FIRM TRAINING AND LABOUR DEMAND IN BELGIUM: DO PRODUCTIVITY DOMINATE COST EFFECTS?

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Firm Training and Labour Demand in Belgium:
Do Productivity Dominate Cost Effects?*

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Abstract

This paper models and estimates the impact of quantitative and qualitative training financed by the firm on labour demand in Belgium. It assumes profit maximising firms producing under a short run monopolistic competition regime, where training can increase labour demand through its positive net effect on labour productivity or decrease it through higher direct labour costs and wages. The estimation of our model on a panel of 17,812 firms over the period 1999-2007 allowing to control for the potential simultaneity between training and labour demand and for unobserved workplace characteristics reveals a small positive impact of training variables on labour demand. This suggests that productivity effects dominate cost effects.

Keywords – Training, Labour Demand, Labour Productivity, Wage Determination, Panel Data

JEL Codes – M53, J23, J24, J30, C23
1. Introduction

Education and training have received considerable attention in recent years since investment in human capital is considered to play an important role in addressing several major issues. For instance, we can quote the increasing inequalities in education, employment and wages, the ageing of the population, the rapid development in technologies which occurs in a context of increasing competition and the evolution in jobs and qualifications.

Policy makers therefore claim for firms to invest in training. But if several studies show that training is beneficial for firm performance (e.g. Bartel 1994, Schonewille 2000, Ballot et al 2001, Barrett and O’Connell 2001, Zwick 2002, de Nève et al 2006), training also represents additional costs, either direct, shadow or induced by wage determination. It has indeed been documented that the higher the human capital, the higher the wages. Mincer (1974) equations for labour suppliers most often stress on a positive impact of training on wages (e.g. Booth 1993, Docquier et al 1999, Arulampalam and Booth 2001, Fougère et al 2001, Leuven and Oosterbeeck 2002, Kuckulenz and Zwick 2003).

In this context, Becker’s (1964) human capital theory suggests that firms will never pay for general training as workers can extract its returns in the form of higher wages, their productivity increasing equally in the training firm and in other firms. This type of training is therefore predicted to be financed only by workers, directly or through lower wages during the training period. In contrast, specific training only increases the workers’ productivity in the firm where he is employed. Productivity returns can therefore be shared by the firm and the worker, and specific training can then be financed by both of them.

However, these theoretical predictions based on perfectly competitive labour market are not in line with empirical evidence, which shows that firms do invest in general training. Bassanini et al (2005) indicate that firms finance on average three quarters of the cost of training courses. This can further be explained by the wage compression hypothesis developed by Acemoglu and Pischke (1999). They emphasize that labour markets imperfections allow the firm to possess some monopsony power which makes wages less sensitive to training than productivity, yielding a larger gap between productivity and wage the greater the level of skills. Such wage compression might for instance arise from the asymmetric information between current and potential employers, as initially suggested by Katz and Ziderman (1990).
In this case, the potential employer does not know exactly the training received by the worker, so that the actual employer can retain his trained worker with a relatively low wage. Other sources of wage compression include the presence of transaction costs, the interaction of specific and general skills and labour market institutions (Acemoglu and Pischke 1999).

This wage compression hypothesis, i.e. the fact that additional productivity is not thoroughly compensated by higher wages, has been empirically supported by Beckmann (2002) in Germany. Moreover, Conti (2005) estimates a significant positive and robust impact of training on productivity of Italian industries over the period 1996-99, and a smaller and less robust impact of training on wages. Considering her preferred specification, an increase in the stock of trained workers in an industry by one percentage point is associated with an increase in productivity of 0.4% and in wages of 0.1%. Analysing longitudinal data on British industries for the years 1983-96, Dearden et al (2006) also report that a rise of one percentage point in training increases value added per hour by 0.6% and hourly wages by only 0.3%. Finally, using a panel data set of 13,000 Belgian firms, Konings (2008) estimates that training increases productivity in a range between 1 and 2% and wages by 0.5%, compared to non training firms.

Considering these training potential productivity and cost effects, the aim of this paper is to examine the impact of training on labour demand. In a first step, we propose to model this influence assuming profit maximising firms producing under a short run monopolistic competition regime. We emphasize that training variables, both quantitative and qualitative, can either increase labour demand through their positive effect on labour physical productivity net from the dropping price required in order to sell additional production, and decrease it through induced increasing direct labour costs and wages. In a second step, we estimate our model on a large panel data set of firms operating in Belgium for the years 1999-2007, which enables to address the potential simultaneity between training and labour demand and to control for unobserved workplace characteristics.

To our knowledge, it is the first attempt to model the impact of training on labour demand from profit maximising firms in a monopolistic competition regime, and to estimate it in the Belgian context.
The remainder of this paper is organised as follows. We present our model of the assumed relationship between labour demand and labour training in Section 2. Section 3 presents the data set and Section 4 is devoted to a presentation and discussion of the impact of labour training on labour demand. Section 5 concludes.

2. The model

2.1. Monopolistic competition and unit labour costs

2.1.1. Profit function

In order to model the influence of training on labour demand, we first assume a short run profit maximising firm $i$ of industry $j$ at year $t$:

$$\pi_{ijt} = p_{ijt} \cdot Q_{ijt} - w_{ijt} \cdot L_{ijt} - CF_{ijt}$$

(1)

where $\pi_{ijt}$ represents its profit, $p_{ijt}$ its output price, $Q_{ijt}$ its output, $w_{ijt}$ its wage cost, $L_{ijt}$ its total employment level and $CF_{ijt}$ its total direct training costs.

We consider monopolistic competition on the product market, where the firm produces close substitutes to other firms in industry $j$. Monopolistic competition presents an adequate framework to study a large number of questions, as it completely determines how product prices are fixed (Cahuc and Zylberberg 2001). This kind of framework has been intensively used (e.g. Nickell and Wadhwani 1991, Wulfsberg 1997). Under this monopolistic competition assumption, firm’s output function can be modelled as follows:

$$Q_{ijt} = \left( \frac{p_{ijt}}{p_{jt}} \right)^{-\eta} \cdot y_{jt}$$

(2)

where $p_{jt}$ is the industry output price index, $\eta$ the absolute value of product demand price-elasticity and $y_{jt}$ the industry output. This relation means that firm $i$ is able to fix its price $p_{ijt}$. 
given output and prices from other firms. If it increases its price with respect to other exogenous prices, $p_{jt}/p_{jt}$, its market share $Q_{jt}/y_{jt}$ decreases by $\eta$.

2.1.2. Production function

Production function is then supposed to correspond to an extended Cobb-Douglas with respect to effective labour (e.g. Bartel 1994, Schonewille 2000, Barrett and O’Connell 2001, Zwick 2002, Conti 2005, Dearden et al 2006). We model effective labour in a rather original manner, as the number of workers multiplied by the ratio of trained workers and by the cost of training per trained worker. The training ratio can be seen as a quantitative indicator of training, the cost of training per trained worker as a qualitative indicator reflecting the intensity of training received by each trained worker. Our augmented Cobb-Douglas production function is thus the following:

$$Q_{jt} = A_{jt} \left( L_{jt} \cdot \frac{T_{jt}}{L_{jt}} \cdot \frac{CF_{jt}}{T_{jt}} \right)^{\alpha} \lambda_1 \lambda_2$$

(3)

where $A_{jt}$ represents the scale parameter including the scale effect and the effect of predetermined capital stock, $T_{jt}$ the number of trained workers, $\frac{T_{jt}}{L_{jt}}$ the training ratio, $\frac{CF_{jt}}{T_{jt}}$ the cost of training per trained worker, $\alpha$ the output elasticity with respect to labour, and $\lambda_1, \lambda_2$, multiplied by $\alpha$, the elasticities of output with respect to the different training variables.

2.1.3. Unit labour costs

We broke up unit direct training costs from the profit function into its three components, the cost of training per trained worker, the training ratio and the employment level:

$$CF_{jt} = \left( \frac{CF_{jt} \cdot T_{jt} \cdot L_{jt}}{T_{jt} \cdot L_{jt}} \right)$$

(4)
We next model wages in logarithms, as the labour demand specification requires hereafter. They are supposed to be determined by the outside option, which itself relates to industry unemployment and wages, to some rent-sharing phenomenon (up to three lags, as estimated by Goos and Konings 2001) and to training that can influence wages through labour supply returns coming from higher human capital:

\[
\ln w_{jt} = \beta_0 + \beta_1 \ln U_{jt} + \beta_2 \ln w^0_{jt} + \beta_3 \ln \left( \frac{\pi}{L_{jt}} \right) + \beta_4 \ln \left( \frac{\pi}{L_{jt-1}} \right) + \beta_5 \ln \left( \frac{\pi}{L_{jt-2}} \right) + \beta_6 \ln \left( \frac{\pi}{L_{jt-3}} \right) + \beta_7 \ln \left( \frac{CF_{jt}}{T_{jt}} \right) + \beta_8 \ln \left( \frac{T_{jt}}{L_{jt}} \right) \quad (5)
\]

where \( U_{jt} \) is the industry unemployment rate, \( w^0_{jt} \) the industry annual wage per worker and 
\[
\left( \frac{\pi}{L_{jt}} \right) \quad \text{the level of firms’ profit per worker at time } t - \tau.
\]

We then sum these wages to unit direct training costs and specify unit labour costs as follows:

\[
\ln w'_{jt} = \ln \left( w_{jt} + \frac{CF_{jt}}{T_{jt}} \cdot \frac{T_{jt}}{L_{jt}} \right) \quad (6)
\]

Combining equations (5) and (6) further enables to specify unit labour costs in logarithms in the following way:

\[
\ln w_{jt} = \beta_0 + \beta_1 \ln U_{jt} + \beta_2 \ln w^0_{jt} + \beta_3 \ln \left( \frac{\pi}{L_{jt}} \right) + \beta_4 \ln \left( \frac{\pi}{L_{jt-1}} \right) + \beta_5 \ln \left( \frac{\pi}{L_{jt-2}} \right) + \beta_6 \ln \left( \frac{\pi}{L_{jt-3}} \right) + \beta_7 \ln \left( \frac{CF_{jt}}{T_{jt}} \right) + \beta_8 \ln \left( \frac{T_{jt}}{L_{jt}} \right) \quad (6)
\]

2.2. Labour demand and training

2.2.1. Labour demand specification

Including the previous assumptions, the short run profit to maximise becomes:
Developing the first order condition from profit with respect to labour and considering variables in logarithms (see Appendix I for details) leads to the following relation between (log of) labour demand and (logs of) different variables of interest:

\[
\ln L_{\mu} = -\frac{1 - \frac{1}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}} \ln A_{\mu} - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \ln \alpha - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \ln \bigg(1 - \frac{1}{\eta}\bigg) + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_0
\]

\[
- \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \ln p_{\mu} - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \ln y_{\mu} + \bigg(\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_2 - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_1 \ln \frac{T_{\mu}}{L_{\mu}}\bigg)
\]

\[
+ \bigg(\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_2 - \frac{\alpha}{\eta} \bigg) \ln \frac{CF_{\mu}}{T_{\mu}} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_1 \ln U_{\mu} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_2 \ln w_{\mu} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_3 \ln \frac{\pi}{L_{\mu-1}} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_4 \ln \frac{\pi}{L_{\mu-2}} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_5 \ln \frac{\pi}{L_{\mu-3}}
\]

2.2.2. The role of training variables

Labour demand depends on the two training variables under interest and we precisely want to estimate the signs of their elasticities, each of these capturing both productivity and cost effects of training on labour demand. For instance, the labour demand elasticity with respect to average cost of trained worker is the following:

\[
\frac{d \ln L_{\mu}}{d \ln \frac{CF_{\mu}}{T_{\mu}}} = \left(\frac{\alpha}{\alpha - 1 - \frac{\alpha}{\eta}}\right) \lambda_2 + \left(\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\right) \beta_6
\]
positive effect coming from the positive output elasticity with respect to labour, \( \alpha \), net of the negative effect coming from the elasticity of the output price – that the monopolistic firm has to fix at a lower level in order to sell this additional output – with respect to labour, \( \frac{\alpha}{\eta} \). This net effect is positive as, to ensure that marginal revenue is positive at the optimum output level, \( \eta \) has necessarily to be in the range \( ]1, \infty[ \) and therefore \( \left( \alpha - \frac{\alpha}{\eta} \right) \) to be positive.

The second term represents the negative impact of training on labour demand coming from additional unit training costs through additional direct and wage costs, which are captured by the positive parameter \( \beta_6' \). These effects on unit labour costs then reduce labour demand by this parameter \( \beta_6' \) multiplied by the negative term \( \frac{1}{\left( \alpha - 1 - \frac{\alpha}{\eta} \right)} \).

Close considerations apply to the labour demand elasticity with respect to training ratio, the positive productivity impact, \( \lambda_1 \), being opposed to the negative costs effects, \( \beta_7' \).

Labour demand is also related to other variables, first to industry output price index, \( p_{jt} \), and to industry output, \( y_{jt} \), and we expect their coefficients of elasticity to be positive. Indeed, considering the industry output price, the monopolistic firm experiences an increase of its market share when prices of its competitors rise and therefore needs to hire more labour. On the other hand, at a given market share, if the industry output increases, the firm’s output also increases.

Second, labour demand is a positive function of the industry unemployment rate, \( U_{jt} \), and a negative function of the industry annual wage per worker, \( w_{jt}^0 \), given the respectively negative and positive effects of these variables on wages.
Third, labour demand is a negative function of the level of firms’ profit per worker with up to three lags, \( \left( \frac{\pi}{L} \right)_{ijt-\tau} \), the wage increasing with the level of profit per worker in case of rent-sharing.

2.2.3. Relation to be estimated

From the estimation point of view, we finally specify the following equation (9):

\[
\ln L_{ijt} = \gamma_0 + \gamma_1 \ln p_{jt} + \gamma_2 \ln y_{jt} + \gamma_3 \frac{T_{ijt}}{L_{ijt}} + \gamma_4 \frac{CF_{ijt}}{T_{ijt}} + \gamma_5 \left( \frac{\pi}{L} \right)_{ijt-1} + \gamma_6 \left( \frac{\pi}{L} \right)_{ijt-2} + \gamma_7 \left( \frac{\pi}{L} \right)_{ijt-3} + \varsigma_t + \phi_j + \varepsilon_{ijt} \tag{9}
\]

where \( L_{ijt} \) is the firm labour demand, or its employment expressed in full-time equivalents jobs, \( p_{jt} \) is the industry output price, measured by the sector-specific value-added prices (the base year is 2006), \( y_{jt} \) is the industry output, measured by the total value added at constant 2006 prices of the industry to which the firm belongs to, \( \frac{T_{ijt}}{L_{ijt}} \) is the firms’ training ratio, \( \frac{CF_{ijt}}{T_{ijt}} \) is the cost of training per trained worker, \( \frac{\pi}{L} \) is the ratio of net income to total employment, \( \varsigma_t \) is a set of year dummies (8 dummies), \( \phi_j \) is a set of industry dummies (8 dummies) and \( \varepsilon_{ijt} \) is the error term.

Equation (9) is a bit different from our model (equation (7)). Indeed, we first remove the industry unemployment rate and the industry annual wage per worker, because of unavailable data. Note however that their effects can partly be captured by the inclusion of industry dummies. In addition, given that we also include firm-specific fixed effects to our model, we also capture part of the outside option. Second, as an important part of our sample is composed by firms that do not train at all, estimating equation (7) would then lead to lose a large number of observations as training variables are expressed in logarithms. We therefore consider the training variables in level rather than in logarithms. The same transformation is applied to the rent-sharing variables that could also be negative or null.
3. The dataset

Our empirical analysis is based on a large panel data set obtained from the Bel-First software which contains both financial statements and social reports of firms operating in Belgium for the last ten years. Financial statements provide information on financial variables (e.g. value added, profits per worker, total wage bill) while social reports contain information on total employment and firm activities of training. As the way to report those training activities has changed in 2008, we do not consider annual accounts of the year 2008, in order to collect homogeneous information on training. Indeed, only formal training was reported before 2008 while firms now have to separate information on formal, informal and initial training. We thus only consider annual accounts from 1999 to 2007 in which only formal training is reported, the latter being defined as training courses generally conceived by lecturers or trainers and given in a class or a centre of training. Firms are traced over time using their VAT number.

We select our sample in the following way. We first only keep firms operating in the Belgian\(^1\) private sector (i.e. whose activities fall into sections C to K of the NACE Rev.1.1.\(^2\)), employing at least 10 workers and whose status corresponds to a profit maximiser organisation not under juridical dispute. Not to consider aberrant data, we eliminate firms presenting a negative value-added and/or a training ratio larger than 100%. We also remove firms for which data are missing.

Our definitive sample consists of an unbalanced panel of 17,812 firms yielding 136,044 firm-year-observations over the period 1999-2007, the exact number depending on the specification and the estimation method. Nominal variables are expressed in kilo euros and deflated by sector-specific value-added prices (the base year is 2006).

[Insert Table 1]

Table 1 depicts the means and standard deviations of the main variables. It indicates that we consider firms of 73 workers on average with a mean training ratio of 8.45% and an average

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\(^1\) The Bel-First software also provides information on firms operating in Luxembourg.

\(^2\) It thus covers the following sectors: i) mining and quarrying (C), ii) manufacturing (D), iii) electricity, gas and water supply (E), iv) construction (F), v) wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G), vi) hotels and restaurants (H), vii) transport, storage and communication (I), viii) financial intermediation (J), and ix) real estate, renting and business activities (K).
cost of formal training per trained worker of 370 euros. We also observe that the average value added per worker amounts to 72,690 euros and the average profit per worker to 11,620 euros. Firms are essentially concentrated in i) wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (30%), ii) manufacturing (27%), and iii) construction (17%).

[Insert Table 2]

Table 2 further compares descriptive statistics between firms reporting formal training activities or not. It emphasizes that 36% of the sampled firms report training activities (i.e. a positive training ratio) for at least one year. In those firms, 42% of the workers are trained at an average cost of 1,850 euros. Firms providing training further employ a larger workforce and present larger values of value-added and profit per worker than the others not providing training. Sectors containing training firms to a bigger extent are: i) electricity, gas and water supply, ii) financial intermediation, iii) manufacturing, iv) real estate, renting and business activities, and v) mining and quarrying. For instance, while 40% of all training firms are encountered in the manufacturing sector, only 24% of all non training firms are encountered in the same sector.

4. Results

We first estimate equation (9) by OLS. Results presented in column 2 of Table 3 point towards the existence of a positive and significant relationship between labour demand and the two training variables. Indeed, the points estimates amounts to 1.82 and 0.002 respectively for the training ratio and the cost of training per trained worker, which yield respective elasticities of 0.15 and 0.00074 at the sample means. This positive impact of training on labour demand therefore seems to support the wage compression hypothesis, the productivity effect dominating the costs effects.

[Insert Table 3]

3 Results of the 3rd Continuing Vocational Training Survey (CVTS3) for Belgium (SPF 2007) emphasize that 62.5% of firms employing at least 10 workers have provided training in 2005. However, this number is related to formal, less formal or informal training activities. Remember that our dataset contains information on formal training only. Results of CVTS3 further indicate that 48.4% of firms have provided formal training to 50.8% of their workers in 2005.
As expected, results also highlight significant and positive impacts of industry price and output on labour demand and significant negative influence of rent-sharing with two or three lags.

But these results should be assessed with caution given that they are subject to several methodological limitations. A first one is related to the potential simultaneity between training and labour demand, as larger firms usually train more their workers than smaller ones. There are several reasons for this fact: “i) the collection of information, the definition of a training plan and the establishment of a training facility involve fixed costs and scale economies; ii) small firms might find more difficult to replace a worker who temporarily leaves for training; and iii) small firms might have fewer opportunities to fully reap the benefits of training through internal reallocation of workers” (Bassanini et al 2005; p. 64). To examine the presence of such a problem, we apply Davidson and MacKinnon’s (1989, 1993) version of the Hausman (1978) test. Results of this test, shown in column 2 of Table 3, indicate that both quantitative and qualitative training are endogenously determined. Above-mentioned OLS results are thus inconsistent.

We address this issue by estimating equation (9) using the first lag of the training variables rather than their current value as our main explanatory variables. This also makes sense as training could take some time to influence firm productivity, as empirically estimated by e.g. Schonewille (2000) and De Nève et al (2006). Findings based on this specification are reported in column 3 of Table 3. Again, they support the existence of a positive and significant impact of training on labour demand. Yet the Hausman (1978) test still rejects the null hypothesis of consistent OLS estimates.

However, these estimates may be biased because time-invariant unobserved workplace characteristics are not controlled for. In consequence, we add to equation (9) a dummy variable for each firm which captures time-invariant unobserved workplace characteristics. One year lag training variables are again considered in order to address the simultaneity problem. We thus examine how changes in lagged training affect changes in current labour demand within firms.
Results, presented in column 4 of Table 3, first still highlight, as expected, significant and positive impacts of industry price and output on labour demand and significantly negative impact of rent-sharing, with one lag. They also emphasize that the impacts of training variables on labour demand decrease sharply after controlling for firm unobserved fixed-effects. However, they remain positive and significant. In addition, the Hausman (1978) test now indicates that the exogeneity of training variables, both quantitative and qualitative, cannot be rejected.

Estimated elasticities of labour demand with respect to training variables at the sample means are reduced to 0.002 and 0.000037, respectively for the training ratio and the cost of training per trained worker. This means that, on average, a rise of 10% in the training ratio (the cost of training per trained worker) is associated with an increase in labour demand of 0.02% (0.00037%). Our results therefore suggest that the net positive productivity effect of training still dominates its negative costs effects in terms of labour demand, though to a much smaller extent than the estimates provided using OLS.

5. Conclusion

The aim of this paper is first to model the influence of training on labour demand, introducing training potential productivity and cost effects, and second to estimate this model on longitudinal data for Belgium.

To model the influence of training on labour demand, we assume profit maximising firms whose direct training costs are included in the profit function, deciding in the short run and producing close substitutes in a monopolistic competition regime. Their production function is supposed to be of a Cobb-Douglas type, augmented to capture potential productivity effects from quantitative and qualitative points of view. Indeed, we consider both a quantitative indicator of training, namely the proportion of trained workers, and a qualitative indicator, the cost of training per trained worker, which reflects the intensity of training received by each trained worker. Unit labour costs are determined by direct training costs, potential human capital wage pressure induced by training and rent sharing.

In the model, training variables can either increase labour demand through their positive effect on labour physical productivity net from the dropping price required to sell additional
production, and they can decrease labour demand through induced increasing direct labour costs and wages. So the net impact of training on labour demand is ambiguous.

We then estimate our model on a large panel data set of 17,812 firms operating in the Belgian private sector during the years 1999-2007, which enables to address the potential simultaneity between training and labour demand and to control for unobserved workplace characteristics. Our empirical findings reveal significant positive impacts of training variables on labour demand. This suggests that the productivity effect of training dominates its costs effect, which could be (partly) explained by the wage compression hypothesis. However, this impact is small, further suggesting that costs are almost as important as productivity effects.

These results allow us to suggest two scenarios. On the one hand, trained workers could be able to value their productivity gain outside their occupying firm and therefore to extract a big part of the difference between the productivity gain and direct training costs through higher bargained wages, which in turn does not lead the firm to heavily increase its labour demand. On the other hand, training could provide some monopsony power to the firm through a specific human capital gain that workers are not able to value outside the firm. This specific human capital benefit could enable the firm to raise its productivity – wage mark-up, representing an important return to training without a large increase in labour demand.

Furthermore, these two scenarios are not necessarily mutually exclusive: after training, both workers could (partially) bargain higher wages in case of productivity gains, while firms also raise their productivity – wage mark-up. And the outcome could be a rather constant labour demand.

In term of training policies, our results may finally suggest that to subsidise training would enable firms to benefit from the positive productivity impact of training while decreasing its cost effects, even though our preceding scenarios do not necessarily support the argument. Moreover, subsidiary training could favour employment under the two conditions that firms don’t transform training in an increased productivity – wage mark-up and workers don’t claim for higher wages as a return for additional productivity.
References


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Table 1. Descriptive statistics of selected variables

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour demand$^1$</td>
<td>73.08</td>
<td>2,558.48</td>
</tr>
<tr>
<td>Value added per worker (k €$^2$)</td>
<td>72.69</td>
<td>239.39</td>
</tr>
<tr>
<td>Profit per worker (k €$^2$)</td>
<td>11.62</td>
<td>123.66</td>
</tr>
<tr>
<td>Training ratio (%)</td>
<td>8.45</td>
<td>21.51</td>
</tr>
<tr>
<td>Cost of training per trained worker (k €$^2$)</td>
<td>0.37</td>
<td>10.25</td>
</tr>
<tr>
<td>Sector (%):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mining and quarrying (C)</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>Manufacturing (D)</td>
<td>27.11</td>
<td></td>
</tr>
<tr>
<td>Electricity, gas and water supply (E)</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Construction (F)</td>
<td>16.61</td>
<td></td>
</tr>
<tr>
<td>Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G)</td>
<td>30.26</td>
<td></td>
</tr>
<tr>
<td>Hotels and restaurants (H)</td>
<td>3.71</td>
<td></td>
</tr>
<tr>
<td>Transport, storage and communication (I)</td>
<td>10.04</td>
<td></td>
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<tr>
<td>Financial intermediation (J)</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>Real estate, renting and business activities (K)</td>
<td>10.89</td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td>136,044</td>
<td></td>
</tr>
<tr>
<td>Number of firms</td>
<td>17,812</td>
<td></td>
</tr>
</tbody>
</table>

$^1$ Firm labour demand is measured as the employment level, expressed in full-time equivalents jobs. $^2$ At 2006 constant prices.
Table 2. Descriptive statistics of selected variable whether the firm trains or not

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Non training firms</th>
<th>Training firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour demand(^1)</td>
<td>43.45 (2840.06)</td>
<td>191.37 (677.36)</td>
</tr>
<tr>
<td>Value added per worker (k €(^2))</td>
<td>65.94 (72.08)</td>
<td>99.66 (514.29)</td>
</tr>
<tr>
<td>Profit per worker (k €(^2))</td>
<td>8.39 (82.09)</td>
<td>24.51 (221.89)</td>
</tr>
<tr>
<td>Training ratio (%)</td>
<td>0 (0)</td>
<td>42.20 (29.76)</td>
</tr>
<tr>
<td>Cost of training per trained worker (k €(^2))</td>
<td>0 (0)</td>
<td>1.85 (22.84)</td>
</tr>
<tr>
<td>Sector (%):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mining and quarrying (C)</td>
<td>0.33 (5.69)</td>
<td>0.46 (6.78)</td>
</tr>
<tr>
<td>Manufacturing (D)</td>
<td>23.85 (42.62)</td>
<td>40.08 (49.01)</td>
</tr>
<tr>
<td>Electricity, gas and water supply (E)</td>
<td>0.03 (1.82)</td>
<td>0.17 (4.15)</td>
</tr>
<tr>
<td>Construction (F)</td>
<td>18.27 (38.64)</td>
<td>10.00 (30.00)</td>
</tr>
<tr>
<td>Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G)</td>
<td>31.83 (46.58)</td>
<td>23.99 (42.71)</td>
</tr>
<tr>
<td>Hotels and restaurants (H)</td>
<td>4.42 (20.54)</td>
<td>0.91 (9.50)</td>
</tr>
<tr>
<td>Transport, storage and communication (I)</td>
<td>10.46 (30.6)</td>
<td>8.37 (27.70)</td>
</tr>
<tr>
<td>Financial intermediation (J)</td>
<td>0.79 (8.85)</td>
<td>1.65 (12.73)</td>
</tr>
<tr>
<td>Real estate, renting and business activities (K)</td>
<td>10.02 (30.03)</td>
<td>14.36 (35.07)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>108,796</td>
<td>27,248</td>
</tr>
<tr>
<td>Number of firms</td>
<td>16,255</td>
<td>6,370</td>
</tr>
</tbody>
</table>

Standard deviations are shown in brackets.

\(^1\) Firm labour demand is measured as the employment level, expressed in full-time equivalents jobs. \(^2\) At 2006 constant prices.
### Table 3. Training and firm labour demand

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Labour Demand (ln)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
</tr>
<tr>
<td>Intercept</td>
<td>2.43*** (0.15)</td>
</tr>
<tr>
<td>Training ratio</td>
<td>1.82*** (0.02)</td>
</tr>
<tr>
<td>Cost of training per trained worker</td>
<td>0.002** (0.001)</td>
</tr>
<tr>
<td>One year lagged training ratio</td>
<td></td>
</tr>
<tr>
<td>One year lagged cost of training per trained worker</td>
<td></td>
</tr>
<tr>
<td>Industry price (ln)</td>
<td>0.44*** (0.07)</td>
</tr>
<tr>
<td>Industry output (ln)</td>
<td>0.04*** (0.009)</td>
</tr>
<tr>
<td>One year lagged profit per worker</td>
<td>-0.000 (0.000)</td>
</tr>
<tr>
<td>Two year lagged profit per worker</td>
<td>-0.0001** (0.00005)</td>
</tr>
<tr>
<td>Three year lagged profit per worker</td>
<td>-0.0001* (0.00006)</td>
</tr>
<tr>
<td>Industry dummies (8)</td>
<td>Yes</td>
</tr>
<tr>
<td>Year dummies (8)</td>
<td>Yes</td>
</tr>
<tr>
<td>R²</td>
<td>0.21 (0.21)</td>
</tr>
<tr>
<td>F-stat</td>
<td>510.25***</td>
</tr>
<tr>
<td>Hausman statistic (training ratio)</td>
<td>-44.34</td>
</tr>
<tr>
<td>p-value</td>
<td>0.000</td>
</tr>
<tr>
<td>Hausman statistic (cost of training per trained worker)</td>
<td>-3.21</td>
</tr>
<tr>
<td>p-value</td>
<td>0.001</td>
</tr>
<tr>
<td>Number of observations</td>
<td>79,077</td>
</tr>
<tr>
<td>Number of firms</td>
<td>16,183</td>
</tr>
</tbody>
</table>

***/**/*: significant at the 1, 5 and 10% level, respectively.

White (1980) heteroscedasticity consistent standard errors are shown in brackets.

'Adjusted R² is reported for OLS estimations and Within R² is reported for fixed-effects estimation.
Appendix I. Labour demand and training under monopolistic competition

We assume profit maximising firms deciding in the short run, with predetermined capital stock:

\[
\text{Max } \pi_{ijt} = p_{ijt} \cdot Q_{ijt} - w_{ijt} \cdot L_{ijt} - CF_{ijt}
\]

We also assume:

- Monopolistic competition: \( \frac{Q_{ijt}}{y_{ijt}} = \left( \frac{p_{ijt}}{p_{ij}} \right)^{-\eta} \)  \( (A2) \)

- Augmented Cobb-Douglas production function:

\[
Q_{ijt} = A_{ijt} \cdot L_{ijt} \cdot \frac{T_{ijt}}{L_{ijt}} \cdot \left( \frac{CF_{ijt}}{T_{ijt}} \right)^{\alpha}
\]

- Direct training costs:

\[
CF_{ijt} = \left( \frac{CF_{ijt}}{T_{ijt}} \cdot \frac{T_{ijt}}{L_{ijt}} \right)
\]

The maximising profit objective function can therefore be expressed as follows:

\[
\text{Max } \pi_{ijt} = p_{ijt} \left( \frac{Q_{ijt}}{y_{ijt}} \right)^{-\eta} \cdot A_{ijt} \left( \frac{T_{ijt}}{L_{ijt}} \cdot \frac{CF_{ijt}}{T_{ijt}} \right)^{\alpha} - w_{ijt} \cdot L_{ijt} - CF_{ijt} \cdot \frac{T_{ijt}}{L_{ijt}}
\]

The profit maximising first order condition (FOC) with respect to labour demand can be expressed as:

\[
\frac{\partial p_{ijt}}{\partial Q_{ijt}} \cdot \frac{\partial Q_{ijt}}{\partial L_{ijt}} \cdot Q_{ijt} + p_{ijt} \cdot \frac{\partial Q_{ijt}}{\partial L_{ijt}} \cdot w_{ijt} - CF_{ijt} \cdot \frac{T_{ijt}}{L_{ijt}} = 0
\]  \( (A6) \)
with:

\[
\frac{\partial p_{ijt}}{\partial Q_{ijt}} = -\frac{P_{ijt}}{\eta y_{jt}} \left( \frac{Q_{ijt}}{y_{jt}} \right)^{\frac{1+\eta}{\eta}}
\]  
(A7)

and

\[
\frac{\partial Q_{ijt}}{\partial L_{ijt}} = A_{ijt} \cdot \alpha L_{ijt}^{\alpha - 1} \cdot \left( \frac{T_{ijt}}{L_{ijt}} \cdot \frac{CF_{ijt}}{T_{ijt}} \right)^{\alpha}
\]  
(A8)

For simplicity in the development, assume \( z = \left( \frac{T_{ijt}}{L_{ijt}} \cdot \frac{CF_{ijt}}{T_{ijt}} \right) \)

Plugging (A7) and (A8) in (A6), the FOC becomes:

\[
-\frac{P_{ijt}}{\eta y_{jt}} \left( \frac{Q_{ijt}}{y_{jt}} \right)^{\frac{1+\eta}{\eta}} \cdot A_{ijt} \cdot \alpha L_{ijt}^{\alpha - 1} \cdot z^\alpha \cdot Q_{ijt} + p_{ijt} \left( \frac{Q_{ijt}}{y_{jt}} \right)^{\frac{1}{\eta}} \cdot A_{ijt} \cdot \alpha L_{ijt}^{\alpha - 1} \cdot z^\alpha = w_{ijt} + \frac{CF_{ijt} \cdot T_{ijt}}{L_{ijt}}
\]

\[
\Rightarrow A_{ijt} \cdot \alpha L_{ijt}^{\alpha - 1} \cdot z^\alpha \left[ -\frac{P_{ijt}}{\eta y_{jt}} \left( \frac{Q_{ijt}}{y_{jt}} \right)^{\frac{1+\eta}{\eta}} \cdot Q_{ijt} + p_{ijt} \left( \frac{Q_{ijt}}{y_{jt}} \right)^{\frac{1}{\eta}} \right] = w_{ijt} + \frac{CF_{ijt} \cdot T_{ijt}}{L_{ijt}}
\]

\[
\Rightarrow A_{ijt} \cdot \alpha L_{ijt}^{\alpha - 1} \cdot z^\alpha \cdot p_{ijt} \left( \frac{Q_{ijt}}{y_{jt}} \right)^{\frac{1}{\eta}} \left[ - \frac{Q_{ijt}}{\eta y_{jt}} \left( \frac{Q_{ijt}}{y_{jt}} \right)^{\frac{\eta}{\eta}} + 1 \right] = w_{ijt} + \frac{CF_{ijt} \cdot T_{ijt}}{L_{ijt}}
\]

\[
\Rightarrow A_{ijt} \cdot \alpha L_{ijt}^{\alpha - 1} \cdot z^\alpha \cdot p_{ijt} \left( \frac{Q_{ijt}}{y_{jt}} \right)^{\frac{1}{\eta}} \left[ - \frac{1}{\eta} + 1 \right] = w_{ijt} + \frac{CF_{ijt} \cdot T_{ijt}}{L_{ijt}}
\]  
(A6')

Transforming (A6') in logarithms and expressing \( Q_{ijt} \) as in (A3), the FOC can be rewritten as:
\[ \ln A_{ijt} + \ln \alpha + (\alpha - 1) \ln L_{ijt} + \alpha \ln z + \ln p_{ijt} - \frac{1}{\eta} \ln A_{ijt} - \frac{1}{\eta} \alpha \ln L_{ijt} - \frac{1}{\eta} \alpha \ln z + \frac{1}{\eta} \ln y_{ijt} + \ln \left(1 - \frac{1}{\eta}\right) \]

\[ = \ln \left( w_{ijt} + \frac{CF_{ijt}}{T_{ijt}}, \frac{T_{ijt}}{L_{ijt}} \right) = \ln w_{ijt} \quad (A6') \]

We then model unit labour costs as follows:

\[ \ln w_{ijt} = \beta_0 + \beta_1 \ln U_{ijt} + \beta_2 \ln w^0_{ijt} + \beta_3 \ln \left( \frac{T_{ijt}}{L_{ijt}} \right) + \beta_4 \ln \left( \frac{CF_{ijt}}{T_{ijt}} \right) + \beta_5 \ln \frac{T_{ijt}}{L_{ijt}} \quad (A9) \]

Plugging (A9) in (A6'') and rearranging terms:

\[ \ln L_{ijt} = - \frac{1}{\eta} \ln A_{ijt} - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \ln \alpha - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \ln p_{ijt} - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \ln y_{ijt} \]

\[ - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \ln \left(1 - \frac{1}{\eta}\right) - \frac{\alpha - \frac{\alpha}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}} \lambda_1 \ln \frac{T_{ijt}}{L_{ijt}} - \frac{\alpha - \frac{\alpha}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}} \lambda_2 \ln \frac{CF_{ijt}}{T_{ijt}} \]

\[ + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_0 + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_1 \ln U_{ijt} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_2 \ln w^0_{ijt} \]

\[ + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_3 \ln \left( \frac{T_{ijt}}{L_{ijt}} \right) + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_4 \ln \left( \frac{CF_{ijt}}{T_{ijt}} \right) + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \beta_5 \ln \left( \frac{T_{ijt}}{L_{ijt}} \right) \quad (A6''') \]

Rearranging terms leads to the final relation between (log of) labour demand and (logs of) variables of interest:
\[
\ln L_{\mu} = -\frac{1 - \frac{1}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \ln A_{\mu} = -\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \ln \alpha = -\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \ln \left(1 - \frac{1}{\eta}\right) + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \beta_0
\]

\[
-\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \ln p_{\mu} - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \ln y_{\mu} + \left(\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \beta_2 - \frac{\alpha}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \lambda_1\right) \ln \frac{T_{\mu\nu}}{\Lambda^2}
\]

\[
+ \left(\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \beta_0 - \frac{\alpha}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \lambda_2\right) \ln \frac{\text{CF}_{\mu\nu}}{\Lambda^2} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \beta_4 \cdot \ln U_{\mu} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \beta_2 \cdot \ln w_{\mu}
\]

\[
+ \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \beta_3 \cdot \ln \left(\frac{\pi}{L}\right)^{-1} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \beta_4 \cdot \ln \left(\frac{\pi}{L}\right)^{-2} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}} \cdot \beta_3 \cdot \ln \left(\frac{\pi}{L}\right)^{-3} \quad (A6^{****})
\]

which is relation (7).
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