# Growth Dynamics of Dairy Processing Firms in the European Union

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**Abstract**

The structure of the dairy processing industry in the European Union has changed enormously in recent decades. In many countries the industry is characterized by a few large companies with a big market share accompanied by many small processors that often produce for niche markets. This paper investigates which factors relate to growth of dairy processing firms. Using a unique ten-year panel data set and recently developed dynamic panel data estimators, the growth process of dairy processors is investigated for six rather diverse European countries. The data structure and the estimation method allow for dealing with endogeneity issues in an appropriate way. Firm size growth measured in total assets is found to be affected by firm size, firm age and financial variables. Growth in number of employees is only affected by firm age and lagged labour productivity. Implications for these results are given in the final section of the paper.

**Keywords:** *EU dairy processing industry, dynamic panel data, firm growth*

## 1. Introduction

The structure of the dairy processing industry in the European Union (EU) has changed dramatically in recent decades. According to Tozanli (1997) the EU dairy industry has moved towards a structure that can be defined as an "oligopolistic market with fringes". This means there is a small number of large processing companies that dominate dairy markets together with a large number of small enterprises that often produce for niche markets. A study by Mahon (2005) on structural changes in the EU dairy industry indicated the same trends. The largest enterprises have increased their market shares dramatically since the mid 1990's, mainly at the cost of middle-sized firms. Mergers, acquisitions and alliances have increased the concentration of dairy processing companies within Europe. However, this picture is not uniform for all European countries. In general, the industry is more concentrated in northern European countries (with Germany as an exception) than in southern and eastern European countries.

We can look at this ongoing consolidation from two different perspectives. On the one hand it may decrease competition and thereby increase the price for consumers and decrease company efficiency. On the other hand, it may enable gains in production due to increased efficiency and scale economies (Perry and Porter, 1985). For dairy processing the size of plants also depends on the density of supplying dairy farms in a given area. This partly explains why countries like The Netherlands, Denmark and Ireland have rather concentrated dairy industries.

The dynamics in the industry are partly determined by firm specific factors and characteristics of the environment in which firms operate. Understanding the underpinning factors of size dynamics is crucial for policy makers and for the firms operating in the industry. To our knowledge these dynamics have not been studied in detail for the EU dairy processing industry. Existing studies are generally applied to food manufacturing industries or at more aggregate level across many industries. Moreover, many studies only give descriptive statistics of industry dynamics, instead of trying to assess causal relationships using regression techniques.

The objective of this paper is to determine factors that systematically influence the growth of dairy processing enterprises in six selected European countries. A dynamic model based on firm growth theories is estimated using ten years of firm-level panel data. The estimation results and the outcome of various hypothesis tests provide good insight in the dynamics of the dairy processing industry structure.

The paper is organized as follows. Section two gives a brief overview of economic theories of firm growth. In section three the empirical firm growth model and the applied dynamic panel data estimation technique is described. Section four shortly introduces the data used. Section five discusses the estimation results and conclusions are drawn in section six.

## 2. Theory of firm growth

The classic model for analyzing firm size dynamics is Gibrat's model which states that firm growth is independent of size. See Sutton (1997) for a detailed overview. According to this model, large and small firms have the same probabilities of achieving particular growth rates in any period. Whatever the shape of the initial size distribution, over time it will become skewed. Industry concentration can be expected to naturally increase overtime (Oliveira and Fortunato, 2005). The results of empirical studies based on Gibrat's model are however mixed. For example, a study by Hall (1987) on the US manufacturing sector found that Gibrat's law does not hold for small firms, while it could not be rejected for larger firms suggesting a non-linear relationship between size and growth. This mixed evidence on Gibrat's model led to extensions by including additional variables and the formulation of alternative firm growth models. Important variables that have been included are discussed below. Note that in these studies firm size is often defined in different ways. It can be measured in physical terms (employees or assets) or in financial terms (turnover or sales).

*Firm age and size*

Firm age and size are considered as building blocks in many alternative firm growth models and are often used together in these models. Note that using size as a determinant of firm growth denies Gibrat's model. However, important studies by Hall (1987) and Evans (1987a; 1987b) and Cooley and Quadrini (2001) showed that firm growth is inversely related to its size and age. Heshmati (2001) extended Evans' model by including additional economic variables. He also found a negative relationship between age and growth for Swedish firms if growth is measured in employment. However, the effect was positive for growth measured in assets and sales.

The negative relationship between growth and size is often explained by diminishing economies of scale. Another explanation is that due to managerial control efficiency losses occur as the firm grows. Firms' physical resources are assumed to grow faster than managerial capacity in this case. Similarly, larger firms are more hierarchically organized than small firms, giving small enterprises an advantage in growth. According to Jovanovic (1982) the age and size effects on firms' dynamics can be explained by learning of firms. Firms learn about their capacities after they started operating. Similarly, Audretsch et al. (1999) argue that firm age is a proxy for the knowledge of technology and the competitive environment, which a firm accumulates over its life-cycle. Therefore, they suggest a positive relationship between firm age and growth if older firms benefit from dynamic economies of scale by learning from experience.

*Financial structure*

Financial factors may influence firms' investment decisions and therefore they are also used to explain firm growth. Cooley and Quadrini (2001) showed that the financing of firm investment affects its survival and growth. Conditioning on other variables, Campello (2006) showed that firms with markedly higher debt than their rivals expand their sales relatively more than those rivals in future years. However, the relationship between growth and leverage is not monotonous. High leveraged firms may expand their sales up to some leverage threshold above which growth starts to decline. Furthermore, high leverage has a downward effect when a firm faces a bad shock. Cooley and Quadrini (2001) state that the probability of firm failure increases as firms borrowed capital increases over internal capital because the high level of debt increases vulnerability to idiosyncratic shocks. Therefore, internal finance plays an important role in achieving the growth especially for small and medium firms by overcoming financial constraints.

Another financial variable presumed to affect the growth and expansion of firms is liquidity. Highly liquidity constrained firms might face difficulties in financing their investments and thus suffer from lower growth rates in the future (Fagiolo and Luzzi, 2006). Having a high level of liquidity may help a firm to finance profitable growth opportunities, especially when external financing is expensive.

According to Heshmati (2001) the effects of financial structure can differ with respect to the size of the firm, as firms face different restrictions that determine their ability to finance growth by issuing debt in the competitive capital market. Fagiolo and Luzzi (2006) state that size and age may affect the firm's ability to overcome its liquidity constraint and gain access to external finances. Small and new firms have limited collateral constraining them in accessing external financial sources.

*Capital intensity*

Another variable that is expected to influence growth of dairy processing enterprises is capital intensity. A good proxy for capital intensity is the ratio of fixed assets to employees (capital-labor ratio). The rationale for inclusion of this variable is that plants with high capital-labor ratios may have lower ratios of variable to fixed costs. Since a plant remains in operation as long as it can cover variable costs, plants with low variable-cost production techniques are more likely to withstand negative shocks than high variable-cost producers (Doms et al., 1995). Heshmati (2001) also found a positive effect of capital intensity on growth.

*Profit*

The relation between profits and firm growth can be positive or negative. Since growth and profit relate to two different and potentially competing firm objectives it can be negative. However, if firms rely on retained profits as their primary source of capital for growth, then a positive relationship exist between profit and growth. Goddard et al. (2002) give three reasons for such a positive relationship. First, retained profits are a major source of funding for a firm seeking expansion. Second, if a firm seeks to raise external capital as an alternative to or in addition to internal capital, adequate profitability is likely to be viewed as an important prerequisite by financial intermediaries Third, if managers are motivated by salaries, power, non-pecuniary benefits and prestige (all of which are perhaps associated more with size than profit) firms may grow faster.

*Productivity*

It is likely that the most productive firms grow while the least productive decrease in size. Firms compete for growth opportunities and selective pressures attribute these growth opportunities discriminating in favor of the most productive firms (Kaen and Baumann, 2003).

## 3. Empirical firm growth model and estimation strategy

Based on the literature discussed in section two and the available data the basic model of firm growth can be written in line with Evans (1987b), Heshmati (2001), and Oliveira and Fortunato (2005):

$$S_{i,t+1} = F\left(A_{it}, S_{it}, Lev_{it}, Liq_{it}, Cir_{it}, Lprod_{it}, Prof_{it}, Z_{it}\right) \quad (1)$$

where $S_{i,t+1}$ is the size of firm $i$ at time $t+1$, $A_{it}$ is the age of the firm at time $t$, $S_{it}$ is size at time $t$, $Lev_{it}$ denotes leverage, defined as total liability to total asset ratio (debts/assets), $Liq_{it}$ indicates liquidity, which is defined as the current ratio (current assets/current liability), $Cir_{it}$ is the capital intensity ratio defined as the ratio of fixed assets to total employment, $Lprod_{it}$ is labour productivity, measured as operating revenue per employee and $Prof_{it}$ are profits defined as earnings before interest, tax, depreciation and amortization (EBITDA). This offsets the measurement error due to different tax, interest rate for capital and asset inventory systems between different countries. Finally, $Z_{it}$ is a vector of five country dummies since we use data of firms from six selected European countries with different structures of the dairy industry.

The availability of panel data allows for modeling heterogeneity in firm growth. Moreover, having multiple observations per firm also allows for testing persistence of firm growth from one period to the next. Using a flexible semi-translog functional form gives the following equation to be estimated:

$$g_{it} = (\alpha_1 - 1)\ln S_{it} + \alpha_2 \ln A_{it} + \alpha_3 (\ln S_{it})^2 + \alpha_4 (\ln A_{it})^2 + \alpha_5 (\ln S_{it})(\ln A_{it}) + \alpha_6 \ln Lev_{it} + \alpha_7 \ln Liq_{it} + \alpha_8 \ln Cir_{it} + \alpha_9 \ln Lprod_{it} + \alpha_{10} \ln Prof_{it} + \gamma Z_{it} + \rho g_{i,t-1} + \lambda_i + \varepsilon_{it} \quad (2)$$

where $g_{it} = \ln S_{i,t+1} - \ln S_{it} = \ln(S_{i,t+1}/S_{it})$ denotes firm growth. This definition of growth is obtained by taking natural logs and subtracting ln $S_{it}$ on both sides of eq. (1), which is also reflected in the parameter ($\alpha_1$-1) for ln $S_{it}$ in eq. (2). The parameter $\alpha_1$ links natural logs of firm size in two subsequent periods. The parameter $\rho$ captures the persistence of firm growth over time and $\lambda_i$ are firm-specific intercept terms. This semi-translog functional form includes an interaction term between firm size and firm age, to capture the joint effect of size and age on firm's growth as discussed by Cooley and Quadrini (2001). The squares of size and age are included as explanatory variables to capture possible nonlinear relationships between firm growth and age and size. Another reason to use a semi-translog function is that the parameter estimates are less affected by influential observations and heteroskedasticity.

Note that this specification allows for testing two propositions of Gibrat's law (Oliviera and Fortunato, 2005). First, growth rates are independent of firm size. This can be tested by investigating whether $H_0 : \alpha_1 - 1 = 0$ holds. Second, above or below average growth for individual firms does not tend to persist from one period to the next, which implies that $\rho = 0$.

According to Heshmati (2001), the result of firm growth models is sensitive to the type of dependent variable used. Therefore, we estimate two models with different dependent size variables, i.e. total assets and the number of employees. The number of employees is preferred as a dependent variable because it is not affected by price inflation unlike total assets.

Equation (2) is a typical dynamic panel data model. Arellano and Bond (1991) showed that consistent estimates can be obtained by first-differencing the equation (to remove the firm-specific effects $\lambda_i$) and using the history of the dependent variable and other model variables as instruments in a GMM procedure. Arellano and Bover (1995) and Blundell and Bond (1998) suggested that the first-differenced moment conditions can be augmented with moment conditions in levels and using lagged first-differences of the series ($\Delta g_{i,t-s}$) as instruments for the equations in levels. This approach has a number of advantages. First, the estimates are more precise and efficient. Second, time-invariant variables like country dummies in our model are dropped by first-differencing. By including moment conditions in levels as proposed by Arellano and Bover (1995) parameters of these variables can also be estimated. Third, in standard first-difference GMM explanatory variables are assumed to be strictly exogenous. Arellano and Bover (1995) introduced a robust system GMM estimator for dynamic panel data models where lagged values of differenced explanatory variables can be used as instruments for level equations if the explanatory variables are not strictly exogenous. Therefore, potentially endogenous financial and performance variables are specified as predetermined and endogenous variables to allow these variables to be instrumented by their lagged differences. Age and dummy variables are specified as exogenous variables.

In final estimation, we employ the asymptotically efficient two-step system GMM estimator augmented with a finite-sample correction to the two-step covariance matrix derived by Windmeijer (2005) in order to correct for downward biased standard errors that affected the original Arellano-Bond estimator. The validity of the over identifying restrictions can be tested using a Sargan test. This indicates validity of chosen instruments and correctness of model specification.

## 4. Data

Data for this study is obtained from the Amadeus database. This is a pan-European database containing financial, legal and basic economic information of over five million private and publicly owned firms across 34 Western and Eastern European countries. From this database we selected data on dairy processing companies from six European countries for the period 1996-2006. Dairy processing firms were selected from the main database on the basis of NACE codes (the European standard of industry classification). The chosen countries have dairy industries that are typical for certain parts of the EU. Three criteria were used in country selection:

1. A dairy processing industry characterized by a large proportion of small and medium sized enterprises (SMEs) vs. an industry with a few large companies
2. New versus old EU member state. Most new member states have a milk production below 1% of the EU-27 total. Only Poland (6%) has a significant share of milk production.
3. Northern European versus Southern European countries. Northern European countries (except for Germany) are characterized by a high concentration of milk collection plants.

Based on these criteria dairy processing firms from Italy, France, the Netherlands, UK, Germany and Poland are selected in the study sample. These countries give a good representation of the varied structure of the EU dairy processing industry and account for about 65% of total dairy production in the EU. Based on the above criteria in total 2635 dairy processing firms are identified and included in the sample. On average about 7 years of data are available per company.

## 5. Results

Estimation results for the two models explaining firm growth in terms of total assets and number of employees, respectively, are given in table 1. Since lagged values are used in the model and because of missing values the total number of observations used in the dynamic panel data model is 7132 for total assets and 4028 for employee growth.

*Table 1. GMM-sys estimation result for growth of firms in assets and employees*

| Variables | | Total asset growth | Employee growth |
|---|---|---|---|
| Intercept | | 5.093 (1.851) ** | -1.728 (1.750) |
| Lagged growth ($g_{t-1}$) | | 0.038 (0.014) ** | 0.003 (0.009) |
| Log size | | -1.237 (0.179) *** | -0.322 (0.086)*** |
| Log age | | 0.018 (0.074) | 0.115 (0.048)** |
| Log size squared | | 0.051 (0.010) *** | 0.006 (0.008) |
| Log age square | | -0.003 (0.006) | -0.007 (0.007) |
| Log age*log size | | -0.007 (0.009) | -0.021 (0.008)** |
| Log lab. productivity | | 0.144 (0.026) *** | 0.594 (0.062)*** |
| Log liquidity | | -0.244 (0.050) *** | 0.048 (0.032) |
| Log leverage | | -0.361 (0.079) *** | 0.060 (0.050) |
| Log capital intensity | | -0.248 (0.031) *** | 0.017 (0.017) |
| Log Profit | | 0.002 (0.002) | 0.149 (0.142) |
| Dummy Germany | | -1.065 (0.558) * | -0.942 (1.184) |
| Dummy Italy | | 0.512 (0.535) | -1.332 (1.135) |
| Dummy Netherlands | | -0.041 (1.146) | -1.675 (1.193) |
| Dummy Poland | | 0.109 (0.535) | 0.129 (1.234) |
| Dummy UK | | -0.436 (0.597) | -0.452 (1.233) |
| Wald | | 1049.17 [0.000] | 5471.39 [0.000] |
| Sargan test | | 465.74 [0.74] | 408.073 [0.514] |
| Auto correlation test | -1st order | -11.57 [0.000] | -3.690 [0.000] |
| | -2nd order | -0.134 [0.89] | -0.139 [0.888] |
| No. observations | | 7132 | 4028 |

Notes: ***indicates the critical at 1% critical level, ** at 5% critical level and * at 10 percent critical level. Figures between round brackets are Windmeijer-robust standards errors and figures between square brackets are p values.

Combining the linear, quadratic and cross-terms for size and age, respectively, elasticities for both variables can be calculated. For size this gives significant values of -0.430 (st. error 0.052) for growth in total assets, and -0.347 (st. error 0.057) for growth in total employees. This significant impact of size on growth violates Gibrat's law. The effect of firm age on growth is mixed. For the asset model age has a significant negative elasticity of -0.054 (st. error of 0.01) but for employee growth there is no such effect. Together, these results suggest that smaller and younger dairy processing firms grow faster than older and larger firms. F-tests show that the richer semi-log specification is preferred over a simpler linear log specification, confirming the existence of age-size interactions in firm growth. Labour productivity has a clear positive impact on firm growth, given the significant elasticity for both models. Leverage and liquidity have a significant negative impact on dairy processing firm growth measured in total assets but not in terms of employees. The sign of leverage is as expected based on financial theories and findings by Oliveira and Fortunato (2005) for service industries. The negative sign suggest that firms with a high liquidity ratio are not growing at faster rate because high liquidity indicates that investment opportunities are not taken. The impact of capital intensity on growth is negative for growth measured in assets as opposed to our expectations, which suggests firms with high variable cost grow faster. Profit is insignificant for both growth measured in total assets and measured in employees. Apparently growth is not financed by profits, but from more structural sources of funding. Interestingly, given that most country dummies have insignificant parameters, it can be concluded that there are no strong country-specific effects on firm growth in the dairy industry. This could mean that the dairy industry is rather homogenous between different European countries. It could also mean that firm-specific heterogeneity, which is implicitly taken into account in estimation, is more relevant and dominates country effects. Surprisingly, lagged growth is persistent for total assets but it is not for employees.

The Wald tests indicate that null hypotheses of all parameters jointly equal to zero are firmly rejected. The Sargan test results indicate that both models are correctly specified and that chosen instruments are valid. Both autocorrelation tests also show satisfactory outcomes: presence of first-order autocorrelation, which we introduced ourselves by first-differencing, and absence of $2^{nd}$ order autocorrelation indicating lack of $1^{st}$ order autocorrelation in the untransformed model, a necessary condition for consistent estimation.

## 6. Conclusions

This paper investigated factors that systematically influence the growth of dairy processing enterprises in six selected European countries using panel data and dynamic panel data estimation techniques. Since it matters how firm size is measured, we estimated a model based on firm growth in total assets and one based on growth in employees. From these two models a number of general conclusions can be drawn. First, firm size seems to matter in growth, rejecting the well-known Gibrat's law that states that firm size is not important in explaining growth. For size measured in total assets we also found that firm growth is persistent over time and that the financial situation affects growth. However, for growth measured in number of employees these results do not hold, implying that the financial situation does not have an impact on job creation growth and that growth in jobs does not sustain over time. This is important information for policy makers that want to formulate competition policies for the European dairy industry. By changing fiscal policies, governments can affect the financial status of dairy processing firms, which affects their growth in total assets. On the other hand, such policies do not have an impact on employment. Labour productivity also has an impact on firm growth, measured either in assets or in employment. So, firms that invest in improving skills of workers are able to grow faster. A final conclusion from these analyses is that there are no specific country effects on firm growth. Note that companies were selected from a eastern European country (Poland), southern European countries with a scattered dairy industry (Italy and to some extent France), and countries with industries dominated by big processors (The Netherlands, France, UK), but apparently growth processes for the dairy industry are not different for these countries.

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