Working papers

New Trends in accounting

and management

University of Lleida

Department of Business
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The persistence of return on assets: differences between industries and differences between firms

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ANALYSIS OF BANKING OWNERSHIP IN THE NEW EU MEMBERS USING FINANCIAL RATIOS

Abstract

This study offers a statistical analysis of the persistence of annual profits across a sample of firms from different European Union (EU) countries. To this end, a Bayesian dynamic model has been used which enables the annual behaviour of those profits to be broken down into a permanent structural component on the one hand and a transitory component on the other, while also distinguishing between general effects affecting the industry as a whole to which each firm belongs and specific effects affecting each firm in particular. This break down enables the relative importance of those fundamental components to be evaluated.

The data analysed come from a sample of 23,293 firms in EU countries selected from the AMADEUS data-base. The period analysed ran from 1999 to 2007 and 21 sectors were analysed, chosen in such a way that there was a sufficiently large number of firms in each country*sector combination for the industry effects to be estimated accurately enough for meaningful comparisons to be made by sector and country. The analysis has been conducted by sector and by country from a Bayesian perspective, thus making the study more flexible and realistic since the estimates obtained do not depend on asymptotic results.

In general terms, the study finds that, although the industry effects are significant, more important are the specific effects. That importance varies depending on the sector or the country in which the firm carries out its activity. The influence of firm effects accounts for more than 90% of total variation and display a significantly lower degree of persistence, with adjustment speeds oscillating around 51.1%. However, this pattern is not homogeneous but depends on the sector and country analysed. Industry effects have a more marginal importance, being significantly more persistent, with adjustment speeds oscillating around 10% with this degree of persistence being more homogeneous at both country and sector levels.

Key words: Dynamic models, Bayesian Inference, MCMC, Abnormal Returns, Persistence of Profits, Return on Assets

1. INTRODUCTION

According to economic theory, in competitive markets, the profit rates of companies should converge towards the mean of the market, although this is not always the case and there are empirical studies that found differences between firms that persist over time (Jacobson, 1988) varying the speed with which firms adjust their benefits to stable values (Geroski and Jacquemin 1988).

Consequently, many studies have been published which attempt to describe the evolution over time of such profits, with a view to analyze whether the differences are transitory, tending to disappear with the passage of time, or are rather permanent, tending to persist along time (see, for example, Waring, 1996; McGahan and Porter, 2003).

Recently, Bou and Satorra (2007) have proposed a dynamic model which allows firms' abnormal profits to be decomposed into a permanent, a transitory and a specific component. Their method is particularly interesting because it enables to evaluate the importance of each component as well as to distinguish between industries components that affect the firm sector as a whole and specific components that affect each firm. Bou and Satorra studied the behaviour of 5,000 Spanish firms over the period 1995-2000 and conclude that significant permanent differences exist at sector and individual firm levels, the latter differences being of greater magnitude. However, they observed no significant differences among the adjustment processes of the transitory components which operate at both sector and firm levels.

Gallizo et al. (2007) extended that study to different European countries using a larger sample of firms. They observe a low persistence of the transitory component due to the growing degree of competitiveness in the business context of the countries studied. Nevertheless, this behaviour is not homogeneous but depends on the sector and country. However, these authors do not distinguish between effects affecting the industry as a whole and those affecting individual firms.

The present study undertakes an extension of Gallizo et al (2007) by distinguishing between industry and specific effects and evaluating the importance of both types of effects. To this end, we adopt the framework proposed by Bou and Satorra (2007) but, unlike them, we analyse a larger sample from different EU countries and we use a Bayesian approach that let us to make exact inferences about the parameters of the model and to compare non-nested models in order to evaluate the joint statistical significance of the different components of the model.

The analysis, performed by country and sector, shows that although the impact of industry-wide shocks is significant, the specific shocks impacting each firm are still more important. That importance varies according to the sector or country in which each firm carries out its activity.

The study is set out as follows: section 2 explains the data used, section 3 describes the model and statistical methodology adopted, section 4 presents the results obtained, and section 5 draws some conclusions. A mathematical appendix is included where the statistical procedures to estimate and compare the different models considered in the paper are described with more detail.

2. DATA

The data analysed come from a sample of 23,293 firms in 6 EU countries selected from the AMADEUS data-base. The period analysed covers from 1999 to 2007 and the frequency of observation is annual. 21 sectors are considered, chosen in such a way that there was a large number of firms in each country*sector combination for the industry effects to be estimated accurately enough for meaningful comparisons to be made by sector and country.

Table 1 (see annex) shows the composition of the sample by countries and sectors. The most represented countries are France, Spain, United Kingdom and Italy which reflects their larger specific weight within the EU. In addition there is no particular preponderance of any sector thus permitting comparisons to be made at sector level.

The profit ratio analysed is the return on assets (ROA) and the percentage of firms with missing data was equal to 6.5%, all of them corresponding to 1999.

Figure 1 and Table 2 show the annual evolution of the average ROA value by country whilst Table 3 shows the evolution of the standard deviation of ROA.

Table 2: Annual evolution of average ROA valu–s by country

		Year									
		1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**Mean**
Country	**Belgium**	5.44%	5.04%	5.10%	4.70%	5.73%	6.78%	6.51%	7.15%	7.35%	5.97%
	France	6.48%	6.23%	6.36%	5.69%	5.23%	5.62%	5.17%	5.57%	5.90%	5.80%
	Italy	6.25%	5.46%	5.40%	5.09%	4.31%	4.50%	4.28%	4.57%	4.23%	4.88%
	Spain	7.01%	6.13%	6.21%	6.01%	6.17%	6.18%	5.81%	5.67%	5.63%	6.08%
	Sweden	9.14%	10.29%	6.71%	5.87%	5.86%	7.64%	8.82%	10.18%	10.40%	8.31%
	United Kingdom	7.26%	6.27%	6.09%	6.16%	6.01%	6.25%	5.68%	6.19%	6.50%	6.26%
	All	6.85%	6.31%	6.06%	5.71%	5.54%	5.92%	5.63%	6.00%	6.12%	6.01%

Table 3: Annual evolution of ROA standard deviation by country

		Year									
		1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**Median**
Country	**Belgium**	11.63%	11.75%	11.55%	11.34%	12.11%	11.71%	11.50%	11.63%	11.55%	11.63%
	France	11.14%	11.11%	11.40%	10.94%	11.06%	11.16%	11.29%	11.12%	11.12%	11.12%
	Italy	9.03%	8.97%	8.32%	8.31%	8.05%	7.55%	7.94%	8.28%	9.74%	8.31%
	Spain	11.47%	11.32%	10.89%	10.82%	10.53%	10.62%	10.21%	10.56%	10.83%	10.82%
	Sweden	14.42%	15.43%	14.46%	14.89%	13.59%	12.57%	11.77%	12.79%	13.49%	13.59%
	United Kingdom	12.48%	12.43%	12.27%	11.51%	12.06%	11.49%	12.24%	11.81%	12.47%	12.24%
	All	11.54%	11.61%	11.32%	11.04%	11.04%	10.80%	10.91%	10.99%	11.46%	11.04%

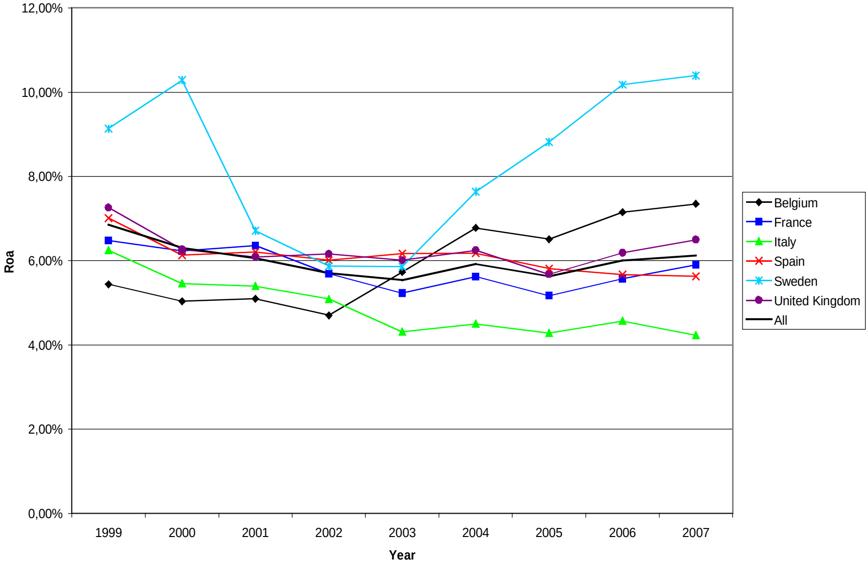

Figure 1: Annual evolution of average ROA by country

The mean ROA for all the firms in the sample oscillated around 6.01% and it decreased in the period 1999-2002, and increased thereafter. The standard deviation of ROA oscillated around 11%. By country, the highest values for ROA were achieved by Swedish firms, whose ROA oscillated around 8.31% but with a more marked decreasing and increasing trends and a higher standard deviations (around 13,59%) than the other countries. The smoother evolution corresponded to the Italian and Spanish firms which mean ROA had a decreasing trend throughout the period and the standard deviations being noticeably smaller and oscillating around 8.31% and 10.82%, respectively.

Table 4 and Figure 2 shows the annual evolution of the average ROA value by sector whilst Table 5 shows the evolution of standard deviations.

Table 4: Annual evolution of average ROA values by sector

		Year									
		1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**Mean**
Sector ACE Rev. 2, Core code (3 digits)	**181**	6.27%	5.56%	4.39%	4.32%	4.16%	4.83%	3.96%	3.07%	2.45%	4.32%
	201	6.09%	5.23%	4.60%	4.96%	4.25%	4.34%	4.14%	4.44%	4.22%	4.66%
	222	7.41%	6.25%	5.60%	5.93%	5.36%	4.75%	4.21%	4.17%	4.13%	5.29%
	251	8.01%	7.15%	6.61%	6.40%	5.52%	6.07%	6.47%	6.78%	7.11%	6.67%
	256	7.31%	6.63%	5.96%	4.98%	4.21%	5.02%	5.53%	6.25%	7.14%	5.88%
	259	7.93%	6.93%	5.88%	5.42%	5.17%	6.33%	6.05%	6.48%	6.37%	6.28%
	282	7.36%	7.18%	6.53%	6.34%	5.85%	6.71%	7.12%	8.14%	8.30%	7.05%
	310	7.27%	7.30%	6.36%	5.75%	4.67%	4.82%	4.29%	4.19%	4.34%	5.43%
	432	6.74%	6.95%	7.48%	7.29%	6.83%	6.85%	6.69%	6.99%	7.48%	7.04%
	451	5.97%	4.72%	5.05%	4.45%	4.42%	4.56%	3.75%	3.73%	3.59%	4.46%
	463	5.10%	4.29%	5.18%	5.21%	5.31%	5.09%	4.17%	4.56%	4.68%	4.84%
	464	6.75%	6.26%	6.23%	6.92%	7.54%	7.58%	7.36%	7.26%	6.84%	6.95%
	466	7.40%	7.24%	6.79%	6.20%	6.37%	7.19%	6.90%	7.54%	8.09%	7.08%
	467	5.96%	6.66%	6.00%	5.97%	6.02%	7.44%	6.49%	7.06%	6.78%	6.49%
	493	3.25%	2.18%	3.25%	3.02%	3.02%	3.01%	3.03%	4.09%	4.50%	3.25%
	494	4.83%	4.28%	5.08%	4.15%	3.67%	3.58%	2.35%	3.52%	4.43%	3.98%
	522	5.57%	5.35%	5.32%	5.56%	5.04%	6.20%	6.26%	6.32%	6.09%	5.75%
	620	12.67%	8.58%	7.01%	4.90%	5.71%	6.84%	7.61%	7.86%	8.35%	7.61%
	702	8.77%	7.33%	6.06%	5.62%	5.81%	6.98%	6.94%	8.33%	8.30%	7.08%
	711	8.14%	9.56%	8.08%	7.30%	7.69%	8.49%	9.08%	9.43%	9.82%	8.60%
	812	7.22%	8.44%	8.84%	8.61%	8.15%	7.57%	7.38%	7.71%	7.32%	7.92%
	All	6.85%	6.31%	6.06%	5.71%	5.54%	5.92%	5.63%	6.00%	6.12%	6.01%

Table 5: Annual evolution of ROA standard deviations by sector

		Year									
		1999	2000	2001	2002	2003	2004	2005	2006	2007	Median
Sector ACE Rev. 2, Core code (3 digits)	**181**	11.29%	10.53%	11.27%	11.70%	12.29%	11.98%	11.17%	11.42%	11.71%	11.42%
	201	12.93%	11.39%	10.31%	11.14%	10.17%	10.61%	11.70%	12.03%	12.60%	11.39%
	222	10.24%	9.83%	10.43%	10.03%	11.62%	11.71%	11.33%	11.01%	11.00%	11.00%
	251	9.99%	10.81%	9.07%	9.62%	9.47%	9.30%	8.96%	10.23%	10.97%	9.62%
	256	10.34%	10.23%	9.62%	9.41%	10.42%	10.06%	10.32%	11.24%	12.10%	10.32%
	259	10.33%	10.29%	9.85%	10.56%	11.06%	9.16%	10.49%	10.65%	12.67%	10.49%
	282	12.30%	10.96%	11.05%	10.74%	10.47%	10.49%	11.12%	11.20%	11.44%	11.05%
	310	8.99%	9.30%	9.35%	9.71%	9.27%	9.91%	10.69%	10.47%	10.80%	9.71%
	432	10.13%	10.76%	10.17%	10.14%	10.34%	9.37%	9.98%	10.21%	10.38%	10.17%
	451	7.02%	6.89%	6.72%	5.99%	6.13%	5.96%	5.79%	5.83%	6.55%	6.13%
	463	9.51%	9.78%	7.95%	8.51%	8.78%	8.50%	9.27%	9.73%	9.72%	9.27%
	464	13.48%	13.34%	13.16%	12.88%	12.87%	13.39%	12.07%	12.11%	11.78%	12.88%
	466	10.44%	10.62%	10.05%	9.73%	9.62%	8.86%	9.72%	9.60%	10.39%	9.73%
	467	8.52%	8.58%	8.74%	7.97%	8.45%	8.35%	8.50%	8.73%	9.78%	8.52%
	493	11.54%	11.59%	11.41%	10.08%	12.62%	11.48%	12.45%	11.66%	12.57%	11.59%
	494	9.34%	9.21%	8.52%	8.56%	8.71%	8.25%	9.61%	9.18%	10.29%	9.18%
	522	10.46%	10.82%	10.15%	10.07%	10.81%	10.30%	10.86%	11.03%	12.27%	10.81%
	620	19.11%	19.15%	20.42%	18.95%	16.65%	15.19%	15.06%	14.76%	14.27%	16.65%
	702	18.52%	17.72%	17.33%	16.82%	16.10%	15.94%	15.24%	15.10%	14.92%	16.10%
	711	13.45%	15.22%	14.08%	14.25%	12.77%	13.96%	12.50%	13.11%	13.68%	13.68%
	812	11.62%	12.01%	11.78%	10.90%	11.04%	11.36%	10.82%	10.94%	11.65%	11.36%
	All	11.54%	11.61%	11.32%	11.04%	11.04%	10.80%	10.91%	10.99%	11.46%	11.04%

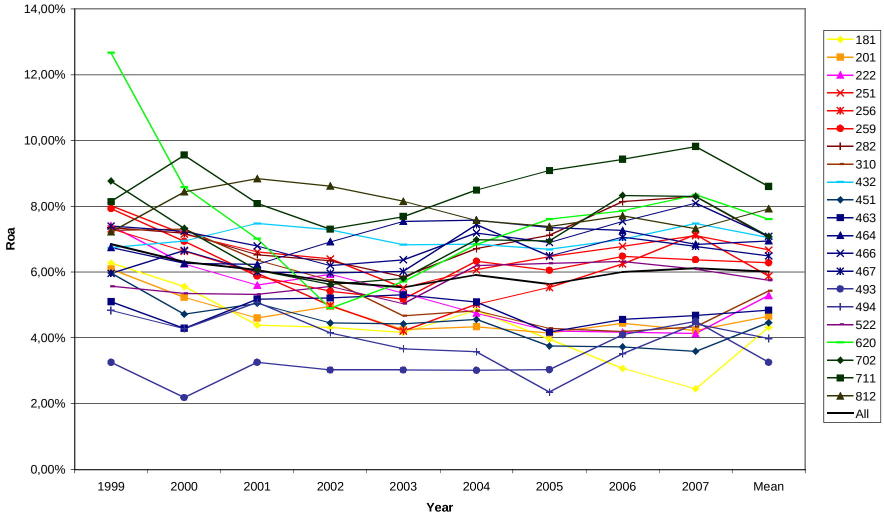

Figure 2: Annual evolution of average ROA by sector

It can be seen that for most sectors, the mean ROA remained more or less constant throughout the period. Notable exceptions to this rule are sector 181 (Printing and service activities related to printing), which shows a decreasing trend for most of the period, and sector 620 (Information technology service activities), with a clear decreasing tendency in the period 1999-2002 followed by an increasing trend from 2003. The most profitable sectors were 711 (Architectural and engineering activities and related technical consultancy) and 812 (Cleaning activities) whose returns oscillated around 8.6% and 7.92%, respectively; the less profitable were transport sectors 493 (Other passenger land transport) and 494 (Freight transport by road) whose returns values oscillated around 3.25% and 3.98%, respectively. If we analysed the evolution of the standard deviations (see Table 5) the more homogeneous sectors were 451 (Sale of motor vehicles) and 467 (Other specialized wholesale) whose standard deviations oscillated around 6.13% and 8.52%, respectively. On the other hand the more heterogeneous sectors were 620 (Information technology service activities) and 702 (Management consultancy activities) whose standard deviations oscillated around 16.65% and 16.10%, respectively.

3. STATISTICAL METHODOLOGY

This section offers a description of the statistical methodology employed in the study. Mathematical details can be found in the appendix.

3.1. Set-up

For each country the data correspond to a sample of N firms for which the value of ROA (hereinafter R) is measured over the period $\{1,\ldots, T\}$.

Let $\{Rit;\ t\in Ti \subseteq \{1,\ldots, T\};\ i=1,\ldots, N\}$ where $Ti = \{tlow,i,\ tlow,i+1,\ \ldots,\ tupp,i\}$ with $1\leq tlow,i < tupp,i \leq T$ denote the periods of time for which information is available regarding ratio R in firm i-th.

Let $yit = Rit - Rmean,\ t$ be the value of abnormal profit in firm i-th over the period t, where $Rmean,t = \dfrac{\sum_{i:t_{low,i}\leq t\leq t_{upp,i}} R_{i,t}}{N_t}$ is the mean of ratio R in the period t, with $Nt = cardinal\{i\in \{1,\ldots,N\}: tlow,i\leq t\leq tupp,i\}$ the number of firms with observed ROA for the period t.

Let $s(i)\in \mathbf{S}=\{1,\ldots, S\}$ be the sector in which firm i-th develops its activity, where S is the number of sectors considered in the study.

3.2. The model

We adopt the framework of Bou and Satorra (2007). The model split up the abnormal profitability of a firm into 3 components: an industrial component, YI, which reflects the influence of permanent and transitory effects affecting the industry to which the firm belongs; a firm-specific component, YF, which reflects the influence of specific permanent and transitory effects that affects each firm individually; and, finally, an idiosyncratic component, U, which reflects the influence of specific and occasional shocks which do no persist in time.

The model's equations are given by:

$$yi,t = yI,s(i),t + yF,i,t + ui,t = pI,s(i) + aI,s(i),t + pF,i + aF,i,t + ui,t \qquad (3.1)$$

$$pI,s(i) \sim N\left(0,\sigma^2_{p_I}\right) \qquad (3.2)$$

$$a_{I,s(i),t+1} = \beta_I\, a_{I,s(i),t} + d_{I,s(i),t} \text{ with } d_{I,s(i),t} \sim N\left(0,\sigma^2_{a_I}\right);\ a_{I,s(i),1} \sim N\left(0,\frac{\sigma^2_{a_I}}{1-\beta_I^2}\right) \qquad (3.3)$$

$$p_{F,i} \sim N\left(0,\sigma^2_{p_F}\right) \qquad (3.4)$$

$$a_{F,i,t+1} = \beta_F\, a_{F,i,t} + d_{F,i,t} \text{ with } d_{F,i,t} \sim N\left(0,\sigma^2_{a_F}\right);\ a_{F,i,t_{low,i}} \sim N\left(0,\sigma^2_F\right) \qquad (3.5)$$

$$u_{i,t} \sim N\left(0, \sigma^2_{u,t}\right) \tag{3.6}$$

with $t \in T_i$; for $i=1,\ldots, N$ and independent errors $\{u_{i,t};\ t \in T_i\ ;\ \text{for } i=1,\ldots, N\}$

where:

$y_{I,s(i),t}$ is the value of the industry component of firm i

$y_{F,i,t}$ is the value of the specific component of firm i

$p_{I,s(i)}$ is the permanent component of $y_{I,s(i),t}$ which captures the difference existing between the different sectors due to their structural features or the nature of their activity, differences which tend to persist in the long term.

$a_{I,s(i),t}$ is the transitory component of $y_{I,s(i),t}$ which captures the temporary differences existing in period t between the different sectors, which tend to disappear with time with speed determined by the parameter $-1 \leq bI \leq 1$, which quantifies the component's degree of persistence.

$p_{F,i}$ is the permanent component of $y_{F,i,t}$ which captures the differences existing between different firms due to their specific structural features, features which tend to persist in the long term.

$a_{F,i,t}$ is the transitory component of $y_{F,i,t}$ which captures each firm's specific temporary differences in the period t, which tend to disappear with time with a speed determined by the parameter $-1 \leq b_F \leq 1$, which quantifies the component's degree of persistence.

$u_{i,t}$ is the idiosyncratic component for each company in the period t and it captures the influence exercised by occasional events specific to each firm which occurred in period t but whose effect has not any persistence along time.

3.3. Estimation and comparison of models

The model's parameters are the components of vector $\boldsymbol{\theta} = \left(\sigma^2_{p_I}, \sigma^2_{a_I}, \beta_I, \sigma^2_F, \sigma^2_{p_F}, \sigma^2_{a_F}, \beta_F, \sigma^2_{u,1}, \ldots, \sigma^2_{u,T}\right)$ as well as the permanent and transitory components of industry and firm-specific effects, $\boldsymbol{\theta}_{I,F} = \left\{\left(p_{I,i}, a_{I,t_{low,i}}, \ldots, a_{I,t_{upp,i}}, p_{F,i}, a_{F,t_{low,i}}, \ldots, a_{F,t_{upp,i}}\right); i = 1,\ldots, N\right\}$.

These parameters are estimated following a Bayesian approach described in the Appendix. This approach allows make exact inferences about the values of the above parameters that reflect the uncertainty associated to their estimation. In addition Bayesian methodology allows model comparison processes to be carried out using criteria which quantify their predictive behaviour, taking into account their complexity and their goodness of fit to data.

4. RESULTS

4.1. General results

In row labelled "*All*", Table 6 gives the estimates for persistence coefficients bI and bF globally. More particularly, for each parameter the median is given for their corresponding a posteriori distribution, as well as the lower and upper limits of the 95% Bayesian credibility interval, created on the basis of the 2.5 and 97.5 quantiles. It can be seen that the industry effect has a large persistence, with adjustment speed to shocks affecting the whole industry (1-bI) being estimated at 9.91%. This result is consistent with the annual evolution of the average ROA by sector shown in Figure 2 that is very smooth for most of them. On the contrary the adjustment speed is considerably lower in the case of the specific effect for firms, which is estimated to be equal to 51.44% and indicates a shorter persistence of these effects.

Table 7 analyses the importance of each component and shows the percentage of total variation of the abnormal profits explained for each component. These percentages were calculated from the decomposition

$$\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(y_{i,t}) = \sum_{i=1}^{N}\sum_{t\in T_i}\left(\operatorname{var}[p_{I,s(i)}] + \operatorname{var}[a_{I,s(i),t}] + \operatorname{var}[p_{F,i}] + \operatorname{var}[a_{F,i,t}] + \operatorname{var}[u_{i,t}]\right) =$$

$$= \sum_{i=1}^{N}\sum_{t\in T_i}\left(\sigma_{p_I}^2 + \frac{\sigma_{a_I}^2}{1-\beta_I^2} + \sigma_{p_F}^2 + \sigma_{a_F}^2\left(\sum_{u=0}^{t-t_{low,i}-1}\beta_F^{2u}\right) + \sigma_F^2\beta_F^{2(t-t_{low,i})} + \sigma_{u,t}^2\right)$$

which follows from (3.1) and they are given by:

$$\frac{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(p_{I,s(i)})}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(y_{i,t})} = \frac{\sigma_{p_I}^2\sum_{i=1}^{N}\operatorname{cardinal}(T_i)}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(y_{i,t})}$$

for industry permanent component p_I,

$$\frac{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(a_{I,s(i),t})}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(y_{i,t})} = \frac{\frac{\sigma_{a_I}^2}{1-\beta_I^2}\sum_{i=1}^{N}\operatorname{cardinal}(T_i)}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(y_{i,t})}$$

for industry transitory component a_I,

$$\frac{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(p_{F,i})}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(y_{i,t})} = \frac{\sigma_{p_F}^2\sum_{i=1}^{N}\operatorname{cardinal}(T_i)}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}(y_{i,t})}$$

for the specific permanent component p_F,

$$\frac{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}\left(a_{F,i,t}\right)}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}\left(y_{i,t}\right)}=\frac{\sum_{i=1}^{N}\sum_{t\in T_i}\left(\sigma_{a_F}^{2}\left(\sum_{u=0}^{t-t_{low,i}-1}\beta_F^{2u}\right)+\sigma_F^{2}\beta_F^{2\left(t-t_{low,i}\right)}\right)}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}\left(y_{i,t}\right)}$$

for the specific transitory component aF and

$$\frac{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}\left(u_{i,t}\right)}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}\left(y_{i,t}\right)}=\frac{\sum_{i=1}^{N}\sum_{t\in T_i}\sigma_{u,t}^{2}}{\sum_{i=1}^{N}\sum_{t\in T_i}\operatorname{var}\left(y_{i,t}\right)}$$

for the idiosyncratic component. Table 7 shows the posterior means of those percentages, as well as those corresponding to the industry effect (sum of expressions (4.1) and (4.2)) and to the firm specific effect (sum of expressions (4.3) and (4.4)).

It can be seen that most of the total variation (97.77%) is explained by firm specific effects, with the specific transitory component (aF) explaining the 58.57% and the specific permanent component (pF) the 39.20%. On the other hand industry effects have a very marginal impact explaining only the 2.06% of total variation. That is due to the degree of stability presented by the evolution of mean levels in each sector (see Figure 2), the value of which has remained essentially constant for most sectors. Also, the transitory effects are preponderant over permanent ones, a fact which underlines the greater importance of temporary shocks for the evolution of firm profits.

4.2. Results by country

Tables 6 to 10 and Figures 3 and 4 show the results obtained by estimating the model (3.1)-(3.6) for each of the countries considered in the study. Concretely, Table 6 show the point estimations and the 95% Bayesian credibility intervals of the adjustment coefficients bI and bF while Figures 3 and 4 show the boxplot corresponding to the posterior distributions of these coefficients.

Table 6: Estimates of persistence coefficients by country

		β_I			β_F		
		Q2.5	**Median**	**Q97.5**	**Q2.5**	**Median**	**Q97.5**
Country	**Belgium**	0.7198	0.8518	0.9290	0.5110	0.5340	0.5575
	France	0.6488	0.8601	0.9510	0.4657	0.4771	0.4888
	Italy	0.8900	0.9695	0.9881	0.4974	0.5125	0.5282
	Spain	0.8434	0.9339	0.9679	0.4597	0.4728	0.4859
	Sweden	0.5034	0.6990	0.8963	0.3615	0.3835	0.4059
	United Kingdom	0.6884	0.8562	0.9417	0.3669	0.3796	0.3930
	All	0.7576	0.9009	0.9553	0.4791	0.4856	0.4923

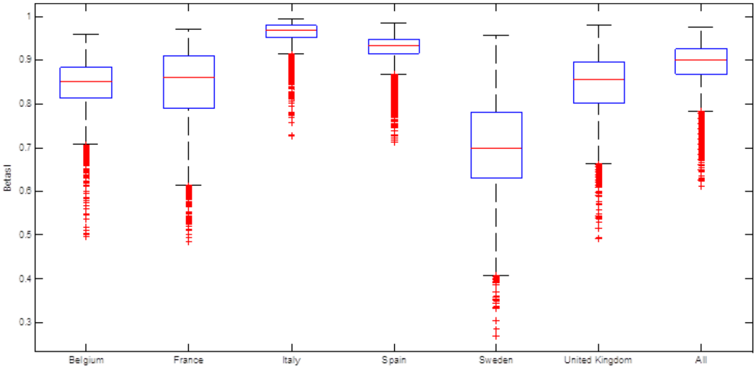

Figure 3: Boxplot of the posterior distribution of β_I by country

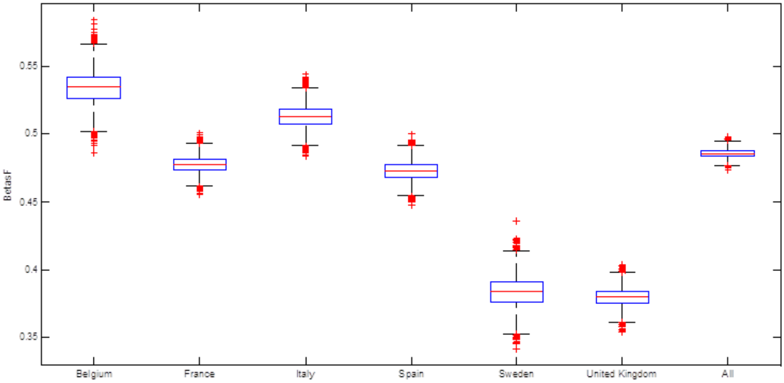

Figure 4: Boxplot of the posterior distribution β_F by country

It can be seen that adjustment speed of Italian and Spanish industries are lower (3.05% and 6.61%, respectively) while Swedish industries are larger (31.10%) with the rest of countries having adjustment speed around 14%-15%. These results are consistent with the annual evolution of their average ROA shown in Figure 1 and commented in section 2. However, the noticeable and statistically significant differences are appreciated in the estimation of the specific adjustment coefficients bF (see Table 6 and Figure 4). The highest adjustment speeds correspond to the English (62.04%) and Swedish (61,65%) firms, with intermediate values in Spain (52.78%) and France (52.29%), and lowest speeds in Italy (49.75%) and Belgium (47.6%). Therefore firms of these latter two countries tend to be more sensitive to their specific shocks, which persisted longer.

An analysis of the importance of each effect for each country's total variability level (see Table 7) shows that, generally speaking, the specific effects have greater impact, oscillating between 86.87% for Italy and 95.83% for Belgium. Industry effects tend to have lower impact, explaining less than 5% of total variation for most of countries. Notable exceptions to this rule are Italy and Sweden where these effects have a non-negligible importance, explaining more than 9% of total variation. Particular striking is the relatively high percentage (5.34%) of total variation explained by the industry permanent component in Swedish firms which reflects a non-negligible trend to exist systematic differences in the profitability of the analysed sector in Sweden.

By component, it is still the transitory effects which account for most variability, which underlines the fact that the greater impact of temporary events on the evolution of firms' profits holds true for all countries alike, Sweden and United Kingdom being the most affected in this regard.

Table 7: Percentage of total variability accounted for by each component by country

		Industry Effect			Firm Effect			
		% Permanent	%Transitory	%Industry	% Permanent	%Transitory	%Firm	%Idiosyncratic
Country	**Belgium**	0.36	2.54	2.90	37.74	58.09	95.83	1.27
	France	1.76	2.20	3.96	36.05	58.80	94.85	1.19
	Italy	2.94	6.37	9.30	38.74	48.14	86.87	3.82
	Spain	0.83	3.26	4.09	39.61	55.70	95.30	0.61
	Sweden	5.34	4.62	9.97	27.56	60.43	87.99	2.04
	United Kingdom	0.77	1.61	2.37	28.13	66.05	94.18	3.45
	All	0.65	1.41	2.06	39.20	58.57	97.77	0.16

Finally, Tables 8 to 10 analyse the joint statistical significance of industry and firm effects. To that aim we consider the following models:

$$\text{Mnone: } pI,i = aI,i,t = pF,i = aF,i,t = 0;\ t \in Ti;\ i=1,\ldots, N$$

$$\text{Mindustry: } pF,i = aF,i,t = 0;\ t \in Ti;\ i=1,\ldots, N$$

$$\text{Mfirm: } pI,i = aI,i,t = 0;\ t \in Ti;\ i=1,\ldots, N$$

$$\text{Mindustry-firm: Model (3.1)-(3.6)}$$

Thus model Mnone supposes that neither the industry effect nor the firm effect are significant; Mindustry supposes that only the industry effect is significant; Mfirm supposes that only the firm effect is significant; and Mindustry-firm supposes that both effects are significant. A comparison of these models is carried out using the MAD, R2 and DIC criteria explained in the Appendix. The results corresponding to MAD and DIC-LPRED criteria, for each country, are shown in Tables 8 and 9, respectively. Concretely, we show the values of the criteria for each compared model, the pvalue of the Friedman test, the mean ranks corresponding to each model and the obtained ranking using multiple rank comparison procedures. Thus it may be seen in Table 8 that, if we use the data corresponding to all the firms the value of the MAD criterion were 8.7968 for model Mnone, 8.5590 for Mindustry, 0.7083 for Mfirm and 0.6883 for Mindustry-firm. The mean ranks corresponding to the Friedman test[1] were 3.5743 for model Mnone; 3.4257 for Mindustry; 1.4846 for Mfirm and 1.5154 for Mindustry-firm. The Friedman test rejected the hypothesis of equality of median MAD for the four compared models (p-value = 0) and the ranking finally adopted was F<I-F<I<N, that is to say, it was model Mfirm which exhibited a tendency to obtain lower MAD values, followed by models MIndustry-firm, MIndustry and, finally, Mnone. The non-existence of significant differences between two of the models compared has been indicated with the symbol ~. Finally in Table 10 the values of R2 criterion are shown for each country and each compared model.

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[1] For each firm of the sample, rank 1 was assigned to the model with the minimum MAD or LPRED criteria, 2 to the model with the second minimum value of MAD or LPRED and so on.

Table 8: Comparison of models by country: MAD criterion (best behaviours in bold type)

		MAD				Mean ranks and Friedman test					
	Effects	**None**	**Industry**	**Firm**	**Industry-Firm**	**None**	**Industry**	**Firm**	**Industry-Firm**	**Pvalues**	**Rankings**
Country	**Belgium**	9.2027	8.9914	**0.4460**	0.6118	3.5610	3.4390	**1.1516**	1.8484	0.0000	F<I-F<I<N [+]
	France	8.9010	8.6810	**0.3475**	0.4471	3.5706	3.4294	**1.2435**	1.7565	0.0000	F<I-F<I<N
	Italy	6.8157	6.3680	**0.7441**	0.7594	3.6374	3.3626	**1.4398**	1.5602	0.0000	F<I-F<I<N
	Spain	8.3271	8.1833	0.5220	**0.5093**	3.5468	3.4532	1.5417	**1.4583**	0.0000	I-F<F<I<N
	Sweden	11.4380	10.9772	1.5771	**1.2749**	3.6056	3.3944	1.7972	**1.2028**	0.0000	I-F<F<I<N
	United Kingdom	9.6257	9.4938	1.1091	**0.9452**	3.5537	3.4463	1.7546	**1.2454**	0.0000	I-F<F<I<N
	All	8.7968	8.5590	0.7083	**0.6883**	3.5743	3.4257	**1.4846**	1.5154	0.0000	F<I-F<I<N

[+] It means that median MAD($\mathbf{M}_{\text{firm}}$) < median MAD($\mathbf{M}_{\textbf{industry}}$) < median MAD($\mathbf{M}_{\textbf{industry}}$) < median MAD($\mathbf{M}_{\textbf{none}}$)

Table 9: Comparison of models by country: DIC and LPRED (best behaviours in bold type)

		DIC $(x10^{6})$				Mean ranks and Friedman test for LPRED					
	Effects	**None**	**Industry**	**Firm**	**Industry-Firm**	**None**	**Industry**	**Firm**	**Industry-Firm**	**Pvalues**	**Rankings**
Country	**Belgium**	0.1059	0.1056	**0.0346**	0.0466	1.3832	1.6168	**4.0000**	3.0000	0.0000	N<I<I-F<F [+]
	France	0.4238	0.4219	**0.1453**	0.1550	1.3518	1.6482	**4.0000**	3.0000	0.0000	N<I<I-F<F
	Italy	0.2380	0.2359	**0.0999**	0.1139	1.3039	1.6961	**4.0000**	3.0000	0.0000	N<I<I-F<F
	Spain	0.3515	0.3502	0.1430	**0.1180**	1.3682	1.6318	3.0006	**3.9994**	0.0000	N<I<F<I-F
	Sweden	0.1227	0.1216	0.0666	**0.0566**	1.2969	1.7031	3.0000	**4.0000**	0.0000	N<I<F<I-F
	United Kingdom	0.3471	0.3463	**0.1752**	0.1768	1.3856	1.6144	**3.6273**	3.3727	0.0000	N<I<I-F<F
	All	1.5889	1.5814	**0.6645**	0.6670	1.3530	1.6470	**3.6258**	3.3742	0.0000	N<I<I-F<F

[+] It means that median LPRED($\mathbf{M}_{\textbf{none}}$) < median LPRED($\mathbf{M}_{\textbf{industry}}$) < median LPRED($\mathbf{M}_{\textbf{firm-ndustry}}$) < median LPRED($\mathbf{M}_{\textbf{firm}}$)

Table 10: Comparison of models by country: R^2 criterion (best behaviours in bold type)

		Effects			
		None	**Industry**	**Firm**	**Industry-Firm**
Country	**Belgium**	0.0000	0.0355	**0.9962**	0.9940
	France	0.0000	0.0371	**0.9973**	0.9962
	Italy	0.0000	0.0654	**0.9819**	0.9813
	Spain	0.0000	0.0315	0.9943	**0.9947**
	Sweden	0.0000	0.0808	0.9765	**0.9834**
	United Kingdom	0.0000	0.0225	0.9823	**0.9865**
	All	0.0000	0.0399	0.9890	**0.9904**

It can be noticed that models Mfirm and Mindustry-firm tend to behave better, a fact which underlines the greater importance of the firm effect. In contrast, the industry effect is marginal, only attaining statistical significance in Spain, Sweden and United Kingdom.

4.3. Results by sector

Tables 11 to 15 and Figures 5 and 6 show the results obtained by estimating models (3.1)-(3.6) for each of the sectors considered in the study. Thus, Table 11 show the point estimations and the 95% Bayesian credibility intervals of the adjustment coefficients bI and bF, while Figures 5 and 6 show the boxplot corresponding to their posterior distributions.

Table 11: Estimates of persistence coefficients by sector

		β_I			β_F		
		Q2.5	**Median**	**Q97.5**	**Q2.5**	**Median**	**Q97.5**
Sector	**181**	0.4897	0.8014	0.9450	0.4145	0.4490	0.4845
	201	-0.5855	0.5371	0.9805	0.4897	0.5554	0.6360
	222	0.4839	0.7653	0.9275	0.5471	0.5762	0.6050
	251	0.1125	0.7569	0.9793	0.4104	0.4454	0.4813
	256	0.3165	0.7092	0.9224	0.4676	0.4959	0.5244
	259	0.5728	0.8970	0.9817	0.4573	0.4913	0.5262
	282	0.7018	0.9432	0.9901	0.3931	0.4229	0.4550
	310	0.5150	0.8138	0.9507	0.5791	0.6127	0.6449
	432	0.3740	0.8111	0.9792	0.3987	0.4226	0.4469
	451	0.5259	0.8723	0.9746	0.4062	0.4274	0.4484
	463	0.4361	0.8483	0.9857	0.3522	0.3803	0.4131
	464	0.6066	0.8681	0.9678	0.5098	0.5313	0.5535
	466	0.5965	0.9152	0.9863	0.4680	0.4970	0.5269
	467	0.4546	0.7650	0.9327	0.4990	0.5251	0.5520
	493	0.7147	0.9508	0.9914	0.5126	0.5511	0.5908
	494	0.1030	0.5168	0.9169	0.4569	0.4788	0.5013
	522	0.2892	0.6866	0.9008	0.4689	0.5003	0.5323
	620	0.4806	0.7450	0.9147	0.3415	0.3679	0.3938
	702	0.3109	0.7140	0.9210	0.3586	0.3905	0.4233
	711	0.3498	0.7896	0.9495	0.3659	0.3987	0.4328
	812	0.4175	0.8376	0.9646	0.3403	0.3669	0.3935
	All	0.7576	0.9009	0.9553	0.4791	0.4856	0.4923

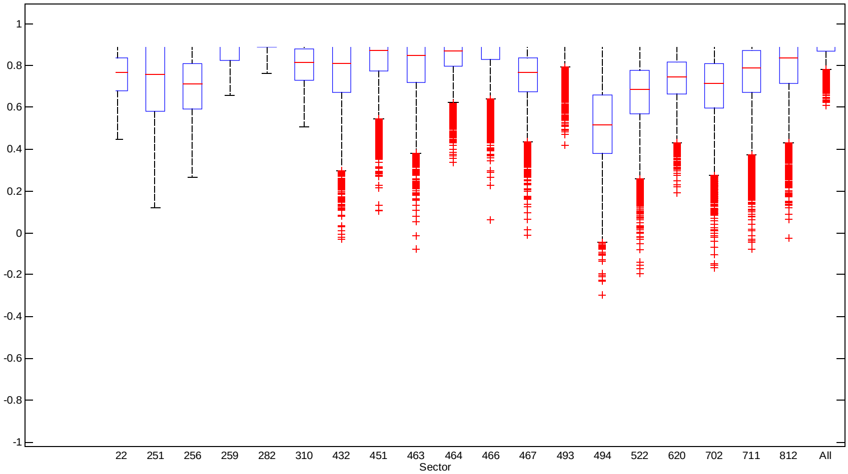

Figure 5: Boxplot of the posterior distribution of β_I by sector

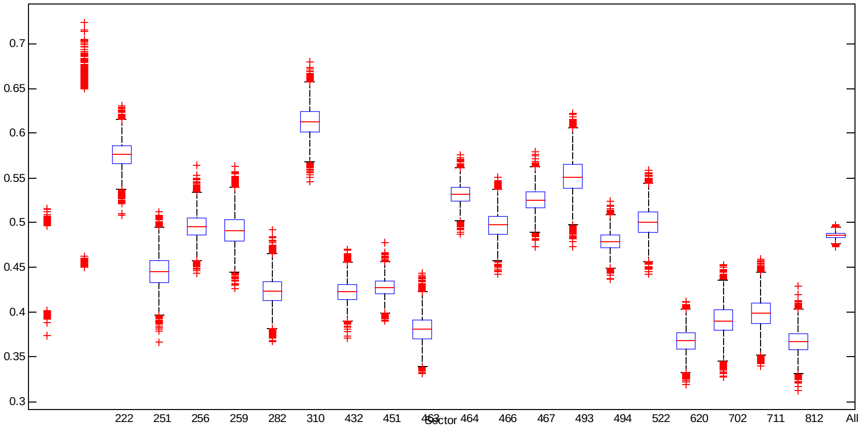

Figure 6: Boxplot of the posterior distribution of β_F by sector

It can be noticed that industry effects tend to have larger persistence than specific effects for most of considered sectors. The estimations of adjustment coefficients bI tend to oscillate around the estimated value for the aggregate model (labelled *All* in Table 11), 0.9009 and do not differ significantly from them. It can be appreciated (see Figure 5) that the more persistent sectors tend to be the construction (sector 432), wholesale (sectors 451 to 467) and passenger transport (sector 493) and some manufacture sectos (259, 282). On the contrary manufactures (sectors 201 to 256, 310), freight transport (sector 494) and services (sectors 181, 522 to 812) tend to be lower persistent.

Statistically significant differences can be noticed in the estimations of coefficients bF (see

Table 11 and Figure 6). The highest adjustment velocities, all of which are over 40%, corresponding to firms in construction (sector 432), service sector (sectors 181 and 620 to 812) and some firms in the wholesale sector (sectors 451 and 463) and manufacture (sectors 251 and 282). In contrast most of manufactures sectors (201, 222, 256, 259, 310), wholesale (464 to 467) and transport (493, 494) tend to have more persistent specific effects.

From an analysis of the importance of each effect on each country's total variability level (see Table 12) it may be observed how, generally speaking, industry effects have greater impact (oscillating between 78.32% for sector 493 (Other passenger land transport) and 97.69% for sector 702 (Management consultancy activities). This is due to the degree of stability in the evolution of mean levels for each sector, as remarked earlier. Worth pointing out, however, is the presence of 4 sectors, 463, 493, 451 (Sale of motor vehicles) and 282 (Manufacture of other general-purpose machinery), for which the industry effect has a significant importance, accounting for more than 10% of the total variability in the ROA evolution of firms in the sector.

By components, transitory effects continue to be those which account for most variability, throwing into relief the fact that the greater importance of temporary factors on the evolution of firms' profits affects most sectors.

Finally, Tables 13 to 15 show the results of the comparison of models **M**none, **M**industry, **M**firm and **M**insdustry-firm respect to criteria MAD (Table 13), DIC-LPRED (Table 14) and R2 (Table 15) by sector. It can be noticed that models Mfirm and Mindustry-firm tend to behave best, underlining the greater importance of the firm effect in each of the sectors analysed too. The importance of the industry effect is rather more marginal, being statistically significant in approximately 50% of the sectors considered in the study.

Table 13: Comparison of models by sector: MAD criterion (best behaviours in bold type)

		MAD				Mean ranks and Friedman test for MAD					
	Effects	**None**	**Industry**	**Firm**	**Industry-Firm**	**None**	**Industry**	**Firm**	**Industry-Firm**	**Pvalues**	**Rankings**
Sector	**181**	7.5023	7.1863	0.3959	**0.3110**	3.6340	3.3660	**1.4969**	**1.5031**	0.0000	F~I-F<I<N
	201	7.7392	7.4479	3.2842	**3.1327**	3.5777	3.4223	**1.4479**	**1.5521**	0.0000	F~I-F<I~N
	222	7.3774	7.1810	**0.8583**	1.0432	3.6068	3.3932	**1.4332**	**1.5668**	0.0000	F~I-F<I<N
	251	6.6519	6.5127	0.4336	**0.4323**	3.5547	3.4453	**1.4548**	**1.5452**	0.0000	F~I-F<I~N
	256	6.9564	6.8254	0.4192	**0.3031**	3.5924	3.4076	**1.4304**	**1.5696**	0.0000	F~I-F<I<N
	259	7.1051	6.9828	1.1470	**1.2569**	3.5807	3.4193	**1.5336**	**1.4664**	0.0000	F~I-F<I<N
	282	7.5472	7.4939	0.4450	**0.3594**	3.4960	3.5040	**1.4324**	**1.5676**	0.0000	F~I-F<I~N
	310	6.6524	6.2580	0.8044	**0.7793**	3.5888	3.4112	**1.5125**	**1.4875**	0.0000	F~I-F<I<N
	432	6.5068	6.3977	0.4980	**0.4737**	3.5017	3.4983	**1.4606**	**1.5394**	0.0000	F~I-F<I~N
	451	4.7571	4.2774	0.3632	**0.3184**	3.6760	3.3240	**1.5328**	**1.4672**	0.0000	F~I-F<I<N
	463	6.1786	5.6479	**0.9071**	0.9139	3.6232	3.3768	**1.5294**	**1.4706**	0.0000	F~I-F<I<N
	464	8.3265	8.2517	**0.1790**	0.2222	3.5306	3.4694	**1.4662**	**1.5338**	0.0000	F~I-F<I~N
	466	6.7969	6.7427	0.5607	**0.3919**	3.5150	3.4850	**1.3707**	1.6293	0.0000	F<I-F<I~N
	467	5.7473	5.7119	0.3936	**0.3906**	3.5149	3.4851	**1.4437**	**1.5563**	0.0000	F~I-F<I~N
	493	7.9613	7.2829	**1.1697**	1.1964	3.6063	3.3937	**1.4068**	1.5932	0.0000	F<I-F<I<N
	494	6.3620	5.8556	0.8934	**0.8395**	3.6505	3.3495	**1.4309**	1.5691	0.0000	F<I-F<I<N
	522	7.1285	7.0662	0.7895	**0.7667**	3.5735	3.4265	**1.4157**	1.5843	0.0000	F<I-F<I<N
	620	11.4077	11.2564	**1.2803**	1.4704	3.5529	3.4471	**1.4765**	**1.5235**	0.0000	F~I-F<I~N
	702	10.3721	10.4535	0.6334	**0.4640**	3.4922	3.5078	**1.5402**	**1.4598**	0.0000	F~I-F<I~N
	711	9.2608	9.0758	1.0995	**1.0069**	3.5309	3.4691	**1.4634**	**1.5366**	0.0000	F~I-F<I~N
	812	7.6806	7.5241	**0.1438**	0.2573	3.5063	3.4937	**1.3992**	1.6008	0.0000	F<I-F<I~N
	All	7.2608	7.0320	0.7084	**0.7016**	3.5712	3.4288	**1.4619**	1.5381	0.0000	F<I-F<I<N

Table 14: Comparison of models by sector: DIC and LPRED criteria (best behaviours in bold type)

		DIC (x10^6)				Mean ranks and Friedman test for LPRED					
		None	Industry	Firm	Industry-Firm	None	Industry	Firm	Industry-Firm	Pvalues	Rankings
Sector	**181**	0.0551	0.0549	**0.0261**	0.0263	1.3208	1.6792	**3.6377**	3.3623	0.0000	N<I<I-F<F
	201	0.0377	0.0376	0.0332	**0.0318**	1.3346	1.6654	**3.6563**	3.3437	0.0000	N<I<I-F<F
	222	0.0902	0.0901	**0.0540**	0.0564	1.3457	1.6543	**3.6853**	3.3147	0.0000	N<I<I-F<F
	251	0.0491	0.0489	**0.0180**	0.0246	1.3792	1.6208	**3.5978**	3.4022	0.0000	N<I<I-F<F
	256	0.0677	0.0675	**0.0278**	0.0285	1.3250	1.6750	**3.7346**	3.2654	0.0000	N<I<I-F<F
	259	0.0574	0.0572	0.0371	**0.0361**	1.3498	1.6502	**3.6290**	3.3710	0.0000	N<I<I-F<F
	282	0.0593	0.0590	0.0307	**0.0263**	1.4035	1.5965	**3.7040**	3.2960	0.0000	N<I<I-F<F
	310	0.0557	0.0554	0.0339	**0.0307**	1.3421	1.6579	**3.6210**	3.3790	0.0000	N<I<I-F<F
	432	0.1011	0.1006	**0.0503**	0.0545	1.4057	1.5943	**3.5539**	**3.4461**	0.0000	N<I<I-F~F
	451	0.1141	0.1126	0.0573	**0.0544**	1.2475	1.7525	**3.6284**	3.3716	0.0000	N<I<I-F<F
	463	0.0850	0.0844	**0.0520**	0.0586	1.3303	1.6697	**3.5202**	**3.4798**	0.0000	N<I<I-F~F
	464	0.1113	0.1110	**0.0401**	0.0455	1.4235	1.5765	**3.6314**	3.3686	0.0000	N<I<I-F<F
	466	0.0623	0.0621	0.0358	**0.0263**	1.3590	1.6410	**3.6709**	3.3291	0.0000	N<I<I-F<F
	467	0.0883	0.0881	0.0457	**0.0449**	1.2534	1.7466	**3.6202**	3.3798	0.0000	N<I<I-F<F
	493	0.0532	0.0526	**0.0305**	0.0323	1.3478	1.6522	**3.6745**	3.3255	0.0000	N<I<I-F<F
	494	0.1115	0.1104	0.0723	0.0645	1.2822	1.7178	**3.6956**	3.3044	0.0000	N<I<I-F<F
	522	0.0692	0.0691	0.0404	**0.0384**	1.3255	1.6745	**3.6931**	3.3069	0.0000	N<I<I-F<F
	620	0.0948	0.0946	0.0541	**0.0521**	1.4479	1.5521	**3.6229**	3.3771	0.0000	N<I<I-F<F
	702	0.0577	0.0576	0.0284	**0.0228**	1.4870	1.5130	**3.4508**	**3.5492**	0.0000	N<I<I-F~F
	711	0.0643	0.0639	0.0420	**0.0374**	1.4196	1.5804	**3.5681**	**3.4319**	0.0000	N<I<I-F~F
	812	0.0882	0.0876	**0.0278**	0.0331	1.4070	1.5930	**3.5500**	**3.4500**	0.0000	N<I<I-F~F
	All	1.5733	1.5651	0.8373	**0.8256**	1.3530	1.6470	**3.6258**	3.3742	0.0000	N<I<I-F<F

Table 15: Comparison of models by country: R^2 criterion (best behaviours in bold type)

		Global			
		None	Industry	Firm	Industry-Firm
Sector	**181**	0.0000	0.0390	0.9921	**0.9954**
	201	0.0000	0.0332	0.7707	**0.7838**
	222	0.0000	0.0165	**0.9690**	0.9591
	251	0.0000	0.0366	0.9834	**0.9848**
	256	0.0000	0.0195	0.9828	**0.9870**
	259	0.0000	0.0227	**0.9348**	0.9270
	282	0.0000	0.0480	0.9903	**0.9932**
	310	0.0000	0.0518	0.9605	**0.9624**
	432	0.0000	0.0415	**0.9874**	0.9867
	451	0.0000	0.0868	0.9819	**0.9841**
	463	0.0000	0.0633	0.9498	**0.9512**
	464	0.0000	0.0214	**0.9970**	0.9966
	466	0.0000	0.0375	0.9832	**0.9879**
	467	0.0000	0.0218	**0.9846**	0.9844
	493	0.0000	0.0957	**0.9436**	0.9421
	494	0.0000	0.0731	0.9509	**0.9543**
	522	0.0000	0.0104	**0.9742**	0.9677
	620	0.0000	0.0291	**0.9609**	0.9559
	702	0.0000	0.0143	0.9881	**0.9906**
	711	0.0000	0.0623	0.9663	**0.9714**
	812	0.0000	0.0570	**0.9978**	0.9951
	All	0.0000	0.0393	**0.9695**	0.9692

5. CONCLUSIONS

This study has carried out a Bayesian statistical analysis of the evolution of abnormal profits in a sample of EU firms. To that end, a Bayesian dynamic model, based on Bou and Satorra (2007), has been used which allows this evolution to be decomposed into its permanent (structural) components on the one hand, and its transitory and idiosyncratic components (both of them temporary) on the other; the model also permits to evaluate the importance of each component to be evaluated by distinguishing between effects which affect the industry to which each firm belongs globally and more specific effects which affect each firm individually. The analysis has been carried out from a Bayesian perspective which, since the estimation process does not depend on asymptotic results and enables a natural treatment of missing data by random imputations, endows the study with greater accuracy, flexibility and realism.

The results obtained underline the statistical significance of industry and firm effects alike, the influence of the latter being more important in that is accounts for more than 90% of total variation. Firm effects also display a significantly lower degree of persistence, with adjustment speeds oscillating around 51.1%, although this pattern is not homogeneous but depend on the sector and country analysed. Thus Swedish and British firms exhibit a lower degree of persistence with adjustment velocities of around 63.5%; the level for Italian and Belgian firms is higher, with adjustment velocities of around 48%; Spanish and French firms lie somewhere in the middle, with adjustment velocities of around 51.5%. At the same time, firms in the manufacture, wholesale and transport sectors tend to exhibit higher persistence levels than construction and service sectors.

Industry effects have a more marginal importance, being significantly more persistent, with adjustment speeds oscillating around 10%. This degree of persistence is more homogeneous at both country and sector levels owing to the greater stability of mean ROA evolution at the sector level. By countries, Italian and Spain tend to have more persistent industry effects (adjustment speeds around 4%-6%) while Swedish industries are the less persistent (adjustment speeds around 30%). By sectors, construction, wholesale and passenger transport sectors tend to be more persistent while manufactures and services tend to be lower.

It would be interesting to incorporate additional characteristics of the firms (size, age) in order to find more homogeneous groups of firms and to incorporate other European countries to the study. We are currently working in these aspects and the results will be presented elsewhere.

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APPENDIX

In this appendix we describe the estimation procedure of the parameters of the model (3.1)-(3.6) and the criteria used in the comparison of model process carried out in the paper.

A.1. Estimation procedure

We have used a Bayesian approach that let us to make exact inferences about the model parameters $(\theta, \theta_{I,F})$ from their posterior distribution $(\theta, \theta_{I,F})$ |Data where Data = {yi,t; t∈Ti ; i=1,…,N}. This distribution is calculated using MCMC methods (see, for example, Robert and Casella, 2004) and, more particularly, *Gibbs sampling*.

Given that we follow a Bayesian approach it is necessary to provide a prior distribution $(\theta, \theta_{I,F})$. Next we describe it.

A.1.1. Prior distribution

It is given by the following distributions:

$$\tau_{u,t} = \frac{1}{\sigma^2_{u,t}} \sim \text{Gamma}\left(\frac{\nu_u}{2}, \frac{\nu_u s^2_u}{2}\right); \; t=1,\ldots,T \qquad (A.1)$$

$$\tau_{p_I} = \frac{1}{\sigma^2_{p_I}} \sim \text{Gamma}\left(\frac{\nu_{p_I}}{2}, \frac{\nu_{p_I} s^2_{p_I}}{2}\right) \qquad (A.2)$$

$$\tau_{a_I} = \frac{1}{\sigma^2_{a_I}} \sim \text{Gamma}\left(\frac{\nu_{a_I}}{2}, \frac{\nu_{a_I} s^2_{a_I}}{2}\right) \qquad (A.3)$$

$$\tau_{p_F} = \frac{1}{\sigma^2_{p_F}} \sim \text{Gamma}\left(\frac{\nu_{p_F}}{2}, \frac{\nu_{p_F} s^2_{p_F}}{2}\right) \qquad (A.4)$$

$$\tau_{a_F} = \frac{1}{\sigma^2_{a_F}} \sim \text{Gamma}\left(\frac{\nu_{a_F}}{2}, \frac{\nu_{a_F} s^2_{a_F}}{2}\right) \qquad (A.5)$$

$$\tau_F \sim \text{Gamma}\left(\frac{\nu_F}{2}, \frac{\nu_F s^2_F}{2}\right) \qquad (A.6)$$

$$\beta_I \sim \text{Unif}(-1,1) \qquad (A.7)$$

$$\beta_F \sim \text{Unif}(-1,1) \qquad (A.8)$$

where (A.1)-(A.8) are assumed to be independents. All of them are standard in the Bayesian literature and they are diffuse if nj ≈ 0.

A.1.2. Posterior distribution

The posterior distribution $(\boldsymbol{\theta}, \boldsymbol{\theta}_{I,F})$ |Data is calculated by means of Bayes theorem and it is given by :

$$(\boldsymbol{\theta}, \boldsymbol{\theta}_{I,F})|\text{Data} \propto [\mathbf{y}|\boldsymbol{\theta}_{I,F}][\boldsymbol{\theta}_{I,F}|\boldsymbol{\theta}]\ [\boldsymbol{\theta}] =$$

$$= \prod_{i=1}^{N} \prod_{t \in T_i} [y_{i,t} \mid p_{I,s(i)}, a_{I,s(i),t}, p_{F,i}, a_{F,i,t}, \tau_{u,t}] \prod_{s=1}^{S} [p_{I,s} \mid \tau_{p_I}][\tau_{p_I}]$$

$$\prod_{s=1}^{S} \prod_{t=2}^{T} [a_{I,s,t} \mid a_{I,s,t-1}, \beta_I, \tau_{a_I}][a_{I,h,1} \mid \beta_I, \tau_{a_I}][\beta_I]\ [\tau_{a_I}]$$

$$\prod_{i=1}^{N} [p_{F,i} \mid \tau_p] \prod_{i=1}^{N} \prod_{t \in t_{low,i}+1}^{t_{upp,i}} [a_{F,i,t} \mid a_{F,i,t-1}, \beta_F, \tau_{a_F}][a_{F,i,t_{low,i}} \mid \tau_F][\beta_F][\tau_{a_F}][\tau_F] \prod_{t=1}^{T} [\tau_{u,t}] \propto$$

$$\propto \prod_{i=1}^{N} \prod_{t \in T_i} \tau_{u,,t}^{\frac{1}{2}} \exp\left[-\frac{\tau_{u,t}}{2} (y_{i,t} - p_{I,s(i)} - a_{I,s(i),t} - p_{F,i} - a_{F,i,t})^2 \right] x$$

$$x \prod_{s=1}^{S} \tau_{p_{I,}}^{\frac{1}{2}} \exp\left[-\frac{\tau_{p_I}}{2} p_{I,s}^2 \right] \tau_{p_I}^{\frac{\nu_{pI}}{2}-1} \exp\left[-\frac{\nu_{p_I} s_{p_I}^2}{2} \tau_{p_I} \right] I_{(0,\infty)}(\tau_{p_I})$$

$$\prod_{i=1}^{N} \prod_{t=2}^{T} \tau_{a_I}^{\frac{1}{2}} \exp\left[-\frac{\tau_{a_I}}{2} (a_{I,i,t} - \beta_{I,} a_{I,i,t-1})^2 \right] \prod_{i=1}^{N} \tau_{a_I}^{\frac{1}{2}} (1 - \beta_I^2)^{\frac{1}{2}} \exp\left[-\frac{\tau_{a_I} (1 - \beta_I^2)}{2} a_{I,i,1}^2 \right]$$

$$\tau_{p_I}^{\frac{\nu_{pI}}{2}-1} \exp\left[-\frac{\nu_{p_I} s_{p_I}^2}{2} \tau_{p_I} \right] I_{(0,\infty)}(\tau_{p_I})\ \tau_{a_I}^{\frac{\nu_{aI}}{2}-1} \exp\left[-\frac{\nu_{a_I} s_{a_I}^2}{2} \tau_{a_I} \right] I_{(0,\infty)}(\tau_{a_I})\ I_{(-1,1)}(\beta_I)$$

$$x\prod_{i=1}^{N}\tau_{p_F}^{\frac{1}{2}}\exp\left[-\frac{\tau_{p_F}}{2}p_{F,i}^{2}\right]\ \tau_{p_F}^{\frac{\nu_{p_F}}{2}-1}\exp\left[-\frac{\nu_{p_F}s_{p_F}^{2}}{2}\tau_{p_F}\right]I_{(0,\infty)}\left(\tau_{p_F}\right)$$

$$\prod_{i=1}^{N}\prod_{t\in t_{low,i}+1}^{t_{upp,i}}\tau_{a_F}^{\frac{1}{2}}\exp\left[-\frac{\tau_{a_F}}{2}\left(a_{F,i,t}-\beta_F a_{F,i,t-1}\right)^2\right]\prod_{i=1}^{N}\tau_F^{\frac{1}{2}}\exp\left[-\frac{\tau_F}{2}a_{F,i,t_{low,i}}^{2}\right]$$

$$\tau_{a_F}^{\frac{\nu_{a_F}}{2}-1}\exp\left[-\frac{\nu_{a_F}s_{a_F}^{2}}{2}\tau_{a_F}\right]I_{(0,\infty)}\left(\tau_{a_F}\right)\tau_F^{\frac{\nu_F}{2}-1}\exp\left[-\frac{\nu_F s_F^{2}}{2}\tau_F\right]I_{(0,\infty)}\left(\tau_F\right)I_{(-1,1)}\left(\beta_F\right)$$

$$\prod_{t=1}^{T}\tau_{u,t}^{\frac{\nu_u}{2}-1}\exp\left[-\frac{\nu_u s_u^{2}}{2}\tau_{u,t}\right]I_{(0,\infty)}\left(\tau_{u,t}\right) \qquad \text{(A.9)}$$

where I_A denotes the indicator function of A. Given that (A.9) is not analytically tractable we use MCMC methods and, more concretely, the Gibbs sampling to calculate it. In order to implement this algorithm we need to specify the full conditional distributions of (A.9) which are calculated next.

A.1.3. Full conditional distributions of (A.9)

1) $(p_{I,s}, \mathbf{a}_{I,s})' \mid \boldsymbol{\theta}_{F,I}-\{p_{I,s}, a_{I,,s}\}$ **,** $\boldsymbol{\theta}$, Data ~ $\mathbf{N}_{T+1}(\mathbf{m}_{I,s},\mathbf{S}_{I,s})$; $s\in\mathbf{S}$ where $\mathbf{a}_{I,s} = (a_{I,s,t};\ t=1,\ldots, T)'$ with

$$\mathbf{m}_{I,s}=\left(\boldsymbol{\Sigma}_{I,s}^{-1}+\sum_{i\in\{1,\ldots,N\}:s(i)=s}\mathbf{X}_i^{'}\mathbf{D}_i^{-1}\mathbf{X}_i\right)^{-1}\left(\sum_{i\in\{1,\ldots,N\}:s(i)=s}\mathbf{X}_i^{'}\mathbf{D}_i^{-1}\mathbf{Y}_i\right)^{-1},\ \mathbf{S}_{I,s}=\left(\boldsymbol{\Sigma}_{I,s}^{-1}+\sum_{i\in\{1,\ldots,N\}:s(i)=s}\mathbf{X}_i^{'}\mathbf{D}_i^{-1}\mathbf{X}_i\right)^{-1}$$

$\mathbf{Y}_i = (y_{i,t} - p_{F,i} - a_{F,i,t}\ ;\ t\in T_i)$, $\mathbf{X}_i = \left(\mathbf{1}_{\text{cardinal}(T_i)\text{x}1}\quad \mathbf{I}_{\text{cardinal}(T_i)}\right)$, $\mathbf{D}_i = \text{diag}\left(\sigma_{u,t}^2;t\in T_i\right)$ and

$$\boldsymbol{\Sigma}_{I,s}=\begin{pmatrix}\sigma_{p_I}^2 & \mathbf{0} \\ \mathbf{0} & \dfrac{\sigma_{a_I}^2}{1-\beta_I^2}\begin{pmatrix}1 & \beta_I & \ldots & \beta_I^{\text{cardinal}(T_i)-1} \\ \beta_I & 1 & \ldots & \beta_I^{\text{cardinal}(T_i)-2} \\ \ldots & \ldots & \ldots & \ldots \\ \beta_I^{\text{cardinal}(T_i)-1} & \beta_I^{\text{cardinal}(T_i)-2} & \ldots & 1\end{pmatrix}\end{pmatrix}$$

Proof

Just consider the following regression model:

$$\mathbf{Y}_i = \mathbf{X}_i\boldsymbol{\gamma}_s + \mathbf{u}_i \text{ with } \mathbf{u}_i \sim \mathrm{N}_{\mathrm{cardinal}(T_i)}(\mathbf{0}, \mathbf{D}_i);\ i \in \{1,\ldots,N\} : s(i) = s$$

$$\boldsymbol{\gamma}_s = (p_{I,s},\ a_{I,s,t};\ t=1,\ldots,\ T)' \sim \mathrm{N}_{T+1}(\mathbf{0},\boldsymbol{\Sigma}_{I,s})$$

2) $(p_{F,i},\mathbf{a}_{F,i}) \mid \boldsymbol{\theta}_{F,I}\text{-}\{p_{F,i},\ \mathbf{a}_{F,i}\},\ \boldsymbol{\theta}$, Data where $\mathbf{a}_{F,i} = (a_{F,i,t};\ t\in T_i)' \sim \mathrm{N}_{1+\mathrm{cardinal}(T_i)}(\mathbf{m}_{F,i},\mathbf{S}_{F,i})$; i=1,…, N with

$$\mathbf{m}_{F,i} = \left(\begin{pmatrix} \tau_{p_F} & \mathbf{0}' \\ \mathbf{0} & \Sigma_{F,i}^{-1} \end{pmatrix} + \mathbf{X}_i'\mathbf{D}_i^{-1}\mathbf{X}_i\right)^{-1} \left(\mathbf{X}_i'\mathbf{D}_i^{-1}\mathbf{z}_i\right),\ \ \mathbf{S}_{F,i} = \left(\begin{pmatrix} \tau_{p_F} & \mathbf{0}' \\ \mathbf{0} & \Sigma_{F,i}^{-1} \end{pmatrix} + \mathbf{X}_i'\mathbf{D}_i^{-1}\mathbf{X}_i\right)^{-1}$$

where $\mathbf{z}_i = (z_{i,t};\ t\in T_i)'$ with $z_{i,t} = y_{i,t} - p_{I,s(i)} - a_{I,s(i),t}$, $\mathbf{D}_i = \mathrm{diag}\left(\sigma_{u,t}^2; t\in T_i\right)$ and $\boldsymbol{\Sigma}_{F,i} = (\sigma_{F,j,\ell})$

with $\sigma_{F,j,\ell} = \mathrm{Cov}\left(a_{F,i,j+t_{low,i}-1}, a_{F,i,\ell+t_{low,i}-1}\right) = \beta_F^{2(\ell-j)}\left(\beta_F^{2(j+t_{low,i}-1)}\sigma_F^2 + \frac{\beta_F^{2(j+t_{low,i}-1)} - 1}{\beta_F^2 - 1}\sigma_{a_F}^2\right)$ if

$1\leq j\leq \ell\leq$ cardinal(T_i)

Proof

Just consider the following regression model

$$\mathbf{z}_i = \mathbf{X}_i\begin{pmatrix} p_{F,i} \\ \mathbf{a}_{F,i} \end{pmatrix} + \mathbf{u}_i \text{ with } \mathbf{u}_i \sim \mathrm{N}_{\mathrm{cardinal}(T_i)}(\mathbf{0}, \mathbf{D}_i) \text{ and}$$

$$\begin{pmatrix} p_{F,i} \\ \mathbf{a}_{F,i} \end{pmatrix} \sim \mathrm{N}_{\mathrm{cardinal}(T_i)+1}\left(\mathbf{0}, \begin{pmatrix} \sigma_{p_F}^2 & \mathbf{0}' \\ \mathbf{0} & \boldsymbol{\Sigma}_{F,i} \end{pmatrix}\right)$$

3) $\tau_{u,t} \mid \boldsymbol{\theta}_{F,I},\ \boldsymbol{\theta} - \{\tau_{u,t}\}$,Data $\sim$ $\mathrm{Gamma}\left(\frac{\nu_u + n_t}{2}, \frac{\nu_u s_u^2 + \sum_{i:t\in T_i}\left(y_{i,t} - p_{I,s(i)} - a_{I,s(i),t} - p_{F,i} - a_{F,i,t}\right)^2}{2}\right)$;

t=1,…, T with $n_{\ell,t}$ = cardinal{i∈ {1,…,N}: t∈ T_i }

4) $\tau_{p_I} \mid \boldsymbol{\theta}_{F,I},\ \boldsymbol{\theta} - \{\tau_{p_I}\}$, Data $\sim$ $\mathrm{Gamma}\left(\frac{\nu_{p_I} + S}{2}, \frac{\nu_{p_I} s_{p_I}^2 + \sum_{s=1}^{S} p_{I,s}^2}{2}\right)$

5) $\tau_{a_I} \mid \boldsymbol{\theta}_{F,I},\ \boldsymbol{\theta}-\{\tau_{a_I}\}$, Data ~ $\text{Gamma}\left(\frac{\nu_{a_I}+TS}{2}, \frac{\nu_{a_I}s_{a_I}^2+\sum_{s=1}^{S}\left\{\left(1-\beta_I^2\right)a_{I,s,1}^2+\sum_{t=2}^{T}\left(a_{I,s,t}-\beta_I a_{I,s,t-1}\right)^2\right\}}{2}\right)$

6) $\tau_{p_F} \mid \boldsymbol{\theta}_{F,I},\ \boldsymbol{\theta}-\{\tau_{p_F}\}$, Data ~ $\text{Gamma}\left(\frac{\nu_{p_F}+N}{2}, \frac{\nu_{p_F}s_{p_F}^2+\sum_{i=1}^{N}p_{F,i}^2}{2}\right)$

7) $\tau_{a_F} \mid \boldsymbol{\theta}_{F,I},\ \boldsymbol{\theta}-\{\tau_{p_F}\}$, Data ~ $\text{Gamma}\left(\frac{\nu_{a_F}+\sum_{i=1}^{N}(\text{cardinal}(T_i)-1)}{2}, \frac{\nu_{a_F}s_{a_F}^2+\sum_{i=1}^{N}\left\{\sum_{t=t_{low,i}+1}^{t_{upp,i}}\left(a_{F,i,t}-\beta_F a_{F,i,t-1}\right)^2\right\}}{2}\right)$

8) $\tau_F \mid \boldsymbol{\theta}_{F,I},\ \boldsymbol{\theta}-\{\tau_F\}$, Data ~ $\text{Gamma}\left(\frac{\nu_F+N}{2}, \frac{\nu_F s_F^2+\sum_{i=1}^{N}a_{F,i,t_{low,i}}^2}{2}\right)$

9) $\beta_I \mid \boldsymbol{\theta}_{F,I},\ \boldsymbol{\theta}-\{\beta_I\}$, Data

In this case the density of this distribution is proportional to:

$$\prod_{s=1}^{S}\prod_{t=2}^{T}\exp\left[-\frac{\tau_{a_I}}{2}\left(a_{I,s,t}-\beta_{I,h_1}a_{I,s,t-1}\right)^2\right]\ \prod_{s=1}^{S}\left(1-\beta_I^2\right)^{\frac{1}{2}}\exp\left[-\frac{\tau_{a_I}\left(1-\beta_I^2\right)}{2}a_{I,h,1}^2\right]I_{(-1,1)}(\beta_I)\propto$$

$$\propto\left(1-\beta_{I,h_1}^2\right)^{\frac{S}{2}}\exp\left[-\frac{1}{2s_{\beta_I}^2}\left(\beta_I-m_{\beta_I}\right)^2\right]I_{(-1,1)}(\beta_I)$$

where $m_{\beta_I}=\frac{\sum_{s=1}^{S}\sum_{t=2}^{T}a_{I,s,t}a_{I,s,t-1}}{\sum_{s=1}^{S}\sum_{t=2}^{T-1}a_{I,s,t}^2}$, $s_{\beta_I}^2=\frac{\sigma_{a_I}^2}{\sum_{s=1}^{S}\sum_{t=2}^{T-1}a_{I,s,t}^2}$

We use a slice sampling step to draw a sample from this distribution. To that aim we draw u~ $\text{Unif}\left(0,\left(1-\beta_I^2\right)^{\frac{S}{2}}\right)$, $\beta_I \sim N\left(m_{\beta_I}, s_{\beta_I}^2\right.$ truncated in $\left(-\left(1-u^{\frac{2}{S}}\right)^{\frac{1}{2}},\left(1-u^{\frac{2}{S}}\right)^{\frac{1}{2}}\right)$

10) $\beta_F \mid \boldsymbol{\theta}_{F,I},\ \boldsymbol{\theta}-\{\beta_F\}$, Data~ $N\left(m_{\beta_F}, s_{\beta_F}^2\right)$ truncated (-1,1) where $m_{\beta_F}=\frac{\sum_{i=1}^{N}\sum_{t\in t_{low,i}+1}^{t_{upp,i}}a_{F,i,t}a_{F,i,t-1}}{\sum_{i=1}^{N}\sum_{t=t_{low,i}}^{t_{upp,i}-1}a_{F,i,t}^2}$,

$$s^2_{\beta_F} = \frac{\sigma^2_{a_F}}{\sum_{i=1}^{N}\sum_{t=t_{low,i}}^{t_{upp,i}-1} a^2_{F,i,t}}$$

Using this distributions and the Gibbs sampling alogirhtm we draw a sample of $((\boldsymbol{\theta}, \boldsymbol{\theta}_{I,F}))|$ Data from which inferences can be made about $\boldsymbol{\theta}$ and $\boldsymbol{\theta}_{I,F}$. More concretely we have obtained point estimations of each component of $\boldsymbol{\theta}$ and $\boldsymbol{\theta}_{I,F}$, as well as Bayesian credibility intervals using the posterior median and the appropriate quantiles of the posterior distribution.

A.1.4. Comparison of models

We have used the following criteria to evaluate each of the models M considered in our study.

- *Mean Absolute Deviation*

This criterion evaluates the predictive behaviour of the model, such that the lower its value, the better its behaviour. It is given by:

$$\text{MAD}(\mathbf{M}) = \frac{1}{N}\sum_{i=1}^{N}\text{MAD}_i(\mathbf{M}) \qquad \text{(A.10)}$$

where:

$$\text{MAD}_i(\mathbf{M}) = \frac{\sum_{t=t_{low,i}+1}^{t_{upp,i}} | y_{i,t} - E\left[y_{i,t} \mid \mathbf{M}, \{y_{i,t_{low,i}}, \ldots, y_{i,t-1}\}, \text{Data}\right] |}{\text{cardinal}(T_i)}; \; i=1,\ldots, N \qquad \text{(A.11)}$$

is the mean absolute deviation in i-th firm and

$$E\left[y_{i,t} \mid \mathbf{M}, \{y_{i,t_{low,i}}, \ldots, y_{i,t-1}\}, \text{Data}\right] = E\left[p_{I,i} + \beta_I a_{I,i,t-1} + p_{F,i} + \beta_F a_{F,i,t-1} \mid \mathbf{M},, \text{Data}\right]$$

- *Determination coefficient*

$$R^2(\mathbf{M}) = 1 - \frac{\sum_{i=1}^{N}\sum_{t=t_{low,i}+1}^{t_{upp,i}}\left(y_{i,t} - E\left[y_{i,t} \mid \mathbf{M}, \{y_{i,t_{low,i}}, \ldots, y_{i,t-1}\}, \text{Data}\right]\right)^2}{\sum_{i=1}^{N}\sum_{t=t_{low,i}}^{t_{upp,i}} y^2_{i,t}} \qquad \text{(A.12)}$$

which takes values between 0 and 1 and measures the percentage of total variation in the data observed, as explained by the model.

- *Deviance Information Criterion (DIC)* first proposed by Spiegelhalter et al. (2002)

$$\mathrm{DIC}(\mathbf{M}) = -2\sum_{i=1}^{N}\mathrm{LPRED}_i(\mathbf{M}) + p_D(\mathbf{M}) \qquad (A.13)$$

where

$$\mathrm{LPRED}_i(\mathbf{M}) = \sum_{t=t_{low,i}}^{t_{upp,i}} E\left[\log\left(f\left(y_{i,t} \mid \mathbf{M}, \boldsymbol{\theta}, \boldsymbol{\theta}_{I,F}\right)\right) \mid \mathrm{Data}\right] \text{ for } i = 1, \ldots, N \qquad (A.14)$$

being $f\left(y_{i,t} \mid \mathbf{M}, \boldsymbol{\theta}, \boldsymbol{\theta}_{I,F}\right)$ the density of a normal distribution $N\left(p_{I,i} + a_{I,i,t} + p_{F,i} + a_{F,i,t,}, \sigma^2_{u,t}\right)$; for $t = t_{low,i}+1, \ldots, t_{upp,i}$; $i=1,\ldots, N$, while

$$p_D(\mathbf{M}) = -2\sum_{i=1}^{N}\mathrm{LPRED}_i(\mathbf{M}) + 2\sum_{t=t_{low,i}}^{t_{upp,i}}\log\left(f\left(y_{i,t} \mid \mathbf{M}, \bar{\boldsymbol{\theta}}, \bar{\boldsymbol{\theta}}_{I,F}\right)\right)$$

is the effective number of model M parameters, where

$$\bar{\boldsymbol{\theta}} = E[\boldsymbol{\theta} \mid \mathrm{Data}] \text{ y } \bar{\boldsymbol{\theta}}_{I,F} = E\left[\boldsymbol{\theta}_{I,F} \mid \mathrm{Data}\right]$$

The DIC criterion evaluates the goodness of fit of the model and has two components: the first, $-2\sum_{i=1}^{N}\mathrm{LPRED}_i(\mathbf{M})$, evaluates the explanatory power of model M, while the second, pD(**M**), measures its degree of parsimony.

All these criteria carry out an aggregate measurement of the degree to which the model is compatible with the observed data. Nevertheless, in this study that compatibility is also measured at a more disintegrated level for each firm in the sample. To this end we use the individual values of the criteria MAD and LPRED, {MADi(M), LPREDi(M); i=1,…,N} for each compared model and we apply the Friedman test (see, for example, Daniel, 1990) as well as a simultaneous rank test[1] to analyse if there are significant differences among the models.

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[1] More concreted we have used the *friedman* and the *multcompare* procedures of the program MATLAB 7.9.0 (R2009 b)

TABLES

Table 1: Number of firms analysed by sector and country

		Country						
NACERev2, 3 code	**Sector (NACERev2, 3 code)**	**Belgium**	**France**	**Italy**	**Spain**	**Sweden**	**United Kingdom**	**Total**
181	Printing and service activities related to printing	62	156	123	142	51	261	795
201	Manufacture of basic chemicals, fertilizers and nitrogen compounds, plastic and synthetic rubber in primary forms	66	103	108	80	32	158	547
222	Manufacture of plastic products	66	381	317	244	68	249	1325
251	Manufacture of fabricated metal products	62	144	183	215	47	90	741
256	Treatment and coating of metals	39	223	325	77	67	275	1006
259	Manufacture of other fabricated metal products	40	151	179	146	53	280	849
282	Manufacture of other general-purpose machinery	45	185	279	98	84	174	865
310	Manufacture of furniture	42	97	302	191	61	146	839
432	Electrical, plumbing and other construction installation activities	89	402	183	482	89	266	1511
451	Sale of motor vehicles	44	563	160	415	107	646	1935
463	Wholesale of food, beverages and tobacco	73	242	139	460	39	358	1311
464	Wholesale of household goods	159	304	282	278	152	393	1568
466	Wholesale of other machinery, equipment and supplies	90	418	85	209	81	53	936
467	Other specialized Wholesale	124	407	165	335	122	224	1377
493	Other passenger land transport	44	307	63	150	47	151	762
494	Freight transport by road	149	628	190	286	118	337	1708
522	Support activities for transportation	82	307	193	188	70	180	1020
620	Information technology service activities	72	344	158	222	119	342	1257
702	Management consultancy activities	69	94	72	250	114	173	772
711	Architectural and engineering activities and related technical consultancy	44	317	51	216	103	158	889
812	Cleaning activities	63	412	188	492	67	58	1280
All	All	1524	6185	3745	5176	1691	4972	23293

Table 12: Percentage of total variability owing to each component by sector

		Industry Effect			Firm Effect			
		% Permanent	%Transitory	%Industry	% Permanent	%Transitory	%Firm	%Idiosyncratic
Sector	**181**	1.24	2.79	4.03	40.02	54.24	94.26	1.71
	201	2.58	0.40	2.98	36.43	50.64	87.07	9.95
	222	0.46	1.70	2.16	33.41	58.11	91.52	6.32
	251	6.41	1.58	7.99	35.59	52.76	88.34	3.67
	256	1.08	1.91	3.00	25.25	68.30	93.55	3.45
	259	1.48	2.02	3.50	28.34	57.88	86.22	10.28
	282	5.34	5.14	10.48	38.21	49.56	87.78	1.75
	310	1.66	3.22	4.88	30.19	58.00	88.20	6.92
	432	4.25	1.80	6.05	31.68	59.73	91.41	2.54
	451	6.35	6.18	12.53	34.91	50.09	84.99	2.48
	463	9.80	4.43	14.23	37.16	45.50	82.66	3.11
	464	1.02	1.75	2.78	36.72	59.38	96.10	1.13
	466	4.58	4.71	9.28	38.17	50.26	88.44	2.28
	467	0.88	3.03	3.91	37.74	54.69	92.43	3.66
	493	6.02	6.98	13.00	35.76	42.55	78.32	8.68
	494	5.90	1.24	7.14	27.55	57.88	85.43	7.43
	522	0.31	1.18	1.50	32.66	63.55	96.21	2.29
	620	1.29	3.79	5.09	29.01	58.47	87.47	7.44
	702	0.43	0.77	1.20	35.97	61.72	97.69	1.11
	711	3.92	5.02	8.94	32.42	54.46	86.88	4.17
	812	3.62	3.99	7.62	36.21	55.76	91.97	0.41
	All	0.65	1.41	2.06	39.20	58.57	97.77	0.16

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Narula, R. and Hagedoorn, J. (1997): Globalization, Organisational Modes and the Growth of International Strategic Alliances. (Working Paper 97-017). Maastricht: Maastricht Economics Research Institute on Innovation and Technology (MERIT).