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The effect of quantitative and qualitative training on labour demand in Belgium: a monopolistic competition approach

Abstract – The objective of this paper is to model and estimate the impact of labour training financed by the firm on labour demand in Belgium, introducing training potential productivity and cost effects. To model this influence, we assume profit maximizing firms producing under a short run monopolistic competition regime. We emphasize that training variables, both qualitative and quantitative, can either increase labour demand through their positive effect on labour physical productivity net from the dropping price required to sell additional production, and that they can decrease labour demand through induced increasing direct labour costs and wages. GMM estimations on a panel of 269 firms observed during the period 1998-2004 show non significant impacts of training variables on labour demand, the productivity and cost effects seeming to offset each other. These results allow us to suggest two scenarios in terms of firms and workers behaviour and that subsidiary training could favour employment under the two assumptions that firms don't transform training in an increased productivity – wage mark-up, but convert additional productivity in employment, and workers don't claim for higher wages as a result of additional productivity.

Keywords – Training, Labour Demand, Human capital, Labour Productivity, Panel Data
JEL Codes – C23, J23, J24, M53

1. Introduction

The impact of labour training, asides or together with other human resources management practices, has been documented from different aspects related to firms behaviour.

It has first been stressed that appropriate training together with other HR practices should improve firm's performance (Knight-Turvey et al. (2004)). Complementarily and from a positive influence of training on performance perspective, it has also been asserted that training programs can contribute to lower the turnover and enhance the productivity in firms (Huselid (1995)). Bartel (1994) considers that a link exists between the use of training programs and firm's productivity. Moreover, productivity could also be favoured through innovation and increased market power. Laursen and Foss (2003) show that firms adopting many HR practices like training are more likely to innovate. Hiltrop (1996, 1999) qualifies training as one of the most efficient ways to attract and retain the more talented persons in the firm. Pfeffer (1998) also identifies training as a way to increase the organisational performance, because it raises skills and initiative of employees and makes them more responsible for quality.

From a theoretical point of view, human capital theory provides a documented framework to understand how training investment can improve labour productivity. At the firm level, this positive impact on performance through increased productivity is also estimated by the positive rate of return to firm investment in formal job training (Carneiro and Almeida (2006)), higher than the rate of return from other investments in physical capital or in schooling. The positive impact of training on productivity is again estimated by de Nève et al. for Belgium (2006), Conti (2004) for Italy, Zwick (2002) and Schonewille (2000) for Germany, Balot et al. (2001) for France and Dearden et al. (2005) for the United Kingdom.

Balmaceda (2005) analyzes firms and workers incentives to invest in general and specific training and how the return related to additional productivity is shared among them. From a Mexican point of view, Lopez-Acevedo (2003) shows that both workers and firms are benefiting from investments in training or work experience.
Acemoglu and Pischke (1999) justify that general training can be financed by firms by the fact that additional productivity is not thoroughly compensated by higher wages. This wage compression hypothesis has been empirically supported in Germany by Beckmann (2002).

Of course, training also presents negative effects in terms of firms perfomance through additional costs. There could be a reason why training, despite high rates of returns, does not appear to be that important among firms, as Careiro and Almaceda (2006) for example observe. First, direct formal costs. Second, shadow, informal costs that can often not be measured and lead to upwards bias estimated returns. Third, additional labour costs induced by wage determination. It has been documented that the higher the human capital, the higher the wages. Mincer equations for labour suppliers most often stress on a positive impact of variables proxies for on-the-job experience (and training) on wages. For example, Docquier et al. (1999) estimate this positive relation in the Belgian context.

In this paper, we further want to document the relation between labour demand and labour training, introducing training potential productivity and cost effects. Section 2 models the assumed relation between the variables. Section 3 presents the sample we have constituted to estimate the relation. Section 4 presents and comments the results. Last section 5 concludes.

2. The model

2.1. General framework

We assume a profit maximising firm i of industry j at time t:

$$Max\,\pi_{ijt} = p_{ijt} \cdot Q_{ijt} - w_{ijt} \cdot L_{ijt} - r_{ijt} \cdot K_{ijt} - CF_{ijt} \tag{1}$$

where π_{ijt} represents its profit, p_{ijt} its output price, Q_{ijt} its output, w_{ijt} its wage cost, L_{ijt} its total employment level, r_{ijt} its user cost of capital, K_{ijt} its capital stock and CF_{ijt} its total direct training costs.

We also assume the firm deciding in the short run, with predetermined capital stock K_{ijt}, so that its maximising profit objective becomes:

$$Max\,\pi_{ijt} = p_{ijt} \cdot Q_{ijt} - w_{ijt} \cdot L_{ijt} - CF_{ijt} \tag{1'}$$

We then assume 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 (Nickell and Wadhwani (1991), Wulfsberg (1997)). Under this monopolistic competition assumption, firm's output function can be modelled as:

$$\frac{Q_{ijt}}{y_{jt}} = \left(\frac{p_{ijt}}{p_{jt}}\right)^{-\eta} \tag{2}$$

where y_{jt} is the industry output, p_{jt} the industry output price index and η the absolute value of product demand price-elasticity. 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 exogeneous prices, $\frac{p_{ijt}}{p_{jt}}$, its market share $\frac{Q_{ijt}}{y_{jt}}$ decreases by η.

Production is supposed to correspond to an extended Cobb-Douglas with respect to homogeneous labour, where training variables potential effects on labour productivity are introduced in a multiplicative form. We introduce the fact that these effects can be either contemporaneous or lagged by one period, as estimated by de Nève et al. (2006):

$$Q_{ijt} = A_{ijt} \cdot \left(L_{ijt} \cdot \frac{T_{ijt}}{L_{ijt}}^{\lambda_1} \cdot \frac{CF_{ijt}}{T_{ijt}}^{\lambda_2} \cdot \frac{T_{ijt-1}}{L_{ijt-1}}^{\delta_1} \cdot \frac{CF_{ijt-1}}{T_{ijt-1}}^{\delta_2} \right)^{\alpha} \tag{3}$$

where A_{ijt} 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 between the number of trained workers and the total number of workers, $\frac{CF_{ijt}}{T_{ijt}}$ the cost of training per trained worker, α the output elasticity with respect to labour, and $\lambda_1, \lambda_2, \delta_1, \delta_2$, multiplied by α, the elasticities of output with respect to the different training variables.
For simplicity, we assume training variables as exogenous. We would like to endogenize them in the maximising process in further research.

We then consider direct training costs, broken up for convenience into three components, the cost of training per trained worker, the training ratio and the employment level:

$$CF_{ijt} = \left(\frac{CF_{ijt}}{T_{ijt}} \cdot \frac{T_{ijt}}{L_{ijt}} \cdot L_{ijt} \right) \tag{4}$$

We also consider wages determined by the outside option, which itself relates to industry unemployment and wages, by some rent-sharing phenomenon (with three lags, as estimated by Goos and Konings (2001)) and by contemporaneous and lagged training that can influence wages through labour supply returns from higher human capital. Wages paid by the firm can therefore be modelled as it follows:

$$\ln w_{ijt} = \beta_0 + \beta_1 \cdot \ln U_{jt} + \beta_2 \cdot \ln w^0_{jt} + \beta_3 \cdot \ln\left(\frac{\pi}{L}\right)_{ijt-1} + \beta_4 \cdot \ln\left(\frac{\pi}{L}\right)_{ijt-2} + \beta_5 \cdot \ln\left(\frac{\pi}{L}\right)_{ijt-3} + \beta_6 \cdot \ln\frac{CF_{ijt}}{T_{ijt}} + \beta_7 \cdot \ln\frac{T_{ijt}}{L_{ijt}}$$
$$+ \beta_8 \cdot \ln\frac{CF_{ijt-1}}{T_{ijt-1}} + \beta_9 \cdot \ln\frac{T_{ijt-1}}{L_{ijt-1}} \tag{5}$$

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

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

$$\ln w^{'}_{ijt} = \ln\left(w_{ijt} + \frac{CF_{ijt}}{T_{ijt}} \cdot \frac{T_{ijt}}{L_{ijt}} \right) \tag{6}$$

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

$$\ln w^{'}_{ijt} = \beta_0 + \beta_1 \cdot \ln U_{jt} + \beta_2 \cdot \ln w^0_{jt} + \beta_3 \cdot \ln\left(\frac{\pi}{L}\right)_{ijt-1} + \beta_4 \cdot \ln\left(\frac{\pi}{L}\right)_{ijt-2} + \beta_5 \cdot \ln\left(\frac{\pi}{L}\right)_{ijt-3} + \beta^{'}_6 \cdot \ln\frac{CF_{ijt}}{T_{ijt}} + \beta^{'}_7 \cdot \ln\frac{T_{ijt}}{L_{ijt}}$$
$$+ \beta_8 \cdot \ln\frac{CF_{ijt-1}}{T_{ijt-1}} + \beta_9 \cdot \ln\frac{T_{ijt-1}}{L_{ijt-1}} \tag{6'}$$

2.2. Labour demand specification

Including the previous assumptions, the short run maximising profit process becomes:

$$\underset{\{L_{ijt}\}}{Max}\,\pi_{ijt} = p_{jt}\cdot\left(\frac{Q_{ijt}}{y_{jt}}\right)^{-\frac{1}{\eta}}\cdot A_{ijt}\cdot\left(L_{ijt}\cdot\frac{T_{ijt}}{L_{ijt}}^{\lambda_1}\cdot\frac{CF_{ijt}}{T_{ijt}}^{\lambda_2}\cdot\frac{T_{ijt-1}}{L_{ijt-1}}^{\delta_1}\cdot\frac{CF_{ijt-1}}{T_{ijt-1}}^{\delta_2}\right)^{\alpha} - w_{ijt}\cdot L_{ijt} - \frac{CF_{ijt}}{T_{ijt}}\cdot\frac{T_{ijt}}{L_{ijt}}\cdot L_{ijt} \qquad (1'')$$

Applying the profit maximising first order condition, considering variables in logarithms and rearranging terms (see appendix for details) leads to the following relation between (log of) labour demand and (logs of) different variables of interest:

$$\begin{aligned}
\ln L_{ijt} = & -\frac{1-\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\cdot\ln A_{ijt} - \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\ln\alpha - \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\ln\left(1-\frac{1}{\eta}\right) + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_0 - \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\ln p_{jt} - \frac{\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\cdot\ln y_{jt} \\
& + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_7^{'} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\cdot\lambda_1\right)\ln\frac{T_{ijt}}{L_{ijt}} + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_6^{'} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\cdot\lambda_2\right)\ln\frac{CF_{ijt}}{T_{ijt}} + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_9 - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\cdot\delta_1\right)\ln\frac{T_{ijt-1}}{L_{ijt-1}} \\
& + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_8 - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\cdot\delta_2\right)\ln\frac{CF_{ijt-1}}{T_{ijt-1}} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_1\cdot\ln U_{jt} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_2\cdot\ln w_{jt}^{0} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_3\cdot\ln\left(\frac{\pi}{L}\right)_{ijt-1} \\
& + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_4\cdot\ln\left(\frac{\pi}{L}\right)_{ijt-2} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\cdot\beta_5\cdot\ln\left(\frac{\pi}{L}\right)_{ijt-3}
\end{aligned} \qquad (7)$$

We will estimate the elasticities between labour demand and training variables. For example, let us comment on the elasticity with respect to contemporaneous average cost of trained workers:

$$\frac{d\ln L_{ijt}}{d\ln\frac{CF_{ijt}}{T_{ijt}}} = -\left(\frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\right)\cdot\lambda_2 + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\right)\cdot\beta_6^{'} \qquad (8)$$

The first term on the right-hand side represents the positive impact of training on labour demand coming from additional labour productivity (through training), λ_2, multiplied by the net positive effect coming from the positive output elasticity with respect to labour, α, and the negative effect coming from the negative elasticity of the output price – that the monopolistic firm has to fix in order to sell this additional output – with respect to labour, $\frac{\alpha}{\eta}$. This net effect is positive as, for the standard second order condition to be satisfied, i.e. to ensure that marginal revenue is not negative at the optimum output level, η has necessarily to be in the range (1,∞) and $\left(\alpha - \frac{\alpha}{\eta}\right)$ to be therefore positive.

The second term represents the negative impact of training on labour demand coming from additional labour costs through additional direct training and wage costs (positive parameter β_6'). These effects on labour costs then reduce labour demand by this parameter β_6' multiplied by the negative term, $\left(\frac{1}{\left(\alpha - 1 - \frac{\alpha}{\eta}\right)}\right)$.

From the estimation point of view, we finally specify equation (7) in the following way:

$$\ln L_{ijt} = \gamma_0 + \gamma_1 \ln p_{jt} + \gamma_2 \ln y_{jt} + \gamma_3 \ln \frac{T_{ijt}}{L_{ijt}} + \gamma_4 \ln \frac{CF_{ijt}}{T_{ijt}} + \gamma_5 \ln \frac{T_{ijt-1}}{L_{ijt-1}} + \gamma_6 \ln \frac{CF_{ijt-1}}{T_{ijt-1}} + \gamma_7 \ln U_{jt}$$
$$+ \gamma_8 \ln \overset{\circ}{w}_{jt} + \gamma_9 \ln\left(\frac{\pi}{L}\right)_{ijt-1} + \gamma_{10} \ln\left(\frac{\pi}{L}\right)_{ijt-2} + \gamma_{11} \ln\left(\frac{\pi}{L}\right)_{ijt-3} \qquad (7')$$

So labour demand is first related to the industry output price index, p_{jt}. We expect the coefficient of elasticity γ_1 to be positive. The monopolistic firm experiences an increase of its market share when prices of its competitors increase and needs more labour. Labour demand is also function of the industry output, y_{jt}, the coefficient of elasticity γ_2 being also positive. Indeed, at market share given, if the industry output increases, the firm's output also increases.

Labour demand then depends on the two training variables, contemporaneous or lagged by one period, and we are precisely interested in the signs of the four elasticities γ_3, γ_4, γ_5 and γ_6, the net impact of training on labour demand being ambiguous. Indeed, as illustrated before, each of these coefficients capture two opposite effects, namely the positive impact of training on labour demand through additional productivity and the negative impact of training on labour demand through higher costs induced by training.

Labour demand is also a positive function of the industry unemployment rate, U_{jt}, and a negative function of the industry annual wage per worker, w^{o}_{jt}, given the respectively negative and positive effects of these variables on wages.
So far, we unfortunately don't have data for these two variables. However, their effects will be partly captured by estimating our model in first differences.

Labour demand is finally 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.

3. The dataset

3.1. The selected sample

Using the Belgian Belfirst dataset, we can get or construct micro data for all variables for the period 1995-2004, except for training and labour demand. Indeed, to get data related to labour demand (proxied by employment) and training, we use the social report that firms have to fill together with their financial balance sheet. Social data are only available since 1996, but data related to 1996 and 1997 appear not to be reliable for training. So we only consider all variables for the period 1998-2004.

We construct our sample in the following way:

We first select the 1885 firms fulfilling the following criteria:
- to be a profit maximiser organisation;
- to employ at least 100 workers;
- not to be under juridical dispute;
- to have published complete financial accounts in 2004.

To obtain a balanced panel, we eliminate firms that do not present accounts during the overall period and firms for which profits per head are not available.
Not to consider aberrant data, we also eliminate firms that, for some years, present either no employment and positive value added or a negative value added, and firms declaring not to train at all.

We finally precisely select a panel of 269 firms during the period 1998-2004.

3.2. Variables to be considered

From this dataset, we obtain or construct variables of interest in the following way (subscript t skipped for convenience):

- firms' labour demand, L_{ij}, is the employment expressed in full-time equivalents jobs. All others variables related to employment are calculated in full-time equivalents;
- firms' output, Q_{ij}, is the value added at constant 2000 prices, in keuros;
- sectoral output, y_j, is the total value added at constant 2000 prices of the main activity branch to which the firm belongs to, in keuros;
- firms'proportion of trained workers, $\frac{T_{ij}}{L_{ij}}$, is the ratio of annual trained workers to total employment;
- firms'average cost of training, $\frac{CF_{ij}}{T_{ij}}$, is the ratio of annual cost of training to the number of trained workers, in keuros;
- industry output price, p_j, is the value added at constant 2000 prices;
- profit per worker, $\frac{\pi}{L}$, is the ratio of net income to total employment, in keuros.

3.3. Descriptive statistics

Table 1: Mean and standard-error (in brackets) of the main variables

	1998	1999	2000	2001	2002	2003	2004
Labour demand, in units	678,11 (1934,823)	680,90 (1841,462)	699,69 (1834,198)	714,23 (1819,581)	708,59 (1738,746)	705,67 (1612,880)	713,17 (1609,558)
Output, in keuros	65560,61 (245267,7)	67053,55 (235143,0)	74518,74 (247550,7)	76199,61 (240508,8)	78064,17 (237118,6)	79030,54 (216063,9)	89896,32 (258061,0)
Value added per worker, in keuros	96,68	98,48	106,50	106,69	110,17	111,99	126,05
Profit per worker, in keuros	28,126 (57,109)	32,309 (99,846)	30,249 (58,482)	35,461 (111,805)	34,342 (129,021)	35,543 (99,407)	38,245 (102,515)
Proportion of trained workers	0,554 (0,345)	0,637 (0,337)	0,64 (0,364)	0,66 (0,344)	0,63 (0,361)	0,66 (0,357)	0,66 (0,341)
Average cost of training, in keuros	1,388 (1,767)	1,36 (1,256)	1,44 (1,415)	1,62 (5,107)	1,39 (1,258)	1,33 (1,196)	1,40 (1,446)
Sectoral price	0,972 (0,079)	0,984 (0,055)	1,00 (1,06E-06)	1,01 (0,046)	1,03 (0,043)	1,03 (0,061)	1,05 (0,084)
Sectoral output, in keuros	13860764 (13484826)	14126223 (13843554)	14535235 (14366322)	14987034 (14981257)	15194163 (15122130)	15726017 (15795460)	15864584 (16043434)

Descriptive statistics indicate that we consider big firms of around 700 workers on average. These firms present a high and increasing labour productivity, from 96 keuros in 1998 to 126 keuros in 2004. They present a rather constant training ratio of around 65% and rather constant direct annual costs of training of 1420 euros per worker.

4. Results

We use GMM estimation technique to estimate equation (7’).

From an econometrical point of view and in order to increase the probability of exogeneity from the instruments, we follow two strategies. The first strategy is to specify the relation with variables in levels, and at least by one period lagged first differences of the variables for instruments. Industry and time dummies are considered as potential instruments, and we also allow for potential individual and time fixed effects in the specification. The second strategy is to specify the relation with variables in first differences, and at least by two periods lagged levels of variables as instruments. We then also allow for industry and time dummies for instruments.

For coherence reason, we also have to check that estimated coefficients are consistent with a reasonable value of around 0,7 for the output elasticity with respect to labour demand, α (Cahuc and Zylberberg (2004)), and an higher than one absolute value for the elasticity of labour demand with respect to prices, η (second order profit maximising condition).

Estimated coefficients are very sensitive to the chosen strategies and very few of them are consistent with the α and η coherent values.

So far, the "best" estimation is the one where variables in the specification are in first differences and instruments are by two periods lagged levels of variables. The estimated equation is then the following:

$$\ln L_{ijt} = \underset{(0.0099)}{-0.0077} + \underset{(0.5409)}{1.3048}^{***} \ln p_{jt} + \underset{(0.7553)}{0.9338}^{*} \ln y_{jt} + \underset{(0.1875)}{0.0393} \ln \frac{T_{ijt}}{L_{ijt}} - \underset{(0.1385)}{0.0752} \ln \frac{CF_{ijt}}{T_{ijt}} - \underset{(0.0594)}{0.0371} \ln \frac{T_{ijt-1}}{L_{ijt-1}}$$
$$- \underset{(0.0213)}{0.0032} \ln \frac{CF_{ijt-1}}{T_{ijt-1}} - \underset{(0.1215)}{0.1056} \ln\left(\frac{\pi}{L}\right)_{ijt-1} - \underset{(0.0354)}{0.0721}^{**} \ln\left(\frac{\pi}{L}\right)_{ijt-2} - \underset{(0.0199)}{0.0437}^{**} \ln\left(\frac{\pi}{L}\right)_{ijt-3}$$

****, **, *, ° : significant at 1%, 5%, 10% or 15% level*
Standard deviation in brackets
Sargan : 13.049

Results from this estimation can be summarized as follows:

- positive and significant effects for the elasticity of labour demand with respect to output price (1,305) and industry output (0,934);
- negative and significant labour demand elasticities with respect to profit per employee, at two (-0.072) or three (-0,044) lags;
- no significant effects from the different training variables on labour demand.

From these estimates of relation (7'), we can also estimate some of the different coefficients relating labour demand and variables of interest of equation (7). Estimated coefficients are:

- a very important and significant product market power of our big firms, corresponding to a low estimate of 1.3973 of the absolute elasticity of product demand with respect to prices:

$$\eta = \frac{1.3048^{***}}{0.9338^{*}} = 1.3973$$

- a rather important though consistent and significant estimate of 0.822 for the elasticity of output with respect to labour input:

$$\alpha = \frac{1.3048^{***} - 1}{1.3048^{***} - 0.9338^{*}} = 0.8216$$

- mostly significant, rather close to those of Goos and Konings (2001) and positive estimates of elasticities of wages with respect to profit per head, respectively with one, two, or three lags, of 0.081, 0.055 and 0.034:

$$\beta_3 = \frac{-0.1056}{\dfrac{1}{0.8216 - 1 - \dfrac{0.8216}{1.3973}}} = 0.0809$$

$$\beta_4 = \frac{-0.0721^{**}}{\dfrac{1}{0.8216 - 1 - \dfrac{0.8216}{1.3973}}} = 0.0553$$

$$\beta_5 = \frac{-0.0437^{**}}{\dfrac{1}{0.8216 - 1 - \dfrac{0.8216}{1.3973}}} = 0.0335$$

Without additional information, we cannot estimate the specific parameters related to the separate productivity and cost effects of training on labour demand (i. e. the β's, the λ's and the δ's). For example, the impact of the contemporaneous average training cost on labour demand is the following:

$$\left[\frac{1}{0.8216 - 1 - \dfrac{0.8216}{1.3973}} \cdot \beta_6^{'} - \frac{0.8216 - \dfrac{0.8216}{1.3973}}{0.8216 - 1 - \dfrac{0.8216}{1.3973}} \cdot \lambda_2 \right] = -0.0752$$

5. Conclusion

In this paper, we try to shed some additional light on the relation between labour demand and labour training, introducing training potential productivity and cost effects, given the fact that this relation does not seem to have been that documented yet, especially in the Belgian case.

To model this 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 market. Their production function is supposed to be of a Cobb-Douglas type, with homogeneous labour, predetermined capital stock and augmented to capture potential productivity effects from qualitative and quantitative training variables. Unit labour costs are determined by direct training costs, potential human capital wage pressure induced by training variables and rent sharing.

In our 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.

This ambiguous impact of training on labour demand is corroborated by our GMM estimations on our panel of 269 firms observed during the period 1998-2004. They show non significant effects of training variables on labour demand, positive productivity effect and negative costs effect of training on labour demand seeming to offset each other.

These results allow us to suggest two scenarios.

Firstly, it is often asserted that enterprises may prefer to hire qualified workers rather than to train new workers because the latter could quit them after training (OCDE (2003)). Yet, our estimations don't contradict the fact that trained workers can give value to their productivity gain outside the training firm: they indicate that the positive impact of training on labour demand through more productivity seems to be offset by the negative impact through more labour costs.

Given that we consider labour training financed by the firm, we might have expected the positive productivity impact to be larger than the negative cost impact. Our first scenario emphasizes then the fact that trained workers manage to extract ex post the difference between the productivity gain and direct training costs through higher wages, which in turn does not lead the firm to increase its labour demand. Carneiro and Almeida (2006) underline moreover that firms do not invest that much in training, in spite of high rates of return, because they have to share training benefits with workers.

Alternatively, our results allow us to suggest a second scenario in which training provides monopsony power to the firm through a specific human capital gain that workers can not give value outside the firm. This specific human capital benefit could enable the firm to develop or to reinforce the wedge between productivity and wage, which represents an important return to training but this happening without increasing labour demand.

Furthermore, these two scenarios are not necessarily mutually exclusive: after training, both workers could convert productivity gains through (partial) wage increases and firms could raise their productivity – wage mark-up, the outcome being a constant labour demand.

Lastly, in term of training policies, our results may suggest that subsidise training would enable firms to benefit from the positive productivity impact of training while decreasing its cost effect, although our above scenarios call for prudence. Likewise, subsidiary training could favour employment under the two assumptions that firms don’t transform training in an increased productivity – wage mark-up, but convert additional productivity in employment, and workers don’t claim for higher wages as a result of additional productivity.

We plan, in further research, to:

- endogenize the choice of training in the maximising profit process;
- include the potential influence of training on firms product market;
- apply the approach to dynamic labour demand schedule, including the role of labour adjustment costs in the relation between labour demand and training;
- question the potential relation between explaining variables like, for example, profits and training;
- assume firms deciding in the long run with a variable capital stock and include potential effects from labour training on output, coming not only from labour productivity but also from other phenomena like capital productivity.

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Appendix. Labour demand and training under monopolistic competition (equation 7)

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

$$Max\,\pi_{ijt} = p_{ijt} \cdot Q_{ijt} - w_{ijt} \cdot L_{ijt} - CF_{ijt} \qquad (A1)$$

We also assume:

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

- Augmented Cobb-Douglas production function:

$$Q_{ijt} = A_{ijt} \cdot \left(L_{ijt} \cdot \frac{T_{ijt}}{L_{ijt}}^{\lambda_1} \cdot \frac{CF_{ijt}}{T_{ijt}}^{\lambda_2} \cdot \frac{T_{ijt-1}}{L_{ijt-1}}^{\delta_1} \cdot \frac{CF_{ijt-1}}{T_{ijt-1}}^{\delta_2} \right)^{\alpha} \qquad (A3)$$

- Direct training costs:

$$CF_{ijt} = \left(\frac{CF_{ijt}}{T_{ijt}} \cdot \frac{T_{ijt}}{L_{ijt}} \cdot L_{ijt} \right) \qquad (A4)$$

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

$$\underset{\{L_{ijt}\}}{Max}\,\pi_{ijt} = p_{jt} \cdot \left(\frac{Q_{ijt}}{y_{jt}} \right)^{-\frac{1}{\eta}} \cdot A_{ijt} \cdot \left(L_{ijt} \cdot \frac{T_{ijt}}{L_{ijt}}^{\lambda_1} \cdot \frac{CF_{ijt}}{T_{ijt}}^{\lambda_2} \cdot \frac{T_{ijt-1}}{L_{ijt-1}}^{\delta_1} \cdot \frac{CF_{ijt-1}}{T_{ijt-1}}^{\delta_2} \right)^{\alpha} - w_{ijt} \cdot L_{ijt} - \frac{CF_{ijt}}{T_{ijt}} \cdot \frac{T_{ijt}}{L_{ijt}} \cdot L_{ijt} \qquad (A5)$$

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

$$\frac{\partial p_{ijt}}{\partial Q_{ijt}} \cdot \frac{\partial Q_{ijt}}{\partial L_{ijt}} \cdot Q_{ijt} + p_{ijt} \cdot \frac{\partial Q_{ijt}}{\partial L_{ijt}} - w_{ijt} - \frac{CF_{ijt}}{T_{ijt}} \cdot \frac{T_{ijt}}{L_{ijt}} = 0 \qquad (A6)$$

with:

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

and

$$\frac{\partial Q_{ijt}}{\partial L_{ijt}} = A_{ijt} \cdot \alpha\, L_{ijt}^{\alpha-1} \cdot \left(\frac{T_{ijt}}{L_{ijt}}^{\lambda_1} \cdot \frac{CF_{ijt}}{T_{ijt}}^{\lambda_2} \cdot \frac{T_{ijt-1}}{L_{ijt-1}}^{\delta_1} \cdot \frac{CF_{ijt-1}}{T_{ijt-1}}^{\delta_2}\right)^{\alpha} \qquad (A8)$$

For simplicity in the development, assume $z = \left(\frac{T_{ijt}}{L_{ijt}}^{\lambda_1} \cdot \frac{CF_{ijt}}{T_{ijt}}^{\lambda_2} \cdot \frac{T_{ijt-1}}{L_{ijt-1}}^{\delta_1} \cdot \frac{CF_{ijt-1}}{T_{ijt-1}}^{\delta_2}\right)$

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

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

$\updownarrow$

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

$\updownarrow$

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

$\updownarrow$

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

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

$$\ln A_{ijt} + \ln\alpha + (\alpha - 1)\ln L_{ijt} + \alpha\ln z + \ln p_{jt} - \frac{1}{\eta}\ln A_{ijt} - \frac{1}{\eta}\alpha\ln L_{ijt} - \frac{1}{\eta}\alpha\ln z + \frac{1}{\eta}\ln y_{jt} + \ln\left(1 - \frac{1}{\eta}\right)$$
$$= \ln\left(w_{ijt} + \frac{CF_{ijt}}{T_{ijt}} \cdot \frac{T_{ijt}}{L_{ijt}}\right) \qquad (A6'')$$

We then model labour costs as follows:

$$\ln w'_{ijt} = \beta_0 + \beta_1\ln U_{jt} + \beta_2\ln w^0_{jt} + \beta_3\ln\left(\frac{\pi}{L}\right)_{ijt-1} + \beta_4\ln\left(\frac{\pi}{L}\right)_{ijt-2} + \beta_5\ln\left(\frac{\pi}{L}\right)_{ijt-3} + \beta_6{}'\ln\frac{CF_{ijt}}{T_{ijt}} + \beta_7{}'\ln\frac{T_{ijt}}{L_{ijt}}$$
$$+ \beta_8\ln\frac{CF_{ijt-1}}{T_{ijt-1}} + \beta_9\ln\frac{T_{ijt-1}}{L_{ijt-1}} \qquad (A9)$$

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

$$\ln L_{ijt} = -\frac{1 - \frac{1}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}}\ln A_{ijt} - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\ln\alpha - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\ln p_{jt} - \frac{\frac{1}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}}\ln y_{jt} - \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\ln\left(1 - \frac{1}{\eta}\right)$$
$$- \frac{\alpha - \frac{\alpha}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}}\lambda_1\ln\frac{T_{ijt}}{L_{ijt}} - \frac{\alpha - \frac{\alpha}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}}\lambda_2\ln\frac{CF_{ijt}}{T_{ijt}} - \frac{\alpha - \frac{\alpha}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}}\delta_1\ln\frac{T_{ijt-1}}{L_{ijt-1}} - \frac{\alpha - \frac{\alpha}{\eta}}{\alpha - 1 - \frac{\alpha}{\eta}}\delta_2\ln\frac{CF_{ijt-1}}{T_{ijt-1}} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta_0$$
$$+ \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta_1\ln U_{jt} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta_2\ln w^0_{jt} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta_3\ln\left(\frac{\pi}{L}\right)_{ijt-1} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta_4\ln\left(\frac{\pi}{L}\right)_{ijt-2}$$
$$+ \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta_5\ln\left(\frac{\pi}{L}\right)_{ijt-3} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta'_6\ln\frac{CF_{ijt}}{T_{ijt}} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta'_7\ln\frac{T_{ijt}}{L_{ijt}} + \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta_8\ln\frac{CF_{ijt-1}}{T_{ijt-1}}$$
$$+ \frac{1}{\alpha - 1 - \frac{\alpha}{\eta}}\beta_9\ln\frac{T_{ijt-1}}{L_{ijt-1}} \qquad (A6''')$$

Rearranging terms leads to the final relation between (log of) labour demand and (logs of) variables of interest:

$$\ln L_{ijt} = -\frac{1-\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\ln A_{ijt} - \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\ln\alpha - \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\ln\left(1-\frac{1}{\eta}\right) + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_0 - \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\ln p_{jt} - \frac{\frac{1}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\ln y_{jt}$$

$$+\left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_7^{'} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\lambda_1\right)\ln\frac{T_{ijt}}{L_{ijt}} + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_6^{'} - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\lambda_2\right)\ln\frac{CF_{ijt}}{T_{ijt}} + \left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_9 - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\delta_1\right)\ln\frac{T_{ijt-1}}{L_{ijt-1}}$$

$$+\left(\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_8 - \frac{\alpha-\frac{\alpha}{\eta}}{\alpha-1-\frac{\alpha}{\eta}}\delta_2\right)\ln\frac{CF_{ijt-1}}{T_{ijt-1}} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_1\ln U_{jt} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_2\ln w_{jt}^0 + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_3\ln\left(\frac{\pi}{L}\right)_{ijt-1}$$

$$+\frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_4\ln\left(\frac{\pi}{L}\right)_{ijt-2} + \frac{1}{\alpha-1-\frac{\alpha}{\eta}}\beta_5\ln\left(\frac{\pi}{L}\right)_{ijt-3} \qquad (A6'''')$$

which is the relation (7) in the paper.