Shed the oldies... it's profitable

Older worker separations and firm performance in Belgium[*]

V. Vandenberghe[1]

Preliminary version.

Comments are most welcome

Abstract

This paper combines two promising ways of exploring the relationship between age and firm performance, and improving our understanding of the labour market for older workers. First, following Illmakunnas & Maliranta (2007) we study the effect of the age structure of firms on productivity-, labour cost-, and hence profitability growth. What is more, we explicitly identify the specific contribution of *hiring* and *separation* of workers of different age. Second, inspired by recent developments in the production function estimation literature, we address the problem of endogeneity of hiring and separation decisions using a structural production function estimator (Levinsohn and Petrin, 2003). It consists of proxying unobserved short-term shocks using changes in the use of intermediate inputs. Using linked employer-employee data covering all sectors of the Belgian private economy we essentially show that *separating older workers* translate into better productivity, lower labour costs and, consequently, higher profit.

JEL Classification: J24, C52, D24

Keywords: Ageing, Labour Productivity, Panel Data Analysis.

[*] *Funding for this research was provided by the Belgian Federal Government - SPP Politique scientifique, programme "Société et Avenir",* The Consequences of an Ageing Workforce on the Productivity of the Belgian Economy, *research contract TA/10/031A*.

[1] Economics Department, IRES, Economics School of Louvain (ESL), Université catholique de Louvain (UCL), 3 place Montesquieu, B-1348 Belgium email : vincent.vandenberghe@uclouvain.be.

1. Introduction

The Belgian population is ageing due to demographic changes[2], so does the workforce of firms active in the country. Between 1998 and 2006, the average age of workers rose by almost 3 years: from 36.2 to 39.1 (Table 1). Such a trend is likely to remain for the foreseeable future. In the coming years, in order to comply with EU recommendations[3] and to alleviate the rising cost of old-age public pension schemes, the Belgian authorities will certainly try to expand employment among individuals beyond 50 years-old[4], reinforcing the demographic trends.

But ageing and policies aimed at maintaining older individuals in employment raise crucial issues that have received too little attention so far. Many existing studies look at the consequence of *ageing population* in terms of higher dependency rates and rising social security costs (Gruber and Wise, 2004). Another strain of the literature on ageing examines the retirement behaviour of older individuals (Mitchell & Fields, 1983) meaning that it primarily covers the supply side of the old-age labour market. But the consequences of *an ageing workforce* from the point of view of firms, forming the demand side of the labour market, have largely been overlooked. Most existing scientific work ignores the question of the willingness of firms to employ older workers (Lumsdaine & Mitchell, 1999). By contrast, anecdotal evidence abounds suggesting that firms "shed" older workers. In the European context, it is for instance quite common to use pre- or early retirement schemes to entice older workers to exit the firm. Using data from the 1997 International Social Survey Program (ISSP), Dorn and Sousa-Poza (2010)[5] show that involuntary early retirement seems to be the rule rather than the exception in several continental European countries. In Germany, Portugal, and Hungary, more than half of all early retirements are, reportedly, not by choice.

There are however, some economists who properly consider the role of labour demand in early retirement decisions. They generally focus on the ratio between older workers' productivity and their

[2] Between 1999 and 2009, the share of individuals aged 50-65 in the total population aged 15-65 rose from 25.2% to 28.8% (http://statbel.fgov.be).

[3] The Lisbon Agenda suggested raising employment of individuals aged 55-64 to at least 50% by 2010.

[4] See Annex 1 for 2008 statistics about the employment rate of older workers in Belgium and in the EU.

[5] The ISSP data allows them to identify individuals who i) were early retirees and who ii) assessed their own status as being involuntary using the item "I retired early - by choice" or "I retired early - not by choice" for the questionnaire.

cost to employers. Evidence of a large productivity-to-wage gap is a priori detrimental to older workers' employment. And one way of assessing the plausibility of these gaps is to using firm-level data on productivity and labour costs, with linked information on the age structure of the workforce. Papers based on that approach tend, in their majority, to conclude that firm productivity has an inverted U-shaped relationship with age, while labour costs are either rising with age or flat beyond a certain threshold (for an international survey see Skirbekk, 2004, but also Hellerstein *et al.*, 1999 for the US; Aubert & Crépont, 2003 for France; Dostie, 2006, for Canada; van Ours & Stoeldraijer, for the Netherlands, Vandenberghe & Waltenberg, 2010 for Belgium).

This paper also uses firm-level data and considers how the age structure relates to productivity and labour costs. But its main interest is to show specifically how hires and separations for different age groups affect a firms' growth in terms of productivity, labour costs and hence profitability. In that sense, this paper is also related to the literature that analyses the relationship between labour turnover and firm performance. Traditionally, the negative aspects of this kind of turnover have been emphasized. Separations are dysfunctional as they involve costs in the form of rehiring and training. Costs may also be caused by employer-initiated separations in the form of firing costs.[6] But there is also the Schumpeterian view of destructive creation, implying that labour turnover can be in the interest of the firm, for example when low-productivity workers quit. Macroeconomists and labour economists would insist on intersectoral and interfirm workers flows as being conducive of higher productivity, particularly when the technological change is rapid (Aghion & Howitt, 1992; Scarpetta *et al*., 2002). One of the results we obtain in this paper it that *separating older workers* translate into better productivity, lower labour costs and, consequently, higher profit.

The productivity result accords with the Schumpeterian view that separation – here of the older employees - can be good for firms' financial performance. It is also supportive of the above-mentioned inverted U-shaped relationship between age and productivity. The positive impact of separation on profitability also validates the idea that Belgian firms use long-term implicit labour contracts à la Lazear (1979) that disconnect wages from productivity.

The point is that these empirical validations are probably, in essence, bad news for the employment rate of older individuals, singularly for the reemployment prospects of those who become unemployed beyond the age of 50. In a universe à-la-Lazear (1979) for instance, workers with seniority are paid

[6] Know for being high in Belgium, particularly for workers who have accumulated seniority.

above their relative productivity, whereas new recruits are paid below their productivity. This kind of implicit contract makes economic sense as *i)* wage and productivity remain aligned in long run, and *ii)* employees have less incentive to shirk or quit their employee. However it also generate problems. First, in the event of overall negative productivity shocks (due to sectoral or economy-wide recessions), firms face strong financial incentives to concentrate job cuts on the older segments of their workforce. Second, re-employment becomes less attractive because it almost inevitably implies a lower salary. This is because the new employers, for whom the previous implicit contract is not binding by definition, make wage offers[7] that are equal, or even inferior, to productivity[8].

2. Decomposition and estimation of firm performance

Following Illmakunnas & Maliranta (2007) we assume that a firm's labor force consists of *M* different age groups (cohorts) *k*= 1, …, *M*, and that the firm's output (here its value added) in period *1* can be defined as the sum of outputs of the different groups:

$$Y_1 = Y_{1,1} + Y_{2,1} + \ldots + Y_{M,1} \qquad [1]$$

The firm's labor productivity is the average of (age group-specific) labor productivities, weighted by labor shares.

$$\frac{Y_t}{L_t} = \sum_{k=1}^{M} \frac{L_{k,1}}{L_1} \frac{Y_{k,1}}{L_{k,1}} \qquad [2]$$

where $L_1 = \sum_{k=1}^{M} L_{k,1}$.

Each age group can further be divided into two subgroups: workers who worked in the previous period 0 and are still working in the firm (i.e *stayer*), and those who have been hired between period 0 and period 1 (i.e. *hired*). The firm's labour productivity can then be expressed as follows:

---

[7] Assuming this is allowed, which is not necessary the case in some countries due to Age (anti) discrimination laws.

[8] What is more, moving from one firm to another, particularly if it implies a change of sector, may also affect a worker's productivity. The move represents a loss of firm- or sector-specific human capital (Becker, 1962). It may also coincide with an age-related loss of productivity (Skirbekk, 2008).

$$\frac{Y_1}{L_1} = \sum_{k=1}^{M} \frac{L_{k,1,stay}}{L_1} \frac{Y_{k,1,stay}}{L_{k,1,stay}} + \sum_{k=1}^{M} \frac{L_{k,1,hire}}{L_1} \frac{Y_{k,1,hire}}{L_{k,1,hire}} \quad [3]$$

Equation [3] can be rewritten as follows

$$\frac{Y_1}{L_1} = \frac{L_{1,stay}}{L_1} \sum_{k=1}^{M} \frac{L_{k,1,stay}}{L_{1,stay}} \frac{Y_{k,1,stay}}{L_{k,1,stay}} + \sum_{k=1}^{M} \frac{L_{k,1,hire}}{L_1} \frac{Y_{k,1,hire}}{L_{k,1,hire}} \quad [4]$$

where $L_{1,stay} = \sum_{k}^{M} L_{k,1,stay}$

Because the shares of stayers and hired workers add up to one,

$$\frac{L_{1,stay}}{L_1} = 1 - \sum_{k=1}^{M} \frac{L_{k,1,hire}}{L_1} \quad [5]$$

equation [4] becomes

$$\frac{Y_1}{L_1} = (1 - \sum_{k=1}^{M} \frac{L_{k,1,hire}}{L_1}) \sum_{k=1}^{M} \frac{L_{k,1,stay}}{L_{1,stay}} \frac{Y_{k,1,stay}}{L_{k,1,stay}} + \sum_{k}^{M} \frac{L_{k,1,hire}}{L_1} \frac{Y_{k,1,hire}}{L_{k,1,hire}} \quad [6]$$

or equivalently

$$\frac{Y_1}{L_1} = \sum_{k}^{M} \frac{L_{k,1,stay}}{L_{1,stay}} \frac{Y_{k,1,stay}}{L_{k,1,stay}} + \sum_{k=1}^{M} \frac{L_{k,1,hire}}{L_1} (\frac{Y_{k,1,hire}}{L_{k,1,hire}} - \frac{Y_{1,stay}}{L_{1,stay}}) \quad [7]$$

where $\frac{Y_{1,stay}}{L_{1,stay}} = \sum_{k=1}^{M} \frac{L_{k,1,stay}}{L_{1,stay}} \frac{Y_{k,1,stay}}{L_{k,1,stay}}$

Equation [7] shows that labour productivity in period 1 is a linear combination of *i)* the productivity of stayers and *ii)* the labour productivity differential between the hired workers and the stayers.

To write the labour productivity level of the firm in period 0, we define a third subgroup: those who were in the firm in period 0, but no longer in period 1 (i.e. those who have separated after 0). We can write the period 0 productivity in an analogous way to [7]:

$$\frac{Y_0}{L_0} = \sum_{k=1}^{M} \frac{L_{k,0,stay}}{L_{0,stay}} \frac{Y_{k,0,stay}}{L_{k,0,stay}} + \sum_{k=1}^{M} \frac{L_{k,0,sepa}}{L_0} (\frac{Y_{k,0,sepa}}{L_{k,0,sepa}} - \frac{Y_{0,stay}}{L_{0,stay}}) \quad [7]$$

with $\sum_{k=1}^{M} L_{k,0,stay} = \sum_{k=1}^{M} L_{k,1,stay}$

As we are primarily interested in labour productivity growth, i.e. the change that occurred between periods 0 and 1, we can focus on:

$$\Delta \frac{Y}{L} = \frac{Y_1}{L_1} - \frac{Y_0}{L_0} \qquad [8]$$

If we make the assumption that the breakdown of the population of stayers between the *k=1…M* age groups remains unchanged between periods 0 and 1 (i.e. $L_{k,0,stay} = L_{k,1,stay} \ldots \forall k$) equation [8] becomes:

$$\begin{aligned} &\frac{Y_1}{L_1} - \frac{Y_0}{L_0} = \\ &\sum_{k=1}^{M} \frac{L_{k,0,stay}}{L_{0,stay}} \left(\frac{Y_{k,1,stay}}{L_{k,1,stay}} - \frac{Y_{k,0,stay}}{L_{k,0,stay}} \right) + \\ &\sum_{k=1}^{M} \frac{L_{k,1,hire}}{L_1} \left(\frac{Y_{k,1,hire}}{L_{k,1,hire}} - \frac{Y_{1,stay}}{L_{1,stay}} \right) + \\ &\sum_{k=1}^{M} \frac{L_{k,0,sepa}}{L_0} \left(\frac{Y_{0,stay}}{L_{0,stay}} - \frac{Y_{k,0,sepa}}{L_{k,0,sepa}} \right) \end{aligned} \qquad [9]$$

The first term on the right-hand side of equation [9] shows the productivity change between period 1 and period 0 that can be ascribed to the stayers. It can be interpreted as productivity growth due to the accumulation of specific human capital and/or experience (on-the-job learning). Note that that part of the overall labour productivity growth can vary by age group *k*.

The second set of terms (i.e. the differences between brackets) captures the productivity effects of hiring of workers in different age groups. Newly hired workers may be more productive than incumbents in period 1 because they are better educated. Adjustment costs related to the hiring of new employees are implicitly included in the above formulation. The relative productivity term in equation [9] should therefore be understood as productivity *net* of adjustment costs.

Finally, the third set of terms indicates the productivity effects of separations of workers according to their age group. Like hiring, separation of type *k* workers can have a net positive effect on overall

labour productivity when these workers' productivity is lower than that of the average incumbent worker in period 0. Similarly, the productivity impact of separations is net of adjustments costs. And these latter can be high in Belgium, particularly when firms dismiss workers who have been employed for many years.

Note finally that the left-hand term of equation [9] can be turned into a growth rate by dividing it by the average productivity level in the periods 0 and 1. On the right-hand side, the productivity effects of new hires or separations of workers in different age groups are thus expresses as fraction (percents) of the average labour productivity in the periods 0 and 1.

$$\frac{\Delta \frac{Y}{L}}{\frac{\overline{Y}}{L}} = \frac{\frac{Y_1}{L_1} - \frac{Y_0}{L_0}}{0.5\left(\frac{Y_1}{L_1} + \frac{Y_0}{L_0}\right)} \qquad [10]$$

A similar decomposition can be applied to the average labour cost level of the firm. In that case ,we just replace *Y* in the above equations by the firm's labour costs (or wages) *W*. This lead to equations that are similar to [9] and [10]. And the final outcome is a set of equations, decomposing the growth of both productivity and labour costs, that be used for analysing *i)* the specific contribution of different age groups and *ii)* the effect hires and separations.

These equations lead to the following econometric models:

$$\frac{\Delta \frac{Y}{L}}{\frac{\overline{Y}}{L}} = \alpha^{Prod} + \sum_{k=1}^{M} \beta_{k,stay}^{Prod} STAYSH_k + \sum_{k=1}^{M} \gamma_{k,hire}^{Prod} HR_k + \sum_{k=1}^{M} \chi_{k,sepa}^{Prod} SR_k + \delta^{Prod} Z + \varepsilon \qquad [11]$$

$$\frac{\Delta \frac{W}{L}}{\frac{\overline{W}}{L}} = \alpha^{Wage} + \sum_{k=1}^{M} \beta_{k,stay}^{Wage} STAYSH_k + \sum_{k=1}^{M} \gamma_{k,hire}^{Wage} HR_k + \sum_{k=1}^{M} \chi_{k,sepa}^{Wage} SR_k + \delta^{Wage} Z + \varepsilon \qquad [12]$$

where $STAYSH_k = \frac{L_{0,k,stay}}{L_{0,stay}} = \frac{L_{1,k,stay}}{L_{1,stay}}$ is the stare of staying workers from age group *k* ,and

$HR_k = \frac{L_{1,k,hire}}{L_1}$ and $SR_k = \frac{L_{0,k,sepa}}{L_0}$ are the hiring and separation rates. We can add a vector of control F variables to capture the influence of various exogenous factors (ie. sectoral and year dummies).

The estimated coefficients $\hat{\beta}, \hat{\gamma}, \hat{\chi}$ correspond to the productivity (and labour costs) differentials visible in equation [9]. On the hiring side the coefficient of main interest estimated with equations [11], [12] has the following interpretation:

$$\gamma^{Prod}_{k,hire} = \frac{\frac{Y_{k,1,hire}}{L_{k,1,hire}} - \frac{Y_{1,stay}}{L_{1,stay}}}{\frac{\overline{Y}}{\overline{L}}} \qquad [13]$$

i.e. it measures the productivity differential between the separated workers of age *k* and all stayers and expresses this differentials in percentage of the period 0 and 1 average productivity. On the separation side, the coefficients of interest are obtained analogously as

$$\chi^{Prod}_{k,hire} = \frac{\frac{Y_{0,stay}}{L_{0,stay}} - \frac{Y_{k,0,sepa}}{L_{k,0,sepa}}}{\frac{\overline{Y}}{\overline{L}}} \qquad [14]$$

and measure the relative productivity of the separated workers. The interpretation of the labour cost coefficients is similar.

The intercept α in [11] and [12] captures the growth rate in the reference age group (prime-age workers hereafter) among the stayers, whereas the estimated β_k for each of the other age groups shares $STAYSH_k$ capture productivity growth differentials vis-à-vis that reference group (idem for the equivalent coefficient in the labour cost equation).

Finally, if we consider that the growth rate for *profitability* can be expressed as the difference between the growth rates of the labour productivity (*Y/L*) and labour costs[9] (*W/L*).

[9] The measure of labour costs used in this paper, which was measured independently of net-value added, includes the value of all monetary compensations paid to the total labour force (both full- and part-time, permanent and temporary), including social security contributions paid by the employers, throughout the year. The summary statistics of the variables in the data set are presented in Table 1.

$$\frac{\Delta\Pi}{\overline{\Pi}} = \frac{\Delta\frac{Y}{L}}{\frac{\overline{Y}}{\overline{L}}} - \frac{\Delta\frac{W}{L}}{\frac{\overline{W}}{\overline{L}}} \qquad [15]$$

where $\overline{\Pi} =: 0.5(\Pi_0 + \Pi_1)$. By inserting [11] and [12] into [15], we obtain an econometric version of a profitability growth equation:

$$\frac{\Delta\Pi}{\overline{\Pi}} = \alpha^{Profit} + \sum_{k=1}^{M}\beta_{k,stay}^{Profit} STAYSH_k + \sum_{k=1}^{M}\gamma_{k,hire}^{Profit} HR_k + \sum_{k=1}^{M}\chi_{k,sepa}^{Profit} SR_k + \delta^{Profit} Z + \varepsilon \qquad [16]$$

where on the basis of [15], the following approximations hold

$$\begin{aligned} \beta_k^{Profit} &\approx \beta_k^{Prod} - \beta_k^{Wage} \\ \gamma_k^{Profit} &\approx \gamma_k^{Prod} - \gamma_k^{Wage} \\ \chi_k^{Profit} &\approx \chi_k^{Prod} - \chi_k^{Wage} \end{aligned} \qquad [17]$$

Our vector of control variables *F* comprises region (#3), year (#8), sector[10] (#76) plus *i)* capital per head growth rate (in order to account for what happens to the other key production factor) and *ii)* exploiting the panel structure of our data - first-observed value of dependent variable.

The three first variables allow for systematic and proportional productivity variation among firms along these dimensions and can be seen to expand the model by controlling for year- and sector-specific productivity shocks, labour quality and intensity of efficiency wages differentials across sectors and other sources of systematic productivity differentials (Hellerstein &Neumark, 1995; Vandenberghe, & Borowczyk Martins, 2010). More importantly, since the data set we used did not contain sector price deflators, the introduction of these sets of dummies can control for asymmetric variation in the price of firms' outputs at sector level. An extension along the same dimensions is made with respect to the labour costs equation. We recall that the labour costs equation is definitional: under the assumption of cost-minimizing firms that operate in the same competitive labour market, all workers in the same demographic categories earn the same wage. By introducing year, region and sector controls we consider the possibility that firms operate in year-, region- and

[10] NACE2 level. See Appendix for detailed list.

sector-specific labour markets[11] and, therefore, allow for wage variation along these dimensions. Of course, the assumption of segmented labour markets, implemented by adding linearly to the labour costs equation the set of dummies, is valid as long there is proportional variation in wages by age group along those dimensions (Hellerstein &Neumark, 1995).

Despite our use of control variables *F*, there remain many possible sources of bias (i.e. implying that ε is not entirely randomly distributed) when estimating equations [11],[12], and [16]. First, there can be time-invariant firm heterogeneity in the productivity and labour costs equation which is correlated with the firm's choice of labour input. In particular new firms often recruit more (young) workers. Henceforth, higher inflows of relatively young workers and intrinsically more productive equipment could be tied, creating spurious correlations. We believe, however, that our use of *growth rates* as dependent variables largely accounts for that problem. Like *within* of *first-difference* transformations, resorting to rates of change from period to period eliminates the contribution of a firm's time-invariant unobservables. Note also that a further control is provided by our inclusion of the first-observed value of the.dependent variable.

This said, from an econometric point of view using what amount to short panel data, the main challenge consists of dealing with the likely presence of a non-random short-tem component ($\boldsymbol{\omega}$) of the residual:

$$\varepsilon = \omega + \sigma \qquad [18]$$

$$cov(\omega, STAYSH) \neq 0,\ cov(\omega, SR)\ cov(\omega, HR) \neq 0,\ E(\sigma_{it})=0$$

In the literature on firm panels, this is know as causing *simultaneity or endogeneity bias* (Griliches & Mairesse, 1995). The underlying economics is intuitive. In the short run (i.e. between periods 0 and 1) firms could be confronted to productivity shocks, ω [18]; say, a positive(negative) shock due to a successful(missed) sales opportunity. Contrary to the econometrician, firms may know about this and respond by expanding (limiting) recruitment (less hires in general or among some specific age groups). This would generate a positive correlation between the importance of inflows and the productivity of firms, thereby leading to overestimated OLS estimates of γ.

To cope with this bias, we adopt here the approach pioneered by Levinsohn & Petrin (2003) and

[11] It is probably the sector dimension that is the most relevant in the case of Belgium.

used or more recently by Dostie (2006) or Vandenberghe & Waltenberg (2010). Their idea is that firms primarily respond to productivity shocks ω by adapting the volume of their *intermediate inputs*. Whenever such kind of information is available in a data set — which happens to be the case with ours — it can be used to proxy productivity shocks. An advantage with respect to more traditional approaches based on instruments[12] is that this method does not carry the burden of relying on instruments that lack a clear-cut economic meaning and which are typically weak.[13] Moreover, by using the LP method, the number of discretionary methodological choices that have to be made by the researchers is reduced, contributing to providing results which are easier to understand and to compare with others in the literature.[14]

Formally, the demand for intermediate inputs is assumed to be a function of productivity shocks as well as the level of capital:

$$int_{it} = I(\omega_{it}, k_{it}) \qquad [19]$$

Assuming this function is monotonic in ω and k, it can be inverted to deliver an expression of ω_{it} as a function of *int* and *k*. Expression (10) thus becomes:

$$y_{it} = A + \alpha\, l_{it} + \eta_1 P_{i1t} + \ldots \eta_N P_{iNt} + ß\, k_{it} + \gamma F_{it} + \theta_i + \omega_{it}(int_{it}) + \varepsilon_{it} \qquad [20]$$

with: $\omega_{it}(int_{it})$ that can be approximated by a polynomial expansion in *int*.

While the latter technique is our preferred one, we have decided to report results of different econometric techniques, because of the well-known challenges and controversies involved in the estimation of any production function (Griliches & Mairesse, 1995).

---

[12] Instrumenting the age by lagged values is a strategy regularly used in the production function literature (Arellano & Bond, 1991) to cope with this short-term simultaneity bias. The Finnish paper that is very similar to this one (Illmakunnas & Maliranta, 2007) uses regional aggregates to instrument firm-level hiring/separation rates. Hiring rates are instrumented by regional graduation rates. They are also instrumented with regional (lagged) separation rates assuming that past separation rates must increase hiring rates. Similarly, regional (lagged) hiring rates and used to predict firm-level separation rates. The authors also use regional homeownership data to instrument firm-level separation rates.

[13] That is instruments that are only weakly correlated with the included endogenous variables.

[14] For example, employing the Arellano-Bond method, Aubert & Crépon (2003) have used a different number of lags for labour (2 lags) and other variables (all lags). Although they chose to reduce the number of lags for labour in order not to inflate too much the orthogonality conditions, it is not clear what procedure has been used to set those lags on the specific values they have chosen. We do not know whether their main results would be robust to different lag choices.

3. Data

We are in possession of a panel of around 9,000 firms with more than 20 employees, that we follow between 1998 and 2006. The data are largely documented in terms of sector, location, size, capital used, labour cost levels, productivity and profits (Table 1). These observations come from the Belfirst database. Via the so-called Carrefour data warehouse, using firm identifiers, we have been able to inject information on 1,200,000 individuals[15] workers employed by these firms with a breakdown into three age groups (<35, 35-49 and >50). Just as in Aubert & Crépon (2003) and Dostie (2006), we have a measure of firms' productivity (the net valued added), which is measured independently from firms' labour costs.[16] The latter includes the value of all monetary compensations paid to the total labour force (both full- and part-time, permanent and temporary), including social security contributions paid by the employers, throughout the year. Using value-added and labour cost, we can compute estimates of profitability and relate the latter to the age structure of the firm. Figure 1 for instance depicts a negative correlation between (relative) profits and the age of workers.

Since our two databases are linked through firm identifiers, we do not need to assign workers to firms using statistical matching methods like in Hellerstein *et al.* (1999). Finally, contrary to Dostie (2006), we do have a measure of firms' capital stock, such that no imputation method is required.

Finally, intermediate inputs pay a key role in our econometric analysis, as they are central to our strategy to overcome the simultaneity bias. They are calculated here as the differences between the firm's turnover (in nominal terms) and its net value-added. They thus reflect the value of goods and services consumed or used up as inputs in production by our firms, including raw materials, services and various other operating expenses.

Table 1 show that the average number of linked employee per company is 122. Turning to the dependent variables, we see that the average nominal (annual) productivity growth is 2%. Over the same period, the average (annual) growth rate of labour costs has been 2.3%, implying that the growth rate of the profit per employee as receded a bit (-0.3%). The average hiring rate, which is the sum of the hiring rates of the three age group, is 19% and, similarly, the average separation rate is 15.5%. Young adults (<35) account for almost 42% of the staying employees, whereas the older

[15] This represents more than 1/3 of the total private employment in Belgium.

[16] Once we regress one variable against the other, we find that *net value added* = 1.43 *labour cost*.

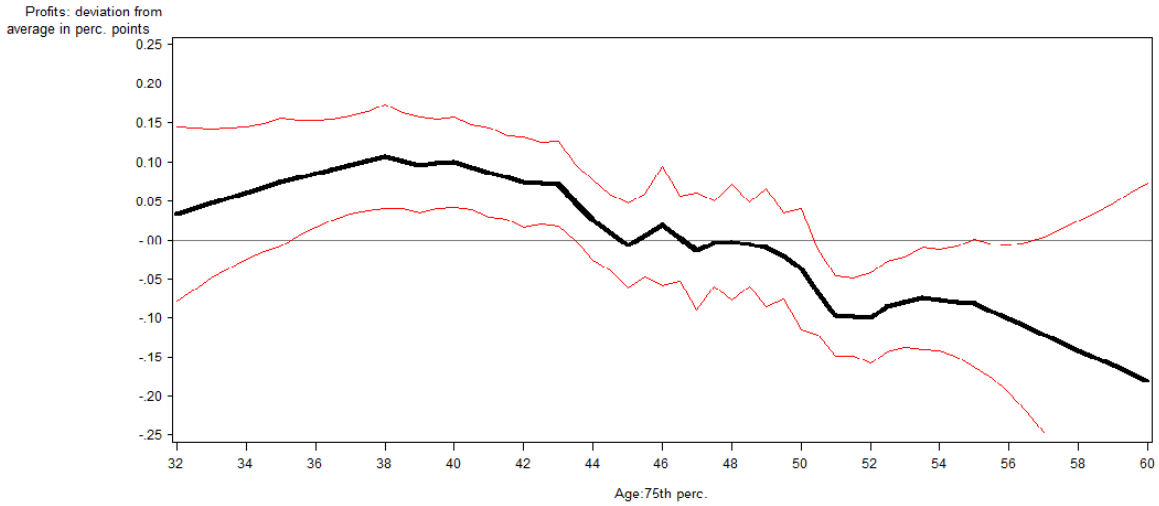
individuals (50+) account for 14.6% of that total.

Table 1 – Descriptive statistics of the estimation sample covering period 1998 to 2006 (growth rates are calculated on a year-to-year basis),

	N	Average	p10	p90
Average employment	77855	122.876	21	193
Labour productivity growth rate	67594	0.020	-0.190	0.226
Labour costs growth rate	68104	0.023	-0.073	0.121
Profitability growth rate	67590	-0.003	-0.182	0.175
Share of stayers aged <35	60564	0.419	0.200	0.676
Share of stayers aged 35-49	60564	0.435	0.257	0.597
Share of stayers aged 50+	60564	0.146	0.005	0.292
Hiring rate of individuals aged <35	61560	0.122	0.013	0.255
Hiring rate of individuals aged 35-49	61560	0.056	0.000	0.130
Hiring rate of individuals aged 50+	61560	0.011	0.000	0.036
Separation rate of individuals aged <35	60964	0.090	0.000	0.192
Separation rate of individuals aged 35-49	60964	0.047	0.000	0.106
Separation rate of individuals aged 50+	60964	0.018	0.000	0.049

Source: Belfirst, Carrefour

Figure 1 : Profits and age of workers (2.5% confidence interval). Period 1998-2006



Source: Belfirst, Carrefour

Note : Data on profits correspond to the ratio of per worker value added and per worker labour costs. These have been centered on the year- and sector-average (NACE 4 digits). The age variable correspond to the upper quartile (75th percentile of the intra-firm age distribution. The sample size is about 9000 and the results on display (profit per age average + confidence intervals) have been estimated using non-parametric regression techniques.

4. Econometric results

In Table 2 and Table 3 we present our main econometric estimates. Table 2 contains the OLS estimates whereas Table 3 those obtained using the LP intermediate good proxy strategy to control for potential short-term simultaneity bias (see Section 2). The entries in the third column are for a separate estimation for the profitability growth rate, but they are roughly equal to the differences of the entries for the productivity and the labour costs growth rates in the first two columns of results.

As to the contribution of stayers, the results with both OLS and LP (our preferred model) suggest that the contribution of young adults to productivity growth is equivalent to that of prime-age workers. The estimated coefficient — capturing the growth rate differential vis-à-vis the reference age group (35-45) — in the lower part of Table 2 and Table 3 are indeed close to zero (and statistically insignificant). The same results are supportive of a negative differential for the older workers. The OLS coefficient in Table 2 is -2.8 and statistically significant, suggesting that older staying workers' contribution to annual productivity growth is 2.8 percentage points lower that that of prime-age workers. The LS coefficient à -2, although is it is not statistically significant, also suggest a lower relative contribution of older workers to productivity. This said, the corresponding

coefficients for the labour cost equation are also negative, implying that the contribution of older workers in terms of profit growth becomes very difficult to differentiate from that of the prime-age workers.

We now turn to the *hiring side*. The results show that recruiting young adults (<35) has no strong and statistically significant effect on productivity or profits. OLS estimates suggest a small *positive* effect on both productivity and labour costs, implying no effect on profits. Similar results are derived from the LP estimation. This holds also for prime-age workers (35-49). By contrast, hiring older workers (50+) strongly reduces productivity. Our preferred LP estimates point as a (statistically significant) reduction of -13.8% (Table 3) of productivity growth. However, the inflow of older workers also translates into lower labour cost growth, implying no deterioration of profit performance.

The most interesting results are to be found on *separation side*. Exiting young adults (<35) have no impact on productivity growth, whereas exiting prime-age (35-49) workers and even more older workers (>50) contribute very positively. Point estimates stemming from the LP equation (Table 3) suggest that departing prime-age workers lead to a 8.8% improvement of annual productivity gains. The equivalent figure for older workers is 23.6%. What is more, for both prime-age and older workers, separation is synonymous of lowing labour cost (-7.9 and -8.4% respectively). These estimates suggest that departing prime-age and older employees have a *i)* lower productivity level that those who stay with the firm and *ii)* that they cost relatively more to employ. It is thus logical to observer in the third column of Table 3 that their departure contribute positively to profit performance (+17.4 and +32.1% respectively).

Table 2: Productivity, labour costs and profit equation. OLS estimates (p-values)

	Productivity	**Labour costs**	**Profits**
Hiring rate of individuals aged <35	0.0310	0.0413	-0.0093
	(0.0786)	(0.0009)	(0.5981)
Hiring rate of individuals aged 35-49	0.0263	0.0254	-0.0093
	(0.2678)	(0.1331)	(0.6954)
Hiring rate of individuals aged 50+	-0.2004	-0.1653	-0.0387
	(0.0001)	(0.0000)	(0.4449)
Separation rate of individuals aged <35	0.0144	-0.0174	0.0292
	(0.4595)	(0.2090)	(0.1348)
Separation rate of individuals aged 35-49	0.0950	-0.0653	0.1685
	(0.0003)	(0.0005)	(0.0000)
Separation rate of individuals aged 50+	**0.2213**	**-0.0421**	**0.2615**
	(0.0000)	(0.1755)	(0.0000)
Share of stayers aged <35	0.0060	-0.0007	0.0063
	(0.5574)	(0.9254)	(0.5419)
Share of stayers 50+	**-0.0281**	**-0.0141**	**-0.0131**
	(0.0497)	(0.1678)	(0.3608)

Source: Belfirst, Carrefour. Our calculus

Table 3: Productivity, labour costs and profit equation. LP estimates (p-values)

	Productivity	**Labour costs**	**Profits**
Hiring rate of individuals aged <35	0.0278	0.0449	-0.0174
	(0.1551)	(0.0014)	(0.3819)
Hiring rate of individuals aged <35	0.0422	0.0439	-0.0079
	(0.1154)	(0.0231)	(0.7733)
Hiring rate of individuals aged 50+	-0.1380	-0.1131	-0.0400
	(0.0172)	(0.0066)	(0.4959)
Separation rate of individuals aged <35	0.0236	-0.0126	0.0364
	(0.2767)	(0.4182)	(0.0985)
Separation rate of individuals aged 35-49	0.0882	-0.0793	0.1746
	(0.0029)	(0.0002)	(0.0000)
Separation rate of individuals aged 50+	**0.2362**	**-0.0844**	**0.3218**
	(0.0000)	(0.0172)	(0.0000)
Share of stayers aged <35	0.0084	0.0046	0.0043
	(0.4629)	(0.5760)	(0.7153)
Share of stayers aged 50+	**-0.0207**	**-0.0026**	**-0.0149**
	(0.2013)	(0.8273)	(0.3677)

Source: Belfirst, Carrefour. Our calculus

5. Conclusions

In this paper we combine two promising ways of analysing the relation ship between age and firm performance and improve our understanding of the labour market for older workers. First, using a strategy put forth by Illmakunnas & Maliranta (2007), we produce estimates of an age group's contribution to firm performances distinguishing what can be ascribed to those *i)* staying with the firm, *ii)* recruited by the firm or *iii)* separating from the firm. By contrast, many existing studies on ageing and firm performance only consider the age group as a whole (Hellerstein *et al.*, 1999; Aubert & Crépont, 2003; Dostie, 2006; Gründ & Westergård-Nielsen , 2008). Second, following Levinsohn & Petrin (2003), unobserved short-term productivity shocks potentially influencing hiring and separation decisions, and causing simultaneity bias, are proxied with intermediate consumption.

Results essentially show that separating older workers translate into significantly better performance for firms established in Belgium. The separation of individual older than 50 improves annual productivity growth by 23.6%. It also leads to lower annual progression of labour costs (-8.4%), implying almost mechanically, better profit performance (+32%). These results are compatible with the view that at end of the working career, labour costs exceed productivity. They are very supportive of the idea that the firms in Belgium face strong incentives to dismiss older workers.

References

Aghion, P. and Howitt, P., 1992. A model of growth through creative destruction, *Econometrica*, 60, pp. 323–351.

Arellano. M. and S. Bond (1991). "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations". *Review of Economic Studies*, No 58, pp. 277-97

Aubert. P. and B. Crépon (2003). "La productivité des salariés âgés : une tentative d'estimation". *Economie et Statistique*. 368. 95-119.

Becker, G. (1962), Investment in Human Capital: A Theoretical Analysis, *Journal of Political Economy*, 70(5), pp. 9.

Borowczyk Martins. D. and V.Vandenberghe (2010). Using Firm-Level Data to Assess Gender Wage Discrimination in the Belgian Labour Market. *mimeo*. Economics School of Louvain. IRES. UCL.

Börsch-Supan. A. (2006). "Introduction". In: Börsch-Supan. A.. A. Brugiavini. . Jürges. J. Mackenbach. J. Siegrist; G. Weber (eds.). *Health. ageing and retirement in Europe. First Results from the Survey of Health. Ageing and Retirement in Europe*. Mannheim Research Institute for the Economics of Aging

Costa. D. (1995). Pensions and Retirement: Evidence from Union Army Veterans. *The Quarterly Journal of Economics*. 110(2). pp. 297-319.

Crépon. B.. N. Deniau. et al. (2002). "Wages. Productivity. and Worker Characteristics: A French Perspective.". *Serie des Documents de Travail du CREST*. Institut National de la Statistique et des Etudes ´Economiques.

Currie. J. and B.C. Madrian (1999). "Health. health insurance and the labor market". In: Ashenfelter. O. and D. Card (eds.) *Handbook of Labor Economics*. vol. 3C. North-Holland: Elsevier. pp. 3309-3416

Daniel. K. and J.S. Heywood (2007). "The determinants of hiring older workers: UK evidence". *Labour Economics*. n.14. p.35-51

de la Croix. D. and P. Pestiau (2007). "Réformer le système des retraites belge". *Regards Economiques* n° 51

Dostie. B. (2006), Wages. Productivity and Aging. *IZA. Discussion Paper No. 2496*. Bonn.

Germany.

Dorn, D. & A. Sousa-Poza, (2010), Voluntary' and 'involuntary' early retirement: an international analysis, *Applied Economics*, Taylor and Francis Journals, 42(4), pp. 427-438

Fair. R. C. (1994) "How fast do old men slow down?". *The Review of Economics and Statistics*. 76 (1): 103-118

Griliches. Z. and J. Mairesse (1995). Production functions: the search for identification. *NBER working paper, No 5067*, NBER, Ma.

Gruber, J. and D. A. Wise (Eds) (2004), *Social Security Programs and Retirement around the World: Micro-Estimation*, NBER Book Series - International Social Security, University of Chicago Press.

Grund and Westergård-Nielsen (2008). *International Journal of Manpower*. Vol. 29(5). pp. 410-422.

Hellerstein. J.K. and Neumark. D. (1995). 'Are Earning Profiles Steeper than Productivity Profiles: Evidence from Israeli Firm-Level Data'. *The Journal of Human Resources*. vol. 30. 1. pp. 89-112.

Hellerstein. J.; Neumark. D.; Troske. K. (1999). Wages. Productivity. and Worker Characteristics: Evidence from Plant-Level Production Functions and Wage Equations. *Journal of Labor Economics*. Vol. 17 (3). pp. 409-446

Ilmakunnas, P. and M. Maliranta, (2007), Ageing, Labour Turnovers and Firm Performance, *ETLA DP*, No 102, The Research Institute of the Finnish Economy, Helsinki

Kalwij. A. and F. Vermeulen (2008). "Health and labour force participation of older people in Europe: what do objective health indicators add to the analysis?". *Health Economics*. Vol. 17(5). May 2008. pp. 619-638

Lazear. E. (1979) "Why is there mandatory retirement?". *Journal of Political Economy*. vol. 87. n.6. pp. 1261-1284

Levinsohn. J. and A. Petrin (2003). Estimating production functions using inputs to control for unobservables. *Review of Economic Studies*. 70 (2). 317-341

Lumsdaine. R. and O. Mitchell (1999). "New development in the economic analysis of retirement". In: Ashenfelter. O. and D. Card (eds.) *Handbook of Labor Economics*. vol. 3C. North-Holland: Elsevier. pp. 3261-3307

Malmberg. B. Lindh. T & Halvarsson. M.. (2005**).** Productivity consequences of workforce ageing - Stagnation or a Horndal effect?. *Arbetsrapport* No 2005:17. Institute for Futures Studies. Stockholm.

Mincer. J. (1994). "Human Capital: a Review". In: Kerr. Clark. Staudohar. Paul (ed.). *Labor economics and industrial relations: Markets and institutions*. Cambridge. Mass. and London: Harvard University Press. 109-141.

Mirrlees. J. (1997). Information and Incentives: The Economics of Carrots and Sticks. *The Economic Journal*. 107(444). pp. 1311-1329.

Mitchell, O.S. and G. S. Fields (1983), The Economics of Retirement Behavior, *NBER working paper*, No 1128, NBER, Ma.

Mitchell, O.S., (1988), The relation of age to workplace injuries, *Monthly labor review*, 111, pp. 8-13.

Neal. D. and S. Rosen. (2000). "Theories of the distribution of earnings". In: Atkinson. A. and F. Bourguignon (eds.), *Handbook of Income Distribution*. vol. 1. North-Holland: Elsevier, pp. 379-427.

Roodman. D. (2006) "How to Do xtabond2". *unpublished note*

Roodman. D. (2003) "XTABOND2: Stata module to extend xtabond dynamic panel data estimator". updated in 2008. (available at: *http://ideas.repec.org/c/boc/bocode/s435901.html*).

Scarpetta, S. & P. Hemmings & T. Tressel & J. Woo (2002), The Role of Policy and Institutions for Productivity and Firm Dynamics: Evidence from Micro and Industry Data, *OECD Economics Department Working Papers*, No 329, OECD, Economics Department

Smith. S.P. (1991). Ending Mandatory Retirement in the Arts and Sciences. *American Economic Review*. 81(2). pp. 106-110.

Shapiro. C. and J.E. Stiglitz (1984). Equilibrium Unemployment as a Worker Discipline Device. *The American Economic Review*. 74(3). pp. 433-444.

Skirbekk, V. (2004). Age and Individual Productivity: A Literature Survey. In G. Feichtinger (Ed.), Vienna Yearbook of Population Research 2004 (pp. 133-153). Vienna: Austrian Academy of Sciences Press.

Skirbekk, V. (2008), Age and productivity capacity: Descriptions, causes and policy options, *Ageing Horizons*, 8, pp. 4-12.

Sneessens. H. and B. Van der Linden (2005). "Les préretraites: une méthode efficace de gestion des carriers et de l'emploi? " *Regards Economiques*, No 33, IRES, Université catholique de Louvain.

The Economist (2010), The silver tsunami. Business will have to learn how to manage an ageing workforce, *The Economist*, Schumpeter column, Feb. 6th.

Vandenberghe, V & D. Borowczyk Martins (2010), Using Firm-Level Data to Assess Gender Wage Discrimination in the Belgian Labour Market (2010) IRES WP, No 2010-7, Economics School of Louvain, UCL, Louvain-la-Neuve.

Vandenberghe, V & F. Waltenberg (2010), Ageing Workforce, Productivity and Labour costs of Belgian Firms (2010), IRES WP, No 2010-3, Economics Schoool of Louvain, UCL, Louvain-la-Neuve.

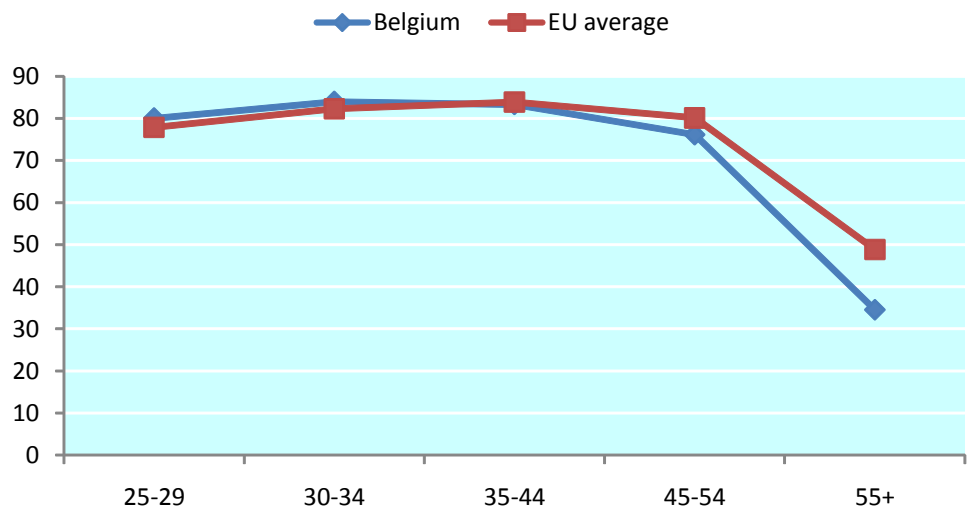
van Ours, J.C & Stoeldraijer, L. (2010), Age, Wage and Productivity, *IZA Discussion Papers* 4765, Institute for the Study of Labor (IZA), Bonn.

Volkoff. S. A.-F. Molinié et A. Jolivet (2000). "Efficaces à tout âge ? Vieillissement démographique et activités de travail. " *Dossier n° 16*. Centre d'Etudes de l'Emploi.

Weesie. J. (2000). 'Seemingly Unrelated Estimation and the Cluster-adjusted Sandwich Estimator'. *Stata Technical Bulletin*. 9(52). pp. 34-46.

Wooldridge. J. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge. Mass.: MIT Press.

Annex 1 – Age and employment rate. Belgium vs. EU, 2008



Source : EU Labour Force Survey

Annex 2: Sectors (Industry. Commerce and Service) and NACE2 codes/definitions

10="I_Industries alimentaires "
11="I_Fabrication de boissons"
12="I_Fabrication de produits à base de tabac"
13="I_Fabrication de textiles"
14="I_Industrie de l'habillement"
15="I_Industrie du cuir et de la chaussure"
16="I_Travail du bois et fabrication d'articles en bois et en liège, à l'exception des meubles; fabrication d'articles en vannerie et sparterie"
17="I_Industrie du papier et du carton"
18="I_Imprimerie et reproduction d'enregistrements"
19="I_Cokéfaction et raffinage"
20="I_Industrie chimique"
21="I_Industrie pharmaceutique"
22="I_Fabrication de produits en caoutchouc et en plastique"
23="I_Fabrication d'autres produits minéraux non métalliques"
24="I_Métallurgie"
25="I_Fabrication de produits métalliques, à l'exception des machines et des équipements"
26="I_Fabrication de produits informatiques, électroniques et optiques"
27="I_Fabrication d'équipements électriques"
28="I_Fabrication de machines et d'équipements n.c.a."
29="I_Construction et assemblage de véhicules automobiles, de remorques et de semi-remorques"
30="I_Fabrication d'autres matériels de transport"
31="I_Fabrication de meubles"
32="I_Autres industries manufacturières"
33="I_Réparation et installation de machines et d'équipements"
35="I_Production et distribution d'électricité, de gaz, de vapeur et d'air conditionné"
36="I_Captage, traitement et distribution d'eau"
37="I_Collecte et traitement des eaux usées"
38="I_Collecte, traitement et élimination des déchets; récupération"
39="I_Dépollution et autres services de gestion des déchets"
41="I_Construction de bâtiments; promotion immobilière"
42="I_Génie civil"
43="I_Travaux de construction spécialisés"

45="C_Commerce de gros et de détail et réparation véhicules automobiles et de motocycles"
46="C_Commerce de gros, à l'exception des véhicules automobiles et des motocycles"
47="C_Commerce de détail, à l'exception des véhicules automobiles et des motocycles"

49="S_Transports terrestres et transport par conduites"
50="S_Transports par eau"
51="S_Transports aériens"
52="S_Entreposage et services auxiliaires des transports"
53="S_Activités de poste et de courrier"
55="S_Hébergement"
56="S_Restauration"
58="S_Édition"

59="S_Production de films cinématographiques, de vidéo et de programmes de télévision; enregistrement sonore et édition musicale"
60="S_Programmation et diffusion de programmes de radio et de télévision"
61="S_Télécommunications"
62="S_Programmation, conseil et autres activités informatiques"
63="S_Services d'information"
64="S_Activités des services financiers, hors assurance et caisses de retraite"
65="S_Assurance, réassurance et caisses de retraite, à l'exclusion des assurances sociales obligatoires"
66="S_Activités auxiliaires de services financiers et d'assurance"
68="S_Activités immobilières"
69="S_Activités juridiques et comptables"
70="S_Activités des sièges sociaux; conseil de gestion"
71="S_Activités d'architecture et d'ingénierie; activités de contrôle et analyses techniques"
72="S_Recherche-développement scientifique"
73="S_Publicité et études de marché"
74="S_Autres activités spécialisées, scientifiques et techniques"
75="S_Activités vétérinaires"
77="S_Activités de location et location-bail"
78="S_Activités liées à l'emploi"
79="S_Activités des agences de voyage, voyagistes, services de réservation et activités connexes"
80="S_Enquêtes et sécurité"
81="S_Services relatifs aux bâtiments; aménagement paysager"
82="S_Services administratifs de bureau et autres activités de soutien aux entreprises"
92="S_Organisation de jeux de hasard et d'argent"
93="S_Activités sportives, récréatives et de loisirs"
94="S_Activités des organisations associatives"
95="S_Réparation d'ordinateurs et de biens personnels et domestiques"
96="S_Autres services personnels"
97="S_Activités des ménages en tant qu'employeurs de personnel domestique"
98="S_Activités indifférenciées des ménages en tant que producteurs de biens et services pour usage propre"
99="S_Activités des organisations et organismes extraterritoriaux"