Productivity, sunk costs and firm exit in the French food industry

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1. Introduction

Firm demography (including both firm entry and exit) is a major component of industry dynamics. Bartelsman *et al.* (2005) show that the firm turnover rate (calculated as the national average rate of entry plus exit, over the period 1989-1994) varies from 16% in the Netherlands to 23% in the United States. Behind the apparent inertia of the stock (the number of existing units at a given date), such important flows deeply modify the distribution of firms by industry, size, location and performance. Food industry is particularly concerned by such demographic processes for several reasons. Some concern the demand side, where change in consumer's tastes or regulatory environment may affect the industry dynamics. Some others are linked to the situation of agro-food chain: firms (that are often small ones) may be affected by both the volatility of agricultural prices and the pressure of downward retailers.

There is a large body of empirical literature devoted to firm exit, as shown by Caves (1998). Until recently, most studies have highlighted the influence of a particular set of determinants (such as firm characteristics, industry, period...). However, following the theoretical contributions of Jovanovic (1982), Hoppenhayn (1992) and Ericson and Pakes (1995) (EP95 hereafter), some empirical studies have proposed to assess the contribution of firm exits to the industry dynamics. Olley and Pakes (1996) study (OP96 hereafter) is one of the most widely used. This study proposes an estimation of the unobserved individual efficiency of the firm, which is introduced after as a determinant of the firm's probability of exit. Clearly, if exit is the expression of a market selection process, the less efficient the firm, the higher its probability of exiting. Such a prediction is widely confirmed by empirical studies. Farinas and Ruano (2005) focus on Spain and find that exiting firms exhibit significantly lower productivity levels than other firms. Bellone *et al.* (2006) analyze post-entry and pre-exit performances of French manufacturing firms and also show that exiters are less efficient than firms still in activity. Frazer (2005) and Shiferaw (2009) find similar results in the case of developing countries (namely Ghana and Ethiopia): only the more efficient firms can survive. Griliches and Regev (1995) and Almus (2004) suggest that this relationship between efficiency and exit may reflect what is called the "Shadow of Death" effect: a lower (and lowering) efficiency would be a symptom of the imminent exit of the firm.

Following this line of research, the aim of our study is to analyse the exit process of the firms in French food industries, using a large unbalanced panel data set of 5,851 firms over the period 1996-2002. We start with the EP95 model and use the semi-parametric method initially developed by OP96 to estimate unobserved individual firm efficiency. Then, this variable is used as a determinant of the probability of exit, in addition to the usual state variables, such as age. But, furthermore, we introduce two supplementary variables, sunk costs and industry concentration.

Sunk costs play an important role in the theoretical models of industry dynamics, as entry barriers for new firms but also as barriers to exit for incumbents (see for example Dixit, 1989; Lambson, 1992; Sutton, 1991; Hopenhayn, 1992; Cabral, 1995). Such predictions are confirmed by numerous empirical tests (Kessides, 1990; Dunne and Roberts, 1991; Farinas and Ruano, 2005, Hölzl, 2005, Gschwandtner and Lambson, 2002, Fotopoulos and Spence, 1998) which find that capital requirements are barriers to exit. In this study we propose an original measurement of these costs, mainly based on the firm's amount of investment and capital, but weighted with several coefficients industry parameters, taking into account leasing, capital depreciation and the resale of second hand equipment.

Our main findings are the following. First, our summary statistics provide evidence for both literature results and expected patterns. The 1996-2002 average annual exit rate equals 6.5% when considering the all food industry. But such a rate greatly varies between industries: while the value is between 4 and 5% for many industries (as *Oils and Fats*, *Dairy Products*, *Grain Products* or *Beverages*) it is more than 8.0% in *Other Food Products* being upper than 10% in some particular sub industries as Sugar Manufacturing or even than 16% in *Bread and pastry goods and cakes shops*.

The goal of our estimation is primarily to explain such differences both between and within industries in terms of exit rate. But, doing this, we first provide some presumably unbiased estimates of the production function. Compared to the OLS and within results, the estimates obtained by using the OP96 method are significantly different: the estimated capital elasticity is higher, while the labor elasticity is lower. This is consistent with the literature devoted to simultaneity and selection bias in production function estimations (Levinsohn and Petrin, 2003). But, our more important findings concern the exit function; the exit probability of firms is negatively and significantly correlated with the individual firm productivity, the firm age and the industry concentration. These results are consistent with the predictions of the theoretical model and with previous studies using similar methods. The original result offered by this study is that, after controlling for these three variables, sunk costs play a significant and negative role: the higher the sunk costs level, the lower the firm propensity to exit. The low magnitude of this effect, which is associated with the large dispersion of the variable value between firms, suggest that this effect is generally light but may become very strong in the particular cases of industries with high sunk costs amounts, as *Grain products* opposed to *Meat*, for instance. In summary, concentration index and sunk costs may explain differences in exit rates between industries, opposing "inert" versus "turbulent" industries, while age and individual efficiency may explain the residual variability observed between firms within an industry.

The rest of this paper is organized as follows: Section 2 introduces the economic model, and Section 3 presents the econometric methods. Data and some summary statistics are introduced in Section 4, while in Section 5; estimation results are provided and analyzed. Section 6 concludes.

2. The economic model

Ericson and Pakes (1995) provide the theoretical model underlying the Olley and Pakes (1996) approach. Their aim is to explain the great variability observed between firms in terms of their performance level, including entry and exit processes. To do so, these authors incorporate, in addition to the usual state variables of the firm (i.e. capital, labour and age), a new variable ω_{it}. ω_{it} is defined as the individual efficiency of the firm *i* observed at the period *t* and explains all the unobserved heterogeneity between firms.

In such a model, entry and exit processes are natural components of industry dynamics. Entrants must invest, in order to explore and then exploit an opportunity offered by the industry. At the same time, at the beginning of any period *t*, the incumbent firm must make two decisions. First, it must decide to continue or exit the industry. Second, if it decides to stay, it must decide how much to invest.

To make the first decision, the firm compares ϕ, which is the cost of remaining in activity (the sell-off value) and *(EDP)*, which is the expected present discount value of activity profit, according to optimal future decisions concerning investment. The Bellman equation is:

$$V_{it}(\omega_{it}, K_{it}, a_{it}) = \max\left\{\phi_{it}, EDP_{it}\right\}, \tag{1}$$

with:

$$EDP_{it} = \max_{I_{it}} \pi(\omega_{it}, K_{it}, a_{it}) - c(I_{it}) + rE\left[V_{it+1}(\omega_{it+1,} K_{it+1}, a_{it+1}) \middle| J_{it}\right], \tag{2}$$

where $\pi(.)$ is the profit of the current period, gross of the investment cost $c(I_{it})$, K_{it} is the capital, a_{it} is the age of the firm and ω_{it} its individual unobserved efficiency. $E(.)$ is the expectation operator, r is a discount factor and J_{it} is the information set available at time t. $V_{it+1}(\omega_{it+1}, K_{it+1})$ is the discounted value at time $t+1$ of the future cash flows of the firm. K_{it} the current capital stock, follows the accumulation equation which includes the rate of capital depreciation δ:

$$K_{it+1} = (1-\delta)K_{it} + I_{it}, \tag{3}$$

The exit rule is based on the comparison between the sell-off value ϕ and the optimal expected discounted profits EDP_{it}, depending on the value of $V_{it}(\omega_{it}, K_{it}, a_{it})$. If the first term is greater than the second, the firm leaves the industry otherwise it stays in. Let z be a decision variable such that $z = 1$ $(z = 0)$ if the firm decides to exit (stay on) the market. Then, the exit rule can be written as,

$$z = \begin{cases} 1 & if \quad \phi_{it} > EDP_{it} \\ 0 & \text{otherwise} \end{cases}, \tag{4}$$

Second, if the firm decides to stay in the industry, it has to choose the level of its investment I_{it} that maximizes EDP_{it}, in relation to the usual state variables capital and age, but also to the unobserved individual efficiency:

$$I_{it} = I(K_{it}, \omega_{it}, a_{it}) \tag{5}$$

We introduce two new variables in this model, namely sunk costs and industry concentration. Sunk costs occur, first, when the firm enters to explore the opportunities that are offered in the industry and, second, as a part of the investment cost for each period *t*. Sunk costs play a role as entry barriers for potential new entrants and as exit barriers for incumbents. Several theoretical arguments may be provided in order to motive this second point. First, sunk costs are supposed to increase the firm future profits: past costs can generate future earnings, by increasing the firm efficiency (Hopenhayn, 1992). Such potential earnings would be lost in case of exit. By increasing the cost of entry, sunk costs create a zone of inaction (Dixit, 1989) where entrants are less likely to enter and where pressure to exit is lower for incumbents. Finally, the sell-off value of the firm may also be affected by sunk costs, particularly when considering "endogenous" sunk costs (Sutton, 1991), as advertising or R&D expenses: a potential buyer may be interested into acquiring brands or technological know-how. Then, both the sell-off value and the expected profits may be affected by the level of these costs. Now, when considering the effect of the second variable, concentration, studies about industry life cycles (Klepper and Miller, 1995; Klepper and Simons, 2005) show that the industry and exit rates greatly depend on the development stage of the industry. Once the *shakeout* process has occurred, a few numbers of firms stay in the industry, concentration degree increases and both entry and exit rates fall. All this suggest rewriting equation (1) under the form:

$$V_{it}(\omega_{it}, K_{it}, a_{it}) = \max\left\{\phi_{it}, EDP_{it}\right\} = f(\omega_{it}, K_{it}, a_{it}, Conc_{it}, SC_{it}), \tag{6}$$

The inclusion of sunk costs and industry concentration completes the theoretical model and allows for a more precise identification of resulting firm heterogeneity through the non-observable individual efficiency ω_{it}.

3. The econometric model

Our goal is to estimate the exit model of firm *i* observed during period *t*:

$$\Pr(Exit_{it}) = f(\omega_{it}, a_{it}, Conc_{it}, SC_{it}, X_{it}), \quad (7)$$

The probability of a firm's exit depends on the individual firm's efficiency, age, level of sunk costs, the industry concentration and some control variables X_{it}, namely industry and time dummies. But ω_{it} cannot be directly observed and has to be estimated by using a production function. In the case of a Cobb-Douglas technology, one may write:

$$\log Y_{it} = \beta_0 + \beta_l \log L_{it} + \beta_k \log K_{it} + \beta_a a_{it} + \omega_{it} + \varepsilon_{it}, \quad (8)$$

Y_{it} is the output of firm i observed at period t, L_{it} is the labor input, K_{it} is the capital input, a_{it} is the age of the firm, and ω_{it} is the individual efficiency, a state variable for the firm's decision, which is known by the firm, but non observed by the econometrician, while ε_{it} is the usual error-term, associated to a non-predictable productivity shock.

It is well known that standard econometric methods, such as OLS, provide biased and inconsistent estimates of the previous production function for (at least) two reasons: simultaneity between output and inputs and selection bias resulting from the exit process[1]. Several methods exist to address these problems, (or at least one), including current panel data estimators, such as within estimator, IV and GMM estimators, and semi-parametric methods, such as the OP96 method, or some extensions of it (Levinsohn and Petrin, 2003; Ackerberg *et al.*, 2006)[2]. In this study we use the OP96 approach, modified as suggested by Levinsohn and Petrin (2003): intermediate consumption *M* is used instead of investment[3] when estimating the unobserved efficiency:

$$\omega_{it} = M^{-1}(M_{it}, K_{it}, Conc_{it}, SC_{it}, a_{it}) = h(M_{it}, K_{it}, Conc_{it}, SC_{it}, a_{it}), \quad (9)$$

Following this and taking into account the introduction of two new variables (namely sunk costs and industry concentration) the OP96 method is implemented as follows. At the first step, one estimates a reduced exit equation:

$$\Pr(Exit_{it}) = f(K_{it}, a_{it}, Conc_{it}, SC_{it}, X_{it}), \quad (10)$$

This provides $\widehat{p_{it}}$ which is the predicted exit probability of firm *i* during period *t*. The second step consists of the estimation of the labor coefficient β_l, which is the only flexible input. The third step consists in writing:

$$\log Y_{it} = \widehat{\beta_l} \log L_{it} + g(Conc_{it}, SC_{it}, \log M_{it}, a_{it}, \log K_{it}, \widehat{p_{it}}) + \eta_{it}, \quad (11)$$

Being non-parametric, g is estimated using a second-order polynomial series. At this step $\beta_k, \beta_a, \beta_{comp}$ and β_{SC} are estimated and the difference between output and its fitted value from the second and third steps yields an estimate of the individual firm's efficiency, $\widehat{\omega_{it}}$. The fourth and final step is the estimation of the exit model from equation 9, including the estimated value of the individual firm's efficiency beside to other variables: the firm age, sunk costs level, the industry concentration, and industry and time dummies.

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1 Some other reasons may exist, that are not taken into account in this study. As one example, Katayama *et al.* (2009) claim that severe measurement errors of both output and inputs occur, when applying to differentiated products industries.

2 Many surveys have been proposed regarding the different ways to estimate total factor productivity. Van Beveren (2007) proposes an empirical application to the case of Belgian food industries.

3 The inversion of *M* in equation 9 is possible when using intermediate consumption, while it is not always the case when using investment which may be equal to 0.

$$\Pr(Exit_{it}) = f(\widehat{\omega}_{it}, a_{it}, SC_{it}, Conc_{it}, Ind_{it}, Year_{it}) \quad (12)$$

4. Data and summary statistics

Our database contains 26,466 observations. This is an unbalanced panel of 5,851 firms from the French food industry, observed during the period 1996-2002. The data are obtained from annual surveys about firms' activity ("*Enquête annuelle d'entreprises*", *EAE* thereafter) which is the official French business-level data collected by the French Office of National Statistics (INSEE), and, in the case of the food industry, by the Statistical Department of the French Agriculture Ministry. This survey only includes firms that employ at least 20 employees.

4.1. The construction of the variables

Using the standard definitions of exit, an incumbent at period t is a firm that is present both during the current year t and the next year $t+1$, while a firm which exits at period t is in the market in year t but not in $t+1$ [4]. The EAE survey has a limit with respect to this measurement of exit: it does not allow any distinction about the reason of exit. A firm may exit from the survey for several reasons: closure, merging or acquisition but also exclusion because of the survey selection rules (size, industry).

Concerning the other variables, we deflate the value-added of firm i operating in sector j at time t by the annual price index of value-added. As a measure of capital used by firm i, we compute the sum of the value of fixed assets at the end of the year and the leased capital. This sum is deflated by the annual price index of capital. Intermediate consumption is deflated by the annual price index of intermediate consumption. Labour input in firm i at time t is the number of its employees at the end of the year. The investment deflated by the annual price index of gross fixed capital formation is used to build the capital series when the value of fixed assets is only available either at the beginning or at the end of the period.

The concentration in the industry is measured by the Herfindahl-Hirschman concentration index calculated from the initial database for each industry s (at the NACE 2, at the 3-digit level) observed at period t:

$$Herf_{st} = \sum_{i=1}^{i=N_{st}} \left(\frac{VA_{it}}{\sum_{i=1}^{i=N_{st}} VA_{it}}\right)^2, \quad (13)$$

We pay particular attention to the sunk costs variable and propose the following indicator:

$$Sunk_{it} = (1-\rho_{st})\left[cI_{it} + c(1-\delta_{st})(1-\alpha_{st}\frac{s_{st}}{c})K_{t-1}\right], \quad (14)$$

During the current period, the sunk cost of a firm is a function of its current investment I_{it} and the lagged value of physical capital K_{it-1}, with several underlying assumptions. First, the firm may lease ρ_{st} percent of its current physical capital K_{it}, such that only the fraction $1-\rho_{st}$ is related to sunk costs. Second, physical capital is affected by a depreciation rate of δ_{st} percent each period. Third, a firm may sell α_{st} percent of its physical capital on the second-hand market at the end of each period at a price s_{st}. From the information available in our database, we can build some proxies for δ_{st}, ρ_{st} and $\alpha_{st}\frac{s_{st}}{c}$. Thus, δ_{st} is built as the ratio between the destructed capital during the current period over the capital stock available at the beginning of the period K_{t-1}. ρ_{st} is approximated by the rental payments divided by the capital in value while $\alpha_{st}\frac{s_{st}}{c}$ is the ratio of the value of used capital sold on the second-hand market over the value of capital. These three variables are assumed to vary over time but are fixed at the industry level, no data being available at the firm level. To sum up, sunk costs will first differ between industries, being low for industries using assets that can be easily leased, have depreciation rate and can be found on a large second-hand market. Such measurement suggests that the more specific the assets, the higher the sunk costs. On

[4] Our database ends in 2002 but information about the presence of a firm in an industry is available till 2003.

a second step, these industry coefficients are applied to firm level variables (investment and capital), and by this the outcome will differ between firms within a given industry.

4.2. Summary statistics

Food industry represents a significant part of manufacturing, in France as well as in many other countries. By the same time, as Food Industry is composed of very different sectors, the effect of the different factors can be clearly observed. Such a situation is clearly emphasized by the statistics of Table 1.

[*Table 1*]

The global average exit rate equals 6.5% of firms per year in the French food industry when considering the 1996-2002 period. This value is in accordance with findings in the literature of firm demography (Bartelsman *et al.*, 2005), in the case of a sample of manufacturing firms excluding the very small firms (less than 20 employees). Furthermore, a great variability in terms of exit rates exists between the sectors composing the food industry. This rate varies between 4.14% and 8.39% with respect to the NACE 3-digit level[5]. A brief classification can be made between:

- The set of industries with a low exit rate (smaller than 5 %): *Oils and fats*, *Dairy Products, Grain Products* and *Beverages*;
- The set of industries with a medium exit rate (between 5 and 6 %): *Meat*, *Fruits and vegetables* products and *Animal feeds*;
- An industry with a very high exit rate: *Other food products*. However, this 3-digit level class is a very heterogeneous one, composed of very different 4-digit level industries. The high value of the exit rate is mainly due to three 4-digit sectors. Two (*Cooking and Bakeries products* and *Bread and pastry goods and cakes shops*) are closer to service activities than to manufacturing both in terms of products and firm's size. The third industry is *Sugar manufacturing*, a declining one, where exit rate largely exceeds entry rate.

An apparent negative correlation exists at the industry level between the exit rate, and the two variables, *size* and *age*, which are commonly used in the empirical literature as determinants of firm survival (Caves, 1998). But this is also clearly the case of the two variables that we introduce *concentration* and *sunk costs*. By the way, one may note the great heterogeneity within food industry between the different 3-digit level sectors in terms of concentration and above all of sunk costs[6].

5. The estimation results

A primary interest of the OP96 approach is to provide unbiased estimates for input coefficients in the production function, in contrasts to OLS estimates which suffers from both endogeneity and selection biases, as well as to the Within estimator, which corrects the simultaneity bias[7] but not the selection one.

[*Table 2*]

Significant differences appear in Table 2 between the results obtained with the different estimators. Such differences are consistent with results provided by the literature devoted to the biases in production function estimation. Simultaneity leads to an upward-biased estimation of the labour estimate and to a downward biased estimation of the capital estimate (Levinsohn and Petrin, 2003). Selection bias has the opposite effect: labour coefficient is underestimated while capital coefficient is upper estimated. The relative position of the different estimates depends on the respective magnitudes of the two biases.

Coming back to our primary interest, the individual firm productivity $\hat{\omega}_{it}$, as estimated in the previous step, is now included as a regressor in the exit equation estimated as a probit model. The results

[5] The corresponding results are available at the 4-digit level upon request.

[6] The examination of the firm-level results shows that there is also a large persistent heterogeneity between firms within a given sector.

[7] One should also note that Within and OP96 corrections of simultaneity differ (time-invariant versus time-varying individual effects).

of this estimation are presented in Table 3, which provides both coefficient estimates and marginal effects[8], allowing for a direct even cautious comparison of the impact of the different variables on the probability of exit.

[*Table 3*]

First, the coefficient of $\hat{\omega}_{it}$ is significantly negative and close to -0.2: the more efficient the firm, the more protected against the risk of exit. This result is consistent with theoretical predictions. As exit process is the result of market selection, the least efficient producers are the first to be eliminated. Similar results may be found in previous empirical studies. OP96 obtain a significant value of -0.16 in the case of the American telecommunications equipment industry, observed during the 1980s. Exploring a very different context, namely the Ghana, Kenya and Tanzania manufacturing firms, Söderbom *et al.* (2006) obtain a negative estimate equal to -0.239. Using the hazard survival rate, Shiferaw (2009) finds a positive estimate for the productivity variable in the case of the private manufacturing sector in Ethiopia, during 1996-2002. Our results also show that the probability of exit is negatively and significantly correlated to the age of the firm. Such a result is consistent both with numerous empirical results and with theoretical models based on the effect of "learning by doing" (Jovanovic, 1982). However it is interesting to compare the marginal effects of individual efficiency and age. The effect of the former is clearly stronger; a 1% increase in efficiency leads to a 2.28% decrease in exit probability, which is about 20 times more than the effect of one additional year of existence of the firm. One may conclude that most of the experience effect is captured by unobserved individual efficiency, with age being a poor proxy. As in R&D models, the absorption capacity of the firm which is largely based upon unobserved characteristics, would greatly improve the effect of experience and then represent a component of unobserved firm efficiency.

A significant negative estimate is obtained for the variable *Concentration*: a higher degree of concentration in the industry clearly reduces the firm probability to exit. This result is consistent with findings about industry life cycles, and more precisely with the so-called "Shakeout" literature (Klepper and Miller, 1995; Klepper and Simons, 2005). When competition is the more intense in an industry, a great number of exits occur. Once this Shakeout period ends, the industry is more concentrated and the exit rate decreases. In the French case, *Meat* industry is an example of the first kind of situation while *Oil and Fats* reflects the second. The effect of sunk costs on exit probability is clearly significant and negative. The intensity of this effect seems significantly lower than the effect of concentration, as shown by the marginal effect. However, at the same time, one has to recall that there is a huge dispersion of sunk cost levels between industries, without speaking of the firm level (from 10^{-4} to 10^{4}!). One may conclude from this that sunk costs play a poor role for most firms and in most industries, but may serve as very important barrier to exit in particular cases.

In summary, industry concentration and sunk costs act as exit barriers. These variables may mostly explain the differences between industries. Recall that *concentration* is measured at the industry level. *Sunk costs* is observed and measured at the firm level but defined in a way (as exogenous sunk costs) that tends to favour inter-industry dispersion and reduce intra-industry dispersion. Together with the variable *age*, the individual efficiency explains most part of the differences observed between firms of a given industry, in terms of propensity to exit.

6. Conclusions

This study uses the OP96 method to estimate the effects of several determinants of a firm's probability of exit. As in previous works using a similar approach, some robust estimates are obtained for the production function arguments. Capital and labor estimates are both different from those obtained when using methods that do not correct for simultaneity and selection biases. Once the unobserved individual efficiency has been estimated for each firm, it is introduced as a regressor in the exit model. Result is that the firm's probability of exit is negatively and significantly correlated with the individual firm' productivity, its age, and the concentration level of the firm's industry. However, this study also provides an original measurement of sunk costs at the firm level which is then introduced in the empirical model. Thus, sunk

[8] The variables *Sunk Costs* and *Concentration* are used under logarithmic forms for easier comparison in terms of marginal effects.

costs appear to play a significant and negative role: the higher the level of sunk costs, the lower the exit rate. The low value of the marginal effect and the large dispersion of the variable value suggest that this determinant effect is generally light but may become very strong in some particular industries. In summary, concentration and sunk costs may explain differences in exit rates between industries, while age and individual efficiency may explain the variability observed between firms within an industry.

Several extensions and improvements can be made with respect to the present study. Some concern the measurement of exit rates. It would be useful to introduce a distinction between exits that correspond to a failure situation (i.e. closure) and that signify a success (i.e. selling, merging and acquisition). Actually, one may posit that both the determinants and effects of exit differ between these two kinds of situations. The present classification of food industries is a second problem. The complete 4-digit level classification is not a very tractable one while being composed of too much groups. At the opposite, some classes of the 3-digit level classification (as "Other food products") are composed of very heterogeneous sub-groups of industries. A specific classification should be developed to provide a more efficient measurement of both concentration and sunk costs.

References

Ackerberg, D., Caves, K. and Frazer, G. (2006). Structural identification of production functions. Unpublished, University of Toronto.

Almus, M. (2004). The shadow of death: An empirical analysis of the pre-exit performance of new German firms. *Small Business Economics* 23(3) : 189-201.

Bartelsman, E., S. Scarpetto and Schivardi, F. (2005). Comparative analysis of firm demographics and survival: Evidence from micro-level sources in OECD countries. *Industrial & Corporate Change* 14(3): 365-391.

Bates, T. (2005). Analysis of young, small firms that have closed: delineating successful from unsuccessful closures. *Journal of Business Venturing* 20: 343-358

Bellone, F., P. Musso, L. Nesta, and Quéré, M. (2006). Productivity and market selection of French manufacturing firms in the nineties. *Revue de l'OFCE* 97(5): 319-349.

Cabral, L. (1995). Sunk costs, firm size and firm growth, *Journal of Industrial Economics* 43(2): 161-172.

Caves, R. (1998). Industrial organization and new findings on the turnover and mobility of firms. *Journal of Economic Literature* 36(4): 1947-1982.

Dimara, E. , Skuras, D. Tsekouras and D. Tzelepis, (2008), Productive efficiency and firm exit in the food sector, *Food Policy* 33: 185-196.

Dixit, A. (1989). Entry and exit decisions under uncertainty. *Journal of Political Economy* 97(3): 620–638.

Dunne, T. and Roberts, M. (1991). Variation in producer turnover across US manufacturing. In Geroski, P. and Schwalbach, J. (eds), *Entry and Market Contestability: An international Comparison.*, Blackwell, London, 187-203.

Ericson, R. and Pakes A., 1995. Markov-Perfect Industry Dynamics: A Framework for Empirical Work. *Review of Economic Studies* 62: 53-82.

Farinas, J. and Ruano, S. (2005). Firm productivity, heterogeneity, sunk costs and market selection. *International Journal of Industrial Organization* 23(7/8): 505-534.

Frazer, G. (2005). Which Firms Die? A look at manufacturing Firm Exit in Ghana. *Economic Development and cultural change* 53(3): 585-617.

Fotopoulos, G. and Spence, N. (1998). Entry and exit from manufacturing industries: Symmetry, turbulence and simultaneity - some empirical evidence from Greek manufacturing industries. *Applied Economics*, 30(2): 245–62.

Griliches, Z. and Regev, H. (1995). Firm productivity in Israeli industry 1979-1988. *Journal of Econometrics*, 65(1): 175-203.

Gschwandtner, A. and Lambson, V. E. (2002), The effects of sunk costs on entry and exit: evidence from 36 countries, *Economic Letters* 77: 109-115.

Hart, P. (2000). Theories of firms' growth and the generations of jobs. *Review of Industrial Organization* 17(3): 229-248.

Hölzl, W. (2005), Tangible and intangible sunk costs and the entry and exit of firms in a small open economy: the case of Austria, *Applied Economics* 37 (21): 2429-2443.

Hoppenhayn, H. (1992). Entry, exit, and firm dynamics in long run equilibrium. *Econometrica* 60(5): 1127-1150.

Jovanovic, B. (1982). Selection and the Evolution of Industry. *Econometrica* 50(3): 649-670.

Katayama, H. , Lu, S. and Tybout, J. R. (2009). Firm-level productivity studies: illusions and a solution, *International Journal of Industrial Organization* 27 (3): 403-413.

Kessides, I. (1990). Market concentration, contestability, and sunk costs. *Review of Economics and Statistics* 72(4): 614-622.

Klepper, S. , Miller, J. H. (1995). Entry, exit, and shakeouts in the United States Market in new manufactured Products. *International Journal of Industrial Organization* 13 (4): 567-591.

Klepper, S. , Simons, K. L. (2005). Industry shakeouts and technological change manufactured Products. *Industrial Journal of Industrial Organization* 23 (1-2): 23-43.

Lambson, V. (1991). Industry evolution with sunk costs and uncertain market conditions. *International Journal of Industrial Organization* 9 (2): 171–196.

Levinsohn, J. and Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *Review of Economic Studies* 70(2): 317-342.

Olley, G. and Pakes, A. (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica* 64(6): 1263-1297.

Roberts, B. and Thompson, S. (2003). Entry and exit in a transition economy: the case of Poland. *Review of Industrial Organization* 22(3): 225–43.

Rosenbaum, D. (1993). Profit, entry and changes in concentration. *International Journal of Industrial Organization* 11(2): 185–203.

Shiferaw, A. (2009). Survival of Private Sector Manufacturing Establishments in Africa: The Role of Productivity and Ownership. *World Development* 37(3): 572-584.

Soderböm, M. , Teal, F. and Harding, A. (2006). The determinants of survival among African manufacturing firms. *Economic Development and Cultural Change* 54(3): 533-555.

Sutton, J. (1991). *Sunk Costs and Market Structure*, MIT Press, Cambridge.

Van Beveren, I. (2007). Total factor Productivity Estimation: A Practical Review. LICOS Discussion Paper Series, Katholieke Universiteit Leuven.

Table 1: Exit by industry, average annual rate, from 1996 to 2002
Nace, 2,3-digit levels

Industry code and name	*Number (Firms)*	*Number (Obs.)*	*Exit Rate (%)*	*Size (Number of Employees)*	*Age (Years)*	*Sunk Cost (€ millions)*	*Herfindahl (*100)*
15 Total	5851	26466	6.50	102	11.03	10.03	2.48
15.1 Meat	1846	8504	6.27	101	10.77	4.74	5.31
15.2 Fish	243	1092	5.40	87	9.54	4.91	3.26
15.3 Fruits, vegetables	232	1058	6.14	140	11.21	13.19	2.55
15.4 Oils and fats	34	169	4.14	140	13.44	21.78	21.98
15.5 Dairy products	368	1931	4.19	179	13.62	18.27	3.43
15.6 Grain products	157	841	4.76	96	12.52	23.53	13.67
15.7 Prepared animal feeds	299	1523	6.11	74	12.85	7.48	4.58
15.8 Other food products	2201	8632	8.39	90	9.97	9.75	1.92
15.9 Beverages	540	2716	4.31	99	12.71	19.06	3.51

Table 2: Estimates of the production function
Food Industry, 1996-2002

Variables	OLS	Within	Olley-Pakes 96
L	0.736 (0.0047)	0.474 (0.0096)	0.565 (0.0053)
K	0.231 (0.0030)	0.233 (0.0056)	0.245 (0.0188)
N	26456	26456	26453
R^2	0.8125	0.2038	

Standard errors are in parentheses and computed using 50 bootstrap replications (OP96).
Time and industry (Nace4 level) dummies are included in each regression but are not reported.

Table 3: Estimates of the exit probit model (marginal effects)
Food Industry, 1996-2002

Variables	(1) Estimates	(2)Marginal Effects
$\hat{\omega}_{it}$	-0.1977 (0.0190)	-0.0228 (0.0021)
Age	-0.0109 (0.0022)	-0.0013 (0.0003)
Concentration	-0.4508 (0.1081)	-0.0519 (0.0124)
Sunk Costs	-0.0257 (0.0095)	-0.0030 (0.0011)
N	26453	26453
Log Likelihood	-6053	

Standard errors are in parentheses.
Time and industry (Nace4 level) dummies are included in each regression but are not reported.