner index. In the case of IV estimates obtained using the control function approach, the first-stage residual always attracts a significant coefficient, which provides evidence of endogeneity.

0.80% reduction of training. Yet, in assessing the economic importance of this effect, one needs to take into account that the cross-country/cross-industry average range of percentage variation of the Lerner index over the sample period is about 7%, while regulatory indicators have varied in our sample by much more (50% on average in the treated industries). Interestingly, the estimated compounded effect of a deregulation – that is the derived estimated effect of deregulation on training via the effect of the former on the Lerner index – is very close to the estimate we obtain from reduced form models: a 10% drop in the regulation index is estimated to increase training by 4.4% to 5% in the linear model and by 2.9% to 3.6% in the GLM specification.

Table 3. *Estimates of training as function of the Lerner index, instrumented with REGNO. Dependent variable: training participation rates.*

Panel A: Linear model, 2SLS

	(1)	(2)	(3)	(4)	(5)
Lerner Index	-1.323 [1.90]*	-1.419 [2.00]**	-1.391 [1.82]*	-1.187 [2.27]**	-1.456 [1.92]*
Percentage with low education		-0.167 [2.49]**	-0.169 [2.48]***	-0.176 [2.71]**	-0.171 [2.49]**
Percentage with intermediate education		-0.074 [1.22]	-0.071 [1.18]	-0.086 [1.47]	-0.083 [1.37]
Percentage females		0.142 [2.31]**	0.141 [2.25]**	0.109 [2.10]**	0.144 [2.27]**
Import-weighted real exchange rate		-0.001 [0.03]	-0.000 [0.01]	-0.014 [0.46]	0.001 [0.05]
Log worked hours gap		-0.042 [0.23]	-0.110 [0.59]	-0.042 [0.26]	-0.031 [0.17]
Percentage large firms			0.040 [1.24]		
Age			0.000 [0.18]		
Employment growth			0.054 [0.84]		
Logarithm of R&D intensity				-0.017 [2.11]*	
Union density					-0.002 [0.96]
EPL times US job turnover					0.149 [1.05]
Durbin-Wu-Hausman exogeneity test ($\chi^2(1)$)	23.75***	24.70***	27.86***	25.89***	27.64***
Coeff. of REGNO in the first-stage regression	0.013 [2.67]***	0.013 [2.71]***	0.013 [2.56]**	0.016 [3.20]***	0.013 [2.58]***
Elasticity of training to the Lerner Index	-1.613	-1.749	-1.744	-1.381	-1.789
Derivative of training wrt REGNO	-0.017	-0.018	-0.019	-0.019	-0.019
Elasticity of training wrt REGNO	-0.445	-0.486	-0.488	-0.497	-0.488
Country by sector dummies	*yes*	*yes*	*yes*	*yes*	*yes*
Country by year dummies	*yes*	*yes*	*yes*	*yes*	*yes*
Sector by year dummies	*yes*	*yes*	*yes*	*yes*	*yes*
Number of observations	1120	1108	1084	985	1108

Table 3 (continued). *Estimates of training as function of the Lerner index, instrumented with REGNO. Dependent variable: training participation rates.*
Panel B: GLM, Two-step IV estimates

	(1)	(2)	(3)	(4)	(5)
Lerner Index	-11.08** [-69.09,-0.05]	-12.44** [-71.03,-0.87]	-13.62* [-130.0,0.04]	-9.36** [-44.74,-0.96]	-13.59** [-87.96,-1.41]
Residual first stage	11.41* [-0.48,66.48]	12.49** [0.59,69.65]	13.64* [-0.56,130.0]	9.14** [0.56,38.04]	13.68** [1.45,89.30]
Percentage with low education		-2.20* [-4.13,0.02]	-2.31* [-4.93,0.32]	-2.26** [-4.04,-0.13]	-2.23* [-4.43,0.45]
Percentage with intermediate education		-0.76 [-2.50,1.56]	-0.75 [-2.60,3.45]	-0.85 [-2.27,0.84]	-0.82 [-3.00,1.57]
Percentage females		1.27* [-0.43,4.02]	1.31* [-0.66,6.34]	0.86 [-0.48,2.90]	1.29 [-0.50,4.85]
Import-weighted real exchange rate		-0.19 [-1.18,1.07]	-0.01 [-1.92,1.23]	-0.18 [-0.99,0.78]	0.02 [-1.15,1.37]
Log worked hours gap		-2.27 [-5.96,7.05]	-1.31 [-6.50,15.19]	-0.55 [-4.70,4.35]	-0.40 [-6.05,9.22]
Percentage large firms			0.55 [-1.30,2.35]		
Age			0.02 [-0.07,0.13]		
Employment growth			0.71 [-3.53,3.80]		
Logarithm of R&D intensity				-0.18* [0.50,0.01]	
Union density					-0.03* [-0.24,0.04]
EPL times US job turnover					-0.70 [-5.24,13.63]
Coeff. of REGNO in the first-stage regression	0.013** [0.008, 0.017]	0.013** [0.008, 0.017]	0.013** [0.008, 0.018]	0.016** [0.011, 0.021]	0.013** [0.008, 0.018]
Elasticity of training to the Lerner Index	-0.651	-0.795	-0.729	-0.589	-0.795
Derived elasticity of training wrt REGNO	-0.289	-0.359	-0.329	-0.317	-0.350
Country by sector dummies	*yes*	*yes*	*yes*	*yes*	*yes*
Country by year dummies	*yes*	*yes*	*yes*	*yes*	*yes*
Sector by year dummies	*yes*	*yes*	*yes*	*yes*	*yes*
Number of observations	1120	1108	1084	985	1108

Notes: Dependent variable: training participation rates. Elasticities with respect to the Lerner index are estimated at the global sample mean; elasticities with respect to regulation, excluding public ownership (REGNO), are estimated at sample means computed only for exposed industries. Robust t-values within brackets in Panel A. Bias-corrected bootstrapped confidence intervals at the 5% statistical level, obtained with 1000 replications, within brackets in Panel B. In Panel A: *, ** and *** means significant at the 10%, 5% and 1% level, respectively. In Panel B, * and ** means that the bias-corrected bootstrapped confidence interval at the 10% and 5% confidence level, respectively, does not include 0.

Conclusions

Does product market deregulation affect workplace training, and if yes, in what direction? This paper has addressed this question both from an empirical and from a theoretical viewpoint. In our empirical analysis we have used repeated cross section data extracted from the European Labour Force Survey, and a sample of 15 European countries and 12 industrial sectors, which we have followed for about 8 years. Our econometric estimates show that an increase in product market deregulation generates a sizeable increase in training incidence. More precisely, we show that the massive regulatory reforms undergone by European countries in certain service and utility industries, as quantified by changes in the OECD indicators of regulatory barriers, have raised competition, which in turn, has increased investment in workplace training. Our empirical results are robust to several sensitivity exercises. They highlight that an important link in the relationship between deregulation and productivity growth is the investment in human capital which takes place in firms.

In order to provide an explanation for these findings, which seem to be at odd with what usually argued in the labour economics literature, we have built a theoretical model of workplace training with imperfect competition in the product and labour market and ex-ante homogeneous firms that is sufficiently general to allow both general and specific training and wages being either set by bargaining or determined by the interaction between supply and demand.

We have identified two contrasting effects at work: on the one hand, a reduction in the barriers to entry for a given number of firms compresses profits per unit of output, and thereby reduces training. On the other hand, and conditional on profits per unit of output, additional entry increases the output (and profit) gains from training, which facilitates investment. These output gains occur because additional training reduces the relative product price and the sensitivity of product demand to prices is larger, the greater the degree of competition in the product market. We have shown that the balance of these effects implies that a deregulation increases training.

Although we believe that the mechanism suggested by our theoretical model is a key determinant of the observed empirical patterns, we do not claim that this model provides the only possible explanation. For example, if firms are heterogeneous, a negative relationship between the degree of stringency of anti-competitive regulation and training can emerge through alternative routes. In fact, if more efficient firms have also lower training costs and train more, one can expect that increasing competition will increase the market share of these firms and therefore average training.

We believe, however, that the mechanism highlighted in our model will hold also in a model with firm heterogeneity. Disentangling the importance of different mechanisms would require sufficiently rich firm-level panel data that include information on training and enough regulatory variation. Unfortunately, firm-level panel data on training are scarce and we are not aware that a dataset with the above-mentioned characteristics is currently available. Clearly, this issue must be left to future research.

References

Acemoglu D and Pischke J (1999), The Structure of Wages and Investment in General Training, *Journal of Political Economy*, pp. 539-72.

Aghion P, Bloom N, Blundell R, Griffith R and Howitt P (2005) Competition and Innovation: An Inverted U Relationship, *Quarterly Journal of Economics*, 117, 701-728

Aghion P, Blundell R, Griffith R, Howitt P and Prantl S (2009) The Effects of Entry on Incumbent Innovation and Productivity, *Review of Economics and Statistics*, 91(1), 20-32.

Aghion P, Burgess R, Redding S and Zilibotti F (2008) The Unequal Effects of Liberalization: Evidence from Dismantling the License Raj in India, *American Economic Review*, 94 (4), 1397- 1412.

Aghion P, Harris C, and Vickers J (1997), Competition and growth with step-by-step innovation: An example, *European Economic Review*, 41, 771-782.

Aghion P, Harris C, Howitt P and Vickers J (2001) Competition, Imitation and Growth with Step-by-Step Innovation, *Review of Economic Studies*, 68(3): 467-492.

Aghion P, and Howitt P (1998) *Endogenous Growth Theory*, Cambridge and London: MIT Press.

Alesina A, Ardagna S, Nicoletti S, Schiantarelli F (2005), Regulation and Investment, *Journal of the European Economic Association*, June, pp.1-35.

Autor D (2001), Why Do Temporary Help Firms Provide Free General Skills?, *Quarterly Journal of Economics,* MIT Press, vol. 116(4), pp. 1409-1448

Baldwin, R. E., Forslid, R., Haaland, J. (1996) Investment Creation and Diversion in Europe; *World Economy*, 19, pp. 635-59

Ballot, G., F. Fakhfakh and E. Taymaz (2001), Firms' human capital, R&D and performance: a study on French and Swedish firms, *Labour Economics*, 8(4), 443-462

Bassanini A, Booth A, Brunello G, De Paola M, Leuven E (2007), Workplace Training in Europe, in Brunello G, Garibaldi P, Wasmer E (eds.), *Education and Training in Europe*, Oxford University Press, Oxford.

Bassanini A, and Brunello G. (2007), Barriers to Entry, Deregulation and Workplace Training, IZA Discussion Paper n.2746.
Bassanini A, Nunziata L. and Venn D. (2009), Job protection legislation and productivity growth in OECD countries, *Economic Policy*, 24(58), pp.349-402.
Blanchard O, Giavazzi F (2003), Macroeconomic effects of regulation and deregulation in goods and labor markets, *The Quarterly Journal of Economics*, 115, 879-907.
Boone J., 2000, Competitive Pressure: The Effects on Investments in Product and Process Innovation, *RAND Journal of Economics*, 31(3), 549-569.
Bottasso A., Sembenelli A. (2001) Market power, productivity and the EU Single Market Program: Evidence from a panel of Italian firms, *European Economic Review*, 45, 167-186.
Conti, G. (2005), "Training, Productivity and Wages in Italy", *Labour Economics*, vol. 12, no. 4, pp. 557-576.
Conway, P., G. Nicoletti (2006), "Product market regulation in the non-manufacturing sectors of OECD countries: measurement and highlights", OECD Economics Department Working Paper no. 530.
Davis, S.J., J.C. Haltiwanger and S. Schuh (1996), *Job Creation and Destruction*, MIT Press, Cambridge, MA and London
Dearden, L., H. Reed and J. van Reenen (2006), "The Impact of Training on Productivity and Wages: Evidence from British Panel Data", *Oxford Bulletin of Economics and Statistics*, vol. 68, no. 4, pp. 397-421.
Duso T. and L.H. Röller (2003), Endogenous deregulation: evidence from OECD countries, *Economics Letters*, 81, 67-71
Ebbinghaus B. and J. Visser (2000) *Trade Unions in Western Europe since 1945*, *The Societies of Europe*. New York: Grove's Dictionaries**.**
EC (1997), Single Market Scoreboard, Bruxelles.
EC (1998), Single Market Scoreboard, Bruxelles.
Efron, B. (1987), Better Bootstrap Confidence Intervals, *Journal of the American Statistical Association*, 82, 171-185.
Gersbach H, Schmutzler A (2001), A product market theory of training, IZA Discussion Paper 327
Gersbach H, Schmutzler A (2006), The Effect of Globalization on Worker Training, IZA Discussion
Paper 2403
Griffith, R., R. Harrison and H. Simpson (2006), Product market reform and innovation in the EU, CEPR Discussion Paper n. 5849.
Gullstrand J., Johansson H. (2005), The Disciplinary Effect of the Single Market on Swedish Firms, *Open Economies Review* 16, 381–398.
Guadalupe, M. (2007), Product Market Competition, Returns to Skill, and Wage Inequality, *Journal of Labor Economics*, 25, 439–474.
Hall R (2000), Reorganization, *Carnegie-Rochester Conference Series on Public Policy,* Volume 52, pp. 1-22.
Haltiwanger, J., S. Scarpetta and H. Schweiger (2006), "Assessing Job Flows across Countries: The Role of Industry, Firm Size and Regulations", IZA Discussion Paper no. 2450
Jovanovic B (2006), Asymmetric Cycles, *Review of Economic Studies*, 73, 145–162.
Klette J. (1999), Market Power, Scale Economies and Productivity: Estimates from a Panel of Establishment Data, *Journal of Industrial Economics*, 47, 451-476.
Kugler A, Pica G (2004), Effects of Employment Protection and Product Market Regulations on the Italian Labour Market, CEPR Discussion Paper no. 4216.
Lazear, E.P., 2003, Firm-Specific Human Capital: A Skill-Weights Approach, NBER Working Paper, No. 9679, May.
Malcomson J (1997), Contracts, Holdup and Labor Markets, *Journal of Economic Literature*, 35, 4, 1916-1957
Micco, A. and C. Pages (2006), "The Economic Effects of Employment Protection: Evidence from International Industry-Level Data", IZA Discussion Paper no. 2433
Nickell S, Nunziata L and Ochel K (2005), Unemployment in the OECD since the 1960s. What do we know? *The Economic Journal*, 115, 1-27.
Nicoletti G, Scarpetta S (2003), Regulation, productivity and growth: OECD evidence, *Economic Policy, pp.* 9-72.
Nicoletti, G., A.Bassanini, E.Ernst, S.Jean, P.Santiago and P.Swaim; (2001) "Product and labour market interactions in OECD countries", OECD Economics Department Working Paper n°314
OECD (2007), Employment Outlook, Paris.
Papke, L.E., and J. Wooldridge (1996), Econometric methods for fractional response variables with an application to 401(k) plan participation rates, *Journal of Applied Econometrics,* 11, pp. 619–632.
Raith M (2001), Competition, Risk and Managerial Incentives, mimeo, University of Chicago.
Sepulveda F (2002), Training and Business Cycles, Michigan State University, mimeo
Smith R.J. and R.W. Blundell (1986), An Exogeneity Test for a Simultaneous Equation Tobit Model with an Application to Labor Supply, *Econometrica*, 54, 679-685.
Stevens M (1996), Transferable Training and Poaching Externalities, in A.L. Booth and D.J. Snower (eds.), *Acquiring Skills: Market Failures, Their Symptoms and Policy Responses*, Cambridge University Press, Cambridge, UK.

Vives X (2006), Innovation and Competitive Pressure, mimeo, Universitad Pompeu Fabra.
Wooldridge J. (2001), *Econometric Analysis of Cross-Section and Panel Data*, Cambridge, Mass.: The MIT Press.
Wasmer E. (2006), General versus Specific Skills in Labor Markets with Search Frictions and Firing Costs, *American Economic Review*, 96(3), 811-831.

Appendix

A. Proof of Proposition 2.

We start by establishing

Lemma A2.1. Consider the commitment equilibrium where each firm sets τ and T in the first stage:

$$\tau = \frac{A}{\mu}(1-\delta)\frac{\theta-1}{\theta} \quad \text{[A.1]}$$

$$T = \frac{Y}{mA(1+\tau)} \quad \text{[A.2]}$$

in the expectation that ex-post employment *L* will be equal to the number of hired trainees *T*. In the absence of commitment, the employer and workers of an arbitrarily-chosen firm *i* cannot increase the value of the Nash maximand by choosing unilaterally $L_i < T$, if the bargaining parties of all other firms set $L = T$ in the second stage.

Proof. In this combination of strategies, the symmetry of prices ($P_i = P$) implies that (see equation [6])

$$\frac{V}{P} = \frac{\theta-1}{\theta}A(1+\tau) - \frac{\mu\tau^2}{2(1-\delta)} \quad \text{[A.3]}$$

In the absence of commitment and with ex-post bargaining over employment, we ask whether it would be profitable for a single bargaining pair, consisting of the employer and her workers, to set $L_i < T$, in contrast with first stage expectations. Unconstrained maximisation of the Nash maximand [3] yield equation [4] and

$$\frac{P_i}{P} = \frac{\theta}{\theta-1}\frac{V}{PA(1+\tau)} \quad \text{[A.4]}$$

Using [A.3] into [A.4] and rearranging gives

$$\frac{P_i}{P} = 1 - \frac{\tau}{2(1+\tau)} \quad \text{[A.5]}$$

The product demand schedule [2] and the production technology imply that ex-post employment is given by

$$L_i = \frac{Y}{mA(1+\tau)}\left(1 - \frac{\tau}{2(1+\tau)}\right)^{-\theta} > T \quad \text{[A.6]}$$

Since $L_i < T$ is not chosen and $L_i > T$ is not feasible, because training in the second period is ruled out, the only feasible solution is $L_i = T$, in line with first-stage expectations. QED.

Next we establish

Lemma A2.2. Consider the first stage strategies of an employer *i*, who chooses training intensity τ_i and the number of trainees T_i, and assume that, in the absence of commitment, wages W_i and employment L_i are bargained over in the second stage to maximise the Nash maximand. Then, for any combination of strategies chosen by other firms and workers, an accommodating strategy, which consists in choosing T_i such that $L_i \le T_i$ is not binding in the second stage, is less profitable than a non accommodating strategy, which selects a value of T_i low enough that in the second stage the equality $L_i = T_i$ holds.

Proof. Suppose that the firm chooses in the first strategy a training intensity τ_i and a number of trainees T_i sufficiently large that, given τ_i, the constraint $L_i \le T_i$ is not binding in the second stage. In the second stage, employment will be set by bargaining at:

$$L_i = \frac{Y}{mA(1+\tau_i)}\left(\frac{P_i}{P}\right)^{-\theta} \qquad \text{[A.7]}$$

where P_i / P is given by [A.4], except that τ must be replaced with τ_i. There can be two cases: either $T_i = L_i$ or $T_i > L_i$. Since the employer can anticipate the result of the bargaining, her net profits will be always higher if she sets $T_i = L_i$, where L_i is defined as in [A.7]. With no loss of generality we can therefore concentrate on this type of strategy (call it "A-strategy" hereafter, with A standing for accommodating, since with this strategy the firm accommodates the employment resulting from the unconstrained bargaining).

Consider now an alternative strategy in which the firm chooses in the first stage the same τ_i but a lower value of T_i, denoted with T_i^*:

$$T_i^* = \frac{Y}{mA(1+\tau_i)}\left(\frac{P_i}{P} + \frac{\theta}{(1-\theta)(1-\delta)}\frac{\mu\tau_i^2}{2A(1+\tau_i)}\right)^{-\theta} < L_i = T_i$$

where $\dfrac{P_i^*}{P} = \dfrac{P_i}{P} + \dfrac{\theta}{(1-\theta)(1-\delta)}\dfrac{\mu\tau_i^2}{2A(1+\tau_i)}$ and the star * indicates the new strategy (called "S-strategy", hereafter, where S stands for "low", since it implies a smaller number of trainees). Since $T_i^* < L_i$ and L_i is the result of the unconstrained maximisation of the Nash maximand given τ_i, the S-strategy implies that the employment constraint $L_i^* = T_i^*$ is binding in the second-stage.

Net profits in the A-strategy are given by:

$$\Pi_A = \left\{(1-\delta)\frac{P_i}{P} - (1-\delta)\frac{V}{PA(1+\tau_i)} - \frac{\mu\tau_i^{\,2}}{2A(1+\tau_i)}\right\}\frac{Y}{m}\left(\frac{P_i}{P}\right)^{-\theta} \qquad \text{[A.8]}$$

and in the S-strategy they are equal to

$$\Pi_S = \left\{(1-\delta)\frac{P_i^*}{P} - (1-\delta)\frac{V}{PA(1+\tau_i)} - \frac{\mu\tau_i^{\,2}}{2A(1+\tau_i)}\right\}\frac{Y}{m}\left(\frac{P_i^*}{P}\right)^{-\theta} \qquad [A.9]$$

The right-hand side terms of equations [A.8] and [A.9] are identical, except for the value of relative prices. Therefore, the function

$$\Pi(p) = \left[(1-\delta)p - (1-\delta)\frac{V}{PA(1+\tau_i)} - \frac{\mu\tau_i^{\,2}}{2A(1+\tau_i)}\right]\frac{Y}{m}p^{-\theta}$$

will be such that $\Pi(p) = \Pi_L$, when $p = P_i / P$, and $\Pi(p) = \Pi_S$ when $p = P_i^* / P$. Define $p_{\max} = \arg\max_p \{\Pi(p)\}$. The first-order conditions for a maximum imply

$$(1-\delta)(1-\theta)p_{\max} + \theta\left[(1-\delta)\frac{V}{PA(1+\tau_i)} + \frac{\mu\tau_i^{\,2}}{2A(1+\tau_i)}\right] = 0$$

while the second-order condition is always verified since $\partial^2\Pi / \partial p^2 = (1-\delta)(1-\theta) < 0$. Using [A.4] and some simple manipulations we obtain:

$$p_{\max} = \frac{P_i^*}{P} = \frac{P_i}{P} + \frac{\theta}{(1-\theta)(1-\delta)}\frac{\mu\tau_i^2}{2A(1+\tau_i)} > \frac{P_i}{P}$$

Therefore $\Pi_S > \Pi_A$, which implies that the A-strategy is dominated by the S-strategy. QED.

We are now ready to prove Proposition 2. Consider the commitment equilibrium where each firm sets τ and T in the first stage as in equations [A.1] and [A.2], in the second stage the bargaining parties set W according to equation [4] and $L = T$. In order to show that this is an equilibrium we need to show that no agent can deviate unilaterally from it and earn a greater pay-off if the others do not deviate. From Lemma A2.1, it follows immediately that no bargaining party can deviate unilaterally in the second stage and earn a greater pay-off by choosing $L \neq T$ in the second stage. Then, consider first-stage deviating strategies (τ_i^*, T_i^*). Let us call again A-strategy any strategy such that the constraint $L_i \leq T_i^*$ is not binding in the second stage (as above A for "accommodating"). Similarly, let us call NA-strategies, first-stage strategies such that $L_i \leq T_i^*$ is binding in the second stage (NA for "non accommodating"). Lemma A2.2 shows that for any A-strategy there exists at least one NA-strategy (the corresponding S-strategy) that yields higher profits. Therefore, if there existed a deviating A-strategy that is profit-improving with respect to the equilibrium, there would also be a deviating NA-strategy that is profit-improving. But, by construction, the commitment equilibrium consists of the combination of NA-strategies that yields the highest profit among all NA-strategies, which excludes the possibility of profit-improving NA-strategies. Therefore there cannot exist profit-improving *A* strategies. As first-stage strategies are either A-strategies or NA-strategies, there are no deviations in the first-stage that yield higher profits.

It remains to prove that the equilibrium is unique. Lemma A2.2 shows that strategies A are dominated, therefore no equilibrium can contain all or a fraction of firms playing A-strategies. But subsection 1.1.1 has already shown that there cannot be any other equilibrium in which all firms in the first stage play NA-strategies, except the commitment equilibrium, which is therefore unique. QED

B. The equilibrium when the cost of entry is fixed

Assume that the cost of entry C is fixed, rather than proportional to output. Equilibrium conditions [12] and [14] become

$$\pi = \frac{1-\delta}{\theta} = C\frac{m}{Y} \qquad [A.18]$$

$$\tau = \frac{A}{\mu}\left(1-\delta - C\frac{m}{Y}\right) \qquad [A.19]$$

Equation [A.18] can be rewritten as:

$$m\theta = \frac{Y(1-\delta)}{C} \qquad [A.20]$$

We show here that the negative relationship between entry costs and training intensity still holds: total differentiation of [A.19] and [A.20] yields

$$\Sigma_1 dm + \Sigma_2 d\tau = \Sigma_5 dC$$
$$\Sigma_3 dm + \Sigma_4 d\tau = \Sigma_6 dC$$

where

$$\Sigma_1 = \frac{C}{Y}\frac{A}{\mu}, \quad \Sigma_2 = 1, \quad \Sigma_3 = \sigma\left(g(m) + g^{'}(m)m\right), \quad \Sigma_4 = 0, \quad \Sigma_5 = -\frac{A}{\mu}\frac{m}{Y}, \quad \Sigma_6 = -\frac{Y(1-\delta)}{C^2}.$$

Since, when $\theta < +\infty$ and $C > 0$, the determinant of the Jacobian is negative, and

$$\Sigma_1\Sigma_6 - \Sigma_3\Sigma_5 = g'(m)m\frac{A}{\mu}\frac{m}{Y} > 0$$

we have that $\frac{d\tau}{dC} < 0$.

C. Definition of variables, sources and descriptive statistics

See Bassanini and Brunello (2007) for the precise definition of variables and sources, except for the following additional variables:

Import weighted real exchange rate

Definition:

$$x_{ikt} = \sum_{i=1}^{I}\sum_{l=1}^{L} m_{iklt_0} e_{klt} p_{lt} / p_{kt}$$

where x stands for the import-weighted real exchange rate, m is to the import share from country l in industry i of country k at a fixed time period t_0 (early 1980s in these data) - the import weights thus vary across industries and countries but are constant in time - e is to the nominal bilateral exchange rate between countries k and l at time t - which varies across partner countries and time, but not across industries - the p variables refer to price levels, as approximated by the GDP deflator, in countries l and k respectively. Within a country in a given year, the variation in industry-specific real exchange rates derives entirely from differences in the import pattern across industries. An increase in the industry-specific exchange rate represents a real depreciation in the price of output produced in industry *i* of country *k* relative to its trading partners (weighted by import shares). Put differently, an increase in the industry-specific exchange rate represents an improvement in the terms of trade in industry *i* for country *k*. Source: OECD (2007).

R&D intensity

Definition: ratio of Business Enterprise Expenditures in R&D to value added. Source: OECD STAN, ANBERD and R&D Databases.

Observed Lerner index

Definition:

$$L_{ijt} = \frac{Y_{ijt} - CV_{ijt}}{Y_{ijt}}$$

where *L* is the observed Lerner index in country i, industry j and time t, CV are variable costs in nominal terms and Y is the value of output (see e.g. Klette, 1999). In practice, CV is the sum of intermediate inputs costs, labour costs and estimated cost of capital. Capital stock is constructed by perpetual inventory method for countries where it is not provided in national accounts at a sufficiently disaggregated level. However, since reconstructed capital stocks are available only in volume terms, in practice nominal capital stocks are obtained by dividing them by value added in volume terms and pre-multiplying them by nominal value added. In the calculation of the cost of capital, we follow Griffith et al. (2006) and assume that capital flows freely across borders so that all countries face a world interest rate, for which we use the US long-term interest rate. Sources: OECD STAN and EO databases.

List of countries

Austria, Belgium, Germany, Denmark, Spain, Finland, France, UK, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, and Sweden.

Table A1. *List of industries.*

NACE Rev. 1	Description
15-16	Food products, beverages and tobacco manufacturing
17-19	Textiles, textile products, leather and footwear manufacturing
20	Wood and wood products manufacturing
21-22	Pulp, paper and related products manufacturing, printing and publishing
23-25	Chemical and fuel products manufacturing, rubber and plastics
26	Other non-metallic mineral products manufacturing
27-28	Basic metals and fabricated metal products manufacturing
34-35	Transport equipment manufacturing
29-33	Other machinery and equipment manufacturing
40-41	Electricity, gas and water supply
60+62	Land and air transport
64	Communications services

Table A2. *Descriptive statistics.*

Variable	Observations	Mean	Standard deviation
Training participation rate	1236	0.078	0.075
Training stock	1236	0.476	0.457
REGNO	1236	0.820	1.593
BEVI	1236	0.790	1.584
Share males	1236	0.756	0.143
Average age	1236	38.86	1.465
Share firms with > 50 employees	1200	0.561	0.223
Share low education	1224	0.373	0.209
Share medium education	1224	0.463	0.177
Import weighted real exchange rate	1236	1.297	1.914
Hours gap	1236	0.002	0.012
Employment growth	1236	-0.002	0.037
Union density	1236	44.526	24.69
EPL*TURN	1236	0.411	0.168
Lerner index	1120	0.100	0.062

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