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FIRM TRAINING AND LABOUR DEMAND IN BELGIUM : DOES 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 short run monopolistic competition conditions, 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 time-invariant workplace characteristics reveals a small positive impact of training variables on labour demand. This suggests that productivity effects could dominate cost effects to a small extent.

JEL CODES : M53, J23, J24, J30, C23.

KEYWORDS : Training, Labour Demand, Labour Productivity, Wage Determination, Panel Data.

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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 capture 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. vielding a larger gap between productivity and wage the greater the level of skills. Such power and its induced 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 the training received by the worker, and more generally his human capital level, as well as the present employer does. So the latter can retain his trained worker at 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%, but hourly wages by only 0.3%. Finally, using a panel data set of more than 170,000 Belgian firms, Konings and Vanormelingen (2010) estimate a productivity premium of 23% for a trained worker, compared to a wage premium of 12%.

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 increased 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. It enables to address the potential simultaneity between training and labour demand and to control for time-invariant 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 1. Section 2 presents the dataset and Section 3 is devoted to a presentation and discussion of the impact of labour training on labour demand. Section 4 concludes.

1. THE MODEL

1.1. MONOPOLISTIC COMPETITION AND UNIT LABOUR COSTS

1.1.1. Profit function

In order to model the influence of training on labour demand, we first assume a short run profit maximising process from firm *i* of industry *j* at year t^1 :

$$Max\mathcal{T}_{ijt} = P_{ijt} \cdot q_{ijt} - W_{ijt} \cdot l_{ijt} - CF_{ijt}$$
(1)

where \mathcal{T}_{ijt} represents its profit, P_{ijt} its output price, q_{ijt} its output, W_{ijt} its wage, l_{ijt} its total employment level and CF_{ijt} its total direct training costs.

¹ Nominal variables are in capital letters and real variables in lower case letters.

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, η 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 in the industry. If it increases its price relatively to other firms exogenous prices, $\frac{P_{ijt}}{P_{i}}$, its market

share $\frac{q_{ijt}}{y_{jt}}$ decreases by η .

1.1.2. Production function

Production function is 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, i.e. by considering both the ratio of trained workers and 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. We introduce these training variables in a Cobb-Douglas production function à la Konings and Vanormelingen (2010) to consider the role of trained workers, augmented to integrate the role of qualitative training²:

$$q_{ijt} = A_{jit} \left(l_{ijt} \left(1 + \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}} \right) \left(1 + \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}} \right) \right)^{\alpha}$$
(3)

² As we consider a short term perspective, we do not include firms' capital stock. Note that van Ours and Stoeldraijer (2010, p.10) conclude from previous studies that "including or not including capital stock information doesn't seem to affect the parameter estimates of production functions based on firm-level micro survey data". This conclusion is in line with results from the meta-analysis performed by Doucouliagos and Laroche (2003).

where A_{iii} represents the scale parameter including the scale effect and the effect of

predetermined capital stock, t_{ijt} the number of trained workers, $\frac{t_{ijt}}{l_{ijt}}$ the training

ratio, $\frac{cf_{ijt}}{t_{ijt}}$ the cost of training per trained worker, α the output elasticity with

respect to labour, and λ_1 , λ_2 , multiplied by α , the semi-elasticities of output with respect to the different training variables. We assume training variables as exogenous³.

1.1.3. 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:

$$cf_{ijt} = \left(\frac{cf_{ijt}}{t_{ijt}}, \frac{t_{ijt}}{l_{ijt}}, l_{ijt}\right)$$
(4)

We also model wages à la Konings and Vanormelingen (2010), assuming that training generates a wage premium through labour supply returns from higher human capital coming from both additional trained workers (Φ_1) together with additional cost of training per trained workers (Φ_2). So the average wage, W_{ijt} , equals to:

$$w_{ijt} = w_{ijt}^{U} \cdot \left(1 + \Phi_1 \cdot \frac{t_{ijt}}{l_{ijt}}\right) \cdot \left(1 + \Phi_2 \cdot \frac{cf_{ijt}}{t_{ijt}}\right)$$
(5)

where w_{iit}^U is the base wage of the untrained workers.

Taking logarithms in order to suit to the labour demand specification requirement

developed hereafter, and replacing ln (1+x) by x for variables $\Phi_1 \cdot \frac{l_{ijl}}{l_{ijt}}$ and

$$\Phi_2 \cdot \frac{CJ_{ijt}}{t_{ijt}}$$
 given that they are sufficiently small:

³ We make this assumption, first in order to make the decomposition between the productivity and cost effects clearer. We also think that such an assumption can be convenient when considering a short run decision process. Indeed, it then seems reasonable to suppose that managers fix a training norm in presence of uncertainty.

$$\ln w_{ijt} = \ln w_{ijt}^U + \Phi_1 \cdot \frac{t_{ijt}}{l_{ijt}} + \Phi_2 \cdot \frac{cf_{ijt}}{t_{ijt}}$$
(6)

We further suppose the base wage to be determined by the outside option, which itself relates to industry unemployment and wages, and to some rent-sharing phenomenon (up to three lags, as estimated by Goos and Konings 2001):

$$\ln w_{ijt}^{U} = \beta_0 + \beta_1 \cdot \ln u_{jt} + \beta_2 \cdot \ln w_{jt}^0 + \beta_3 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-1} + \beta_4 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-2} + \beta_5 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-3}$$
(7)

where u_{jt} is the industry unemployment rate, w_{jt}^0 the industry annual wage per worker and $\left(\frac{\pi}{l}\right)_{ijt-\tau}$ the level of firms' profit per worker at time $t - \tau$.

Plugging (7) in (6) leads to:

$$\ln w_{ijt} = \beta_0 + \beta_1 \cdot \ln u_{jt} + \beta_2 \cdot \ln w_{jt}^0 + \beta_3 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-1}$$

$$+ \beta_4 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-2} + \beta_5 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-3} + \Phi_1 \cdot \frac{t_{ijt}}{l_{ijt}} + \Phi_2 \cdot \frac{cf_{ijt}}{t_{ijt}}$$

$$(8)$$

We then sum these wages to unit direct training costs, in order to better measure unit labour costs and to consider the cost of training per trained worker in the maximising profit objective. We therefore specify unit labour costs as follows:

$$\ln w_{ijt} = \ln \left(w_{ijt} + \frac{cf_{ijt}}{t_{ijt}} \cdot \frac{t_{ijt}}{l_{ijt}} \right)$$
(9)

Combining relations (8) and (9) finally enables to specify unit labour costs in logarithms in the following way:

$$\ln w_{ijt}^{'} = \beta_{0} + \beta_{1} \cdot \ln u_{jt} + \beta_{2} \cdot \ln w_{jt}^{0} + \beta_{3} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-1} + \beta_{4} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-2} + \beta_{5} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-3} + \Phi_{1}^{'} \cdot \frac{t_{ijt}}{l_{ijt}} + \Phi_{2}^{'} \cdot \frac{cf_{ijt}}{t_{ijt}}$$
(9')

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1.2. LABOUR DEMAND AND TRAINING

1.2.1. Labour demand specification

Considering the previous assumptions, the short run profit to maximise becomes (see Appendix I for details):

$$\begin{aligned} Max_{\substack{\{I_{ijt}\}\\\{L_{ijt}\}}} = & \left(\frac{q_{ijt}}{y_{jt}}\right)^{-\frac{1}{\eta}} \cdot A_{ijt} \cdot \left(l_{ijt} \cdot \left(1 + \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}}\right) \cdot \left(1 + \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}}\right)\right)^{\alpha} \\ & - w_{ijt} \cdot l_{ijt} - \frac{cf_{ijt}}{t_{ijt}} \cdot \frac{t_{ijt}}{l_{ijt}} \cdot l_{ijt} \end{aligned}$$
(1')

Developing the first order condition from profit maximising with respect to labour (see Appendix I for details) leads to the following relation between log of labour demand and the two training variables of interest:

$$\ln l_{ijt} = -\frac{1-\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln A_{ijt} - \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln \alpha - \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln \left(1-\frac{1}{\eta}\right) + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{0} - \frac{\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln y_{jt}$$

$$+ \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \Phi_{1}^{i} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \lambda_{1}\right) \cdot \frac{t_{ijt}}{l_{ijt}} + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \Phi_{2}^{i} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \lambda_{2}\right) \cdot \frac{cf_{ijt}}{t_{ijt}}$$

$$+ \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{1} \cdot \ln u_{jt} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{2} \cdot \ln w_{jt}^{0} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{3} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-1}$$

$$+ \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{4} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-2} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{5} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-3}$$

$$(10)$$

1.2.2. The role of training variables

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

$$\frac{d \ln l_{ijt}}{d \frac{cf_{ijt}}{t_{ijt}}} = -\left(\frac{\alpha - \frac{\alpha}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}}\right) \cdot \lambda_2 + \left(\frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\right) \cdot \Phi_2'$$
(11)

The first term on the right-hand side represents the positive impact of training on labour demand coming from additional labour productivity through qualitative training, λ_2 , multiplied by the positive effect coming from the positive output elasticity with respect to labour, α , net of the negative effect coming from the elasticity of the output price (that the monopolistic firm has to lower in order to sell this additional output) with respect to labour, $\frac{\alpha}{\eta}$. This net effect $\left(\alpha - \frac{\alpha}{\eta}\right)$ is

positive, as η has necessarily to be in the range $]1,\infty[$ in order to ensure that marginal revenue is positive at the optimum output level.

The second term represents the negative impact of training on labour demand coming from use parameter Φ'_2 . These additional unit model this parameter Φ'_2 multiplied by the negative term $\frac{1}{\left(\alpha - 1 - \frac{\alpha}{\eta}\right)}$ coming from additional direct and wage costs, which are captured by the positive parameter Φ_2' . These additional unit labour costs then reduce labour demand by

$$\frac{1}{\alpha - 1 - \alpha}$$

Close considerations apply to the labour demand semi-elasticity with respect to training ratio, where the positive productivity impact depending on λ_l is then to be opposed to the negative costs effects captured by Φ'_1 .

Labour demand is also related to other variables. First its elasticity with respect to industry output y_{it} is expected to be positive. Indeed, at a given market share, if the industry output increases, the monopolistic firm's output also increases and therefore requires to hire more labour.

Second, labour demand is positively related to the industry unemployment rate u_{it} and negatively to the industry annual wage per worker w_{ii}^0 , considering the respectively negative and positive effects of these variables on wage costs.

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 costs increasing with the level of profit per worker in case of rent-sharing.

1.2.3. Labour demand relation to be estimated

We finally specify the following labour demand relation to be estimated:

$$\ln l_{ijt} = \gamma_0 + \gamma_1 \ln \gamma_{jt} + \gamma_2 \cdot \frac{t_{ijt}}{l_{ijt}} + \gamma_3 \cdot \frac{cf_{ijt}}{t_{ijt}} + \gamma_4 \cdot \left(\frac{\pi}{l}\right)_{ijt-1} + \gamma_5 \cdot \left(\frac{\pi}{l}\right)_{ijt-2} + \gamma_6 \cdot \left(\frac{\pi}{l}\right)_{ijt-3} (+u_i) + \varphi_j + \zeta_t + \varepsilon_{ijt}$$

$$(12)$$

where l_{ijt} is the firm labour demand, measured by its employment expressed in fulltime equivalents jobs, 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, u_i is the firm effect associated to firm *i*, φ_j is a set of industry dummies (8 dummies), ς_t is a set of year dummies (8 dummies) and ε_{ijt} is the error term.

Relation (12) is a bit different from our specified relation (10). Indeed, we first remove the industry unemployment rate and the industry annual wage per worker, because of unavailable data. Note that their effects can partly be captured by the inclusion of industry dummies. In addition, given that we also consider firm-specific fixed-effects in our model, we also capture part of the outside option. Second, as rent-sharing variables could be negative or null, estimating relation (10) would then lead to lose a large number of observations as these variables are expressed in logarithms. We therefore consider the rent-sharing variables in level rather than in logarithms.

2. THE PANEL DATASET

Our empirical analysis is based on a large panel dataset obtained from the Bel-First software which contains both financial statements and social reports of firms operating in Belgium. 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. We 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 build our sample in the following way. We first select firms operating in the Belgian⁴ private sector (i.e. whose activities fall into sections C to K of the NACE Rev.1.1.⁵), employing at least 10 workers and whose status corresponds to a profit maximiser organisation not under juridical dispute. Not to consider absurd data, we discard firms presenting a negative value-added and/or a training ratio larger than 100%. We also remove firms for which data are missing.

Our final sample consists of an unbalanced panel of 17,812 firms yielding 136,044 firm-year-observations over the period 1999-2007, while the number of observations considered in our selected estimations (see Section 3) is 79,077. Nominal variables are expressed in kilo euros and deflated by sector-specific value-added prices (the base year is 2006).

TABLE 1. DESCRIPTIVE STATISTICS OF SELECTED VARIABL	ES
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Variables:	Mean	Std. Dev.
Labour demand ¹	73.08	2,558.48
Value added per worker (k \mathfrak{E}^2)	72.69	239.39
Profit per worker (k €²)	11.62	123.66
Training ratio (%)	8.45	21.51
Cost of training per trained worker (k € ²)	0.37	10.25
Sector (%):		
Mining and quarrying (C)	0.35	
Manufacturing (D)	27.11	
Electricity, gas and water supply (E)	0.06	
Construction (F) Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G)	16.61 30.26	
Hotels and restaurants (H)	3.71	
Transport, storage and communication (I)	10.04	
Financial intermediation (J)	0.96	
Real estate, renting and business activities (K)	10.89	
Number of observations		136,044
Number of firms		17812

¹ Firm labour demand is measured as the employment level, expressed in full-time equivalents jobs. ² At 2006 constant prices.

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 cost of formal training per trained worker of 370 euros on an annual basis. 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

⁴ The Bel-First software also provides information on firms operating in Luxembourg.

⁵ The sample 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).

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%).

TABLE 2. DESCRIPTIVE STATISTICS O	F SELECTED VARIA	BLE WHETHER	THE FIRM
TRAINS OR NOT			

Variables:	Non training	Training
	firms	firms
Labour demand ¹	43.45	191.37
	(2840.06)	(677.36)
Value added per worker (k ϵ^2)	65.94	99.66
	(72.08)	(514.29)
Profit per worker (k € ²)	8.39	24.51
	(82.09)	(221.89)
Training ratio (%)	0	42.20
	(0)	(29.76)
Cost of training per trained worker (k € ²)	0	1.85
	(0)	(22.84)
Sector (%):		
Mining and quarrying (C)	0.33	0.46
	(5.69)	(6.78)
Manufacturing (D)	23.85	40.08
	(42.62)	(49.01)
Electricity, gas and water supply (E)	0.03	0.17
	(1.82)	(4.15)
Construction (F)	18.27	10.00
	(38.64)	(30.00)
Wholesale and retail trade, repair of motor vehicles,	31.83	23.99
motorcycles and personal and household goods (G)	(46.58)	(42.71)
Hotels and restaurants (H)	4.42	0.91
	(20.54)	(9.50)
Transport, storage and communication (I)	10.46	8.37
	(30.6)	(27.70)
Financial intermediation (J)	0.79	1.65
	(8.85)	(12.73)
Real estate, renting and business activities (K)	10.02	14.36
	(30.03)	(35.07)
Number of observations	108,796	27,248
Number of firms	16.255	6.370

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 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 euros⁶. Firms providing training further employ a larger workforce and present expected 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

⁶ These data can be compared to the results of the 3rd Continuing Vocational Training Survey (CVTS3) for Belgium (SPF 2007), who emphasize that 48.4% of firms have provided formal training to 50.8% of their workers in 2005.

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 listed in the same sector.

3. **RESULTS**

We first estimate relation (12) 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, estimated coefficients amount to 1.82 and 0.002 respectively for the effects of the training ratio and of the cost of training per trained worker, which yields respective elasticities of 0.15 and 0.00074 at the sample means. This positive impact of training on labour demand could therefore support the wage compression hypothesis, where the productivity effect dominates the costs effects. It also leads to additional employment at the firm level.

TABLE 3. TRAINING AND FIRM LABOUR DEMAND

Dependent variable:	Labour Demand (ln)		
	OLS	OLS	Fixed-effects
Intercont	2.62***	2.64***	1.13***
Intercept	(0.15)	(0.15)	(0.44)
Training ratio	1.82***		
	(0.02)		
Cost of training per trained worker	0.002**		
	(0.001)	1 07***	0.02***
One year lagged training ratio		(0.02)	(0.008)
One year lagged cost of training per trained		0.003**	0.0001***
worker		(0.001)	(0,00004)
Industry output (In)	0.03***	0.03***	0.14***
	(0.008)	(0.008)	(0.03)
One year lagged profit per worker	-0.000	-0.000	-0.00006*
	(0.000)	(0.00006)	(0.00003)
Two year lagged profit per worker	-0.0001**	-0.00005	0.00001
	(0.00005)	(0.00005)	(0.00003)
Three year lagged profit per worker	-0.0001*	-0.0001**	0.00002
	(0.00006)	(0.00006)	(0.00002)
Industry dummies (8)	Yes	Yes	Yes
Year dummies (8)	Yes	Yes	Yes
\mathbf{R}^{2}	0.21	0.21	0.03
F-stat	533.86***	523.34***	86.05***
Hausman statistic (training ratio)	-44.4	-43.08	0.57
p-value	0.000	0.000	0.571
Hausman statistic (cost of training per trained worker)	-3.22	-3.43	-0.29
p-value	0.001	0.001	0.768
Number of observations	79,077	79,077	79,077
Number of firms	16,183	16,183	16,183

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

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

¹Adjusted R² is reported for OLS estimations and Within R² is reported for fixed-effects estimation.

As to be expected, results also highlight significant and positive impact of industry 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 relation (12) using the first lag of the training variables rather than their current value as our main explanatory variables. This can also be considered 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.

Moreover, these estimates may not be consistent because time-invariant workplace characteristics are not controlled for. In consequence, we add to relation (12) a dummy variable for each firm which captures time-invariant workplace characteristics (u_i) . One year lag training variables are again considered in order to address the simultaneity problem. We thus examine how changes in lagged training variables affect changes in current labour demand within firms.

Results, presented in column 4 of Table 3, first still highlight, as expected, a significant positive impact of industry output on labour demand and a significant negative impact of rent-sharing, with one lag. They also emphasize that the impacts of training variables on labour demand remain significantly positive but decrease sharply after controlling for firm unobserved fixed-effects. This result is not surprising: because training may be related to firm size, the positive and large coefficient associated to the training ratio in the OLS specification may capture the fact that the training ratio increases with the firm size. Cahuc & Zylberberg (2006) also argue that OLS estimations lead to larger training returns than estimations based on panel data using alternative estimation techniques (like GMM). 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 while using fixed-effects, though to a much smaller extent than the estimates provided using OLS.

CONCLUSION

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

We assume profit maximising firms deciding in the short run and producing close substitutes under monopolistic competition conditions. Their production function is supposed to be of a Cobb-Douglas type, augmented to capture potential productivity effects coming from quantitative and qualitative training. 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 then reflects the intensity of training received by each trained worker. Their unit labour costs are determined by direct training costs, potential human capital wage pressure induced by training and rent sharing. Finally, direct training costs also negatively enter as such in the profit function.

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

We next 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 timeinvariant workplace characteristics. Our empirical findings from fixed-effects estimation reveal significant positive impacts of training variables on labour demand. This suggests that their productivity effect dominates their costs effect, which could be (partly) explained by the wage compression hypothesis. However, these estimated impacts are 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 hardly 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.

Note that these two scenarios are not necessarily mutually exclusive: after training, it could also be the case that workers bargain higher wages in case of productivity gains, and that 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 increase their labour demand through the positive productivity impact of training accompanied by the decreasing costs through subsidies, though considering that our two preceding scenarios do not necessarily support this suggestion. In other words, to subsidize training could favour employment under the two conditions that firms do not transform training in an increased productivity – wage mark-up and that workers do not ask for higher wages as a return for their additional productivity.

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APPENDIX I. LABOUR DEMAND AND TRAINING UNDER MONOPOLISTIC COMPETITION

We assume profit maximising firms deciding in the short run, with predetermined capital stock⁷:

$$Ma \mathscr{T}_{ijt} = P_{ijt} \cdot q_{ijt} - W_{ijt} \cdot l_{ijt} - CF_{ijt}$$
(A1)

We also assume:

- Monopolistic competition:

$$\frac{q_{ijt}}{y_{jt}} = \left(\frac{P_{ijt}}{P_{jt}}\right)^{-\eta}$$
(A2)

- Augmented Cobb-Douglas production function:

$$q_{ijt} = A_{ji} \left(l_{ijt} \left(1 + \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}} \right) \left(1 + \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}} \right) \right)^{\alpha}$$
(A3)

- Direct training costs:

$$\mathcal{C}f_{ijt} = \left(\frac{\mathcal{C}f_{ijt}}{t_{ijt}}, \frac{t_{ijt}}{l_{ijt}}, l_{ijt}\right) \tag{A4}$$

⁷ Nominal variables are in capital letters and real variables in lower case letters.

The maximising profit objective function can therefore be expressed as follows⁸:

$$Max_{ijt} = \left(\frac{q_{ijt}}{y_{jt}}\right)^{-\frac{1}{\eta}} \cdot A_{ijt} \cdot \left(l_{ijt} \cdot \left(1 + \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}}\right) \cdot \left(1 + \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}}\right)\right)^{\alpha} - w_{ijt} \cdot l_{ijt} - \frac{cf_{ijt}}{t_{ijt}} \cdot \frac{t_{ijt}}{l_{ijt}} \cdot l_{ijt}$$
(A5)

Applying the profit maximising first order condition (FOC) with respect to labour demand leads to:

$$\frac{\partial p_{ijt}}{\partial q_{ijt}} \cdot \frac{\partial q_{ijt}}{\partial l_{ijt}} \cdot q_{ijt} + p_{ijt} \frac{\partial q_{ijt}}{\partial l_{ijt}} - w_{ijt} - \frac{cf_{ijt}}{t_{ijt}} \cdot \frac{t_{ijt}}{l_{ijt}} = 0$$
(A6)

with:

$$\frac{\partial p_{ijt}}{\partial q_{ijt}} = -\frac{1}{\eta \cdot y_{jt}} \cdot \left(\frac{q_{ijt}}{y_{jt}}\right)^{\frac{1+\eta}{\eta}}$$
(A7)

and

$$\frac{\partial q_{ijt}}{\partial l_{ijt}} = A_{jit} \partial d_{ijt}^{\alpha - 1} \cdot \left(\left(1 + \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}} \right) \left(1 + \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}} \right) \right)^{\alpha}$$
(A8)

For convenience in the development, we consider

$$z = \left(\left(1 + \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}} \right) \cdot \left(1 + \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}} \right) \right)$$

⁸ Where profit is now considered in real terms and P_{jt} is introduced as the deflator.

From relation (A2):

$$P_{ijt} = \left(\frac{q_{ijt}}{y_{jt}}\right)^{-\frac{1}{\eta}} \cdot P_{jt}$$
$$\downarrow^{\uparrow}$$
$$p_{ijt} = \left(\frac{q_{ijt}}{y_{jt}}\right)^{-\frac{1}{\eta}}$$

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

(A6')

Transforming (A6') in logarithms and expressing q_{ijt} as in (A3), the FOC can be rewritten as:

$$\ln A_{ijt} + \ln \alpha + (\alpha - 1) \cdot \ln l_{ijt} + \alpha \cdot \ln \left(\left(1 + \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}} \right) \cdot \left(1 + \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}} \right) \right)$$
$$-\frac{1}{\eta} \cdot \ln A_{ijt} - \frac{1}{\eta} \cdot \alpha \cdot \ln l_{ijt} - \frac{1}{\eta} \cdot \alpha \cdot \ln \left(\left(1 + \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}} \right) \cdot \left(1 + \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}} \right) \right)$$
$$+ \frac{1}{\eta} \cdot \ln y_{jt} + \ln \left(1 - \frac{1}{\eta} \right) = \ln \left(w_{ijt} + \frac{cf_{ijt}}{t_{ijt}} \cdot \frac{t_{ijt}}{l_{ijt}} \right) = -\ln w_{ijt}$$

We then model unit labour costs as follows:

$$\ln w_{ijt}^{'} = \beta_{0} + \beta_{1} \cdot \ln u_{jt} + \beta_{2} \cdot \ln w_{jt}^{0} + \beta_{3} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-1} + \beta_{4} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-2} + \beta_{5} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-3} + \Phi_{1}^{'} \cdot \frac{t_{ijt}}{l_{ijt}} + \Phi_{2}^{'} \cdot \frac{cf_{ijt}}{t_{ijt}}$$
(A9)

Plugging (A9) in (A6'') and replacing ln (1+x) by x for the variables $\lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}}$ and

 $\lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}}$, which is allowed given that these variables are sufficiently small:

$$\ln A_{ijt} + \ln \alpha + (\alpha - 1) \cdot \ln l_{ijt} + \alpha \cdot \lambda_{1} \cdot \frac{t_{ijt}}{l_{ijt}} + \alpha \cdot \lambda_{2} \cdot \frac{cf_{ijt}}{t_{ijt}} - \frac{1}{\eta} \cdot \ln A_{ijt} - \frac{1}{\eta} \cdot \alpha \cdot \ln l_{ijt}$$
$$- \frac{1}{\eta} \cdot \alpha \cdot \lambda_{1} \cdot \frac{t_{ijt}}{l_{ijt}} - \frac{1}{\eta} \cdot \alpha \cdot \lambda_{2} \cdot \frac{cf_{ijt}}{t_{ijt}} + \frac{1}{\eta} \cdot \ln y_{jt} + \ln \left(1 - \frac{1}{\eta}\right) = \beta_{0} + \beta_{1} \cdot \ln u_{jt} + \beta_{2} \cdot \ln w_{jt}^{0} \quad (A6''')$$
$$+ \beta_{3} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-1} + \beta_{4} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-2} + \beta_{5} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-3} + \Phi_{1}^{'} \cdot \frac{t_{ijt}}{l_{ijt}} + \Phi_{2}^{'} \cdot \frac{cf_{ijt}}{t_{ijt}}$$

Rearranging terms:

$$\begin{split} \ln l_{jjt} &= -\frac{1-\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln A_{ijt} - \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln \alpha - \frac{\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln y_{jt} \\ &- \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln \left(1-\frac{1}{\eta}\right) - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \lambda_1 \cdot \frac{t_{ijt}}{l_{ijt}} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \lambda_2 \cdot \frac{cf_{ijt}}{t_{ijt}} \\ &+ \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_0 + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_1 \cdot \ln u_{jt} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_2 \cdot \ln w_{jt}^0 \\ &+ \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_3 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-1} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_4 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-2} \\ &+ \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_5 \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-3} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \Phi_1^- \cdot \frac{t_{ijt}}{l_{ijt}} \\ &+ \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \Phi_2^- \cdot \frac{cf_{ijt}}{t_{ijt}} \end{split}$$

(A6'''')

Rearranging terms leads to the final relation between log of labour demand and the two training variables of interest:

$$\begin{split} \ln l_{ijt} &= -\frac{1-\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln A_{ijt} - \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln \alpha - \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln \left(1-\frac{1}{\eta}\right) + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{0} \\ &- \frac{\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \ln y_{jt} + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \Phi_{1}^{'} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \lambda_{1}\right) \cdot \frac{t_{ijt}}{l_{ijt}} \\ &+ \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \Phi_{2}^{'} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}} \cdot \lambda_{2}\right) \cdot \frac{cf_{ijt}}{t_{ijt}} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{1} \cdot \ln u_{jt} \\ &+ \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{2} \cdot \ln w_{jt}^{0} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{3} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-1} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{4} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-2} \\ &+ \frac{1}{\alpha-1-\frac{\alpha}{\eta}} \cdot \beta_{5} \cdot \ln \left(\frac{\pi}{l}\right)_{ijt-3} \end{split}$$

(A6'''')

which is relation (10).