Firm and industry effects: The importance of sample design

Abstract

Purpose: This paper examines how sample design affects the relative importance of firm and industry factors in explaining performance variations.

Design/methodology/approach: Using a sample of 14,204 Spanish firms over a ten-year time frame, this study uses partial sensitivity analysis to examine the biases in results as a consequence of three methodological relevant concerns: outliers, industry classification and time period.

Findings: Results indicate that the industry effect, supported by the industrial organization theory, has been underestimated in the empirical tests.

Originality/value: This study examines the biases in results as a consequence of three methodological relevant concerns (outliers, sector classification and time period), which have not been sufficiently studied to date. Moreover, the study provides some new evidence favourable to the Industrial Organization (IO) perspective, which could have been biased and underestimated by the literature, since most of the analyses do not consider the methodological issues studied in this paper.

Keywords: *Sample design; sensitivity analysis; firm effect; industry effect; performance*

Paper type: Viewpoint

Firm and industry effects: The importance of sample design

1. Introduction

Why are some firms more competitive than others? This is a key concern for academics and managers. The answer to this question would not only improve the academic knowledge base but also provide relevant information to guide practitioners. For almost three decades an interesting academic debate has developed - the firm-industry effect debate (Rumelt, 1991) – to understand why some firms are more competitive, and thereby achieve better performance (Pehrsson, 2016; Certo *et al*., 2017; Schröder and Yim, 2018), than their rivals.

The firm-industry effect debate involves two theoretical frameworks: the Resource-Based Theory (RBT), which postulates that resources and capabilities (the firm effect) determine organizational performance, and the Industrial Organization (IO) theory, which considers that the structure of the sector (the industry effect) is what drives profitability. The debate has also been the source of extensive discussion (e.g., Short *et al*., 2016; Parnell, 2006), in which most studies find that it is the firm effect that is dominant (e.g. Andonova and Ruíz-Pava, 2016; Karniouchina *et al*., 2013; Xia and Walker, 2015; Bowman and Ambrosini, 2010), which is more consistent with the RBT. However, although most studies appear to favour the firm effect, this has not led to a consensus and the debate is still ongoing.

Our work aims to highlight the importance of the sample design in the empirical studies carried out in this debate. We will focus on three of those aspects: *outliers, industry classification* and *time period.* There have been discrepancies in the literature regarding the importance of these issues which may have resulted in a number of conceptual, methodological, and practical limitations, obstructing rigorous theory advancement in this area. For instance, studies rarely refer to outliers in their samples and how to handle them. However, the presence of outliers and the way they are dealt with may have an impact on firm and industry effects. The greater the number of exceptional firms (i.e., firms that outperform the industry average), the higher the intra-industry distributions and the lower the impact of industry effects will be (Hawawini *et al*., 2003). Similarly, the industry classification may play a role in assessing the impact of firm and industry effects. In this case, the more aggregated the industry definitions, the more likely the true industry effects are obscured (McGahan and Porter, 2005). Despite the potential impact this may have on supporting one theoretical approach over the other, this aspect has been seldom investigated in the literature. Finally, the time period is argued to play a role in explaining the impact of firm and industry effects. Different theoretical approaches might explain different results when the temporal frameworks vary in length (Mauri and Michaels, 1998). Overall, these aspects might positively or negatively bias the weight of the firm and industry effects being analysed. To a greater or lesser extent, this would erroneously skew support for the RBT over that of the IO, or vice versa.

Consequently, there is a need for more attention in this area. In particular, we want to emphasize that the sampling characteristics are essential because the results could differ significantly if these are modified, and could lead to spurious conclusions, both theoretical and practical. Based on the above discussion, this study addresses the following two research questions:

(1) Given a specific sample, are the firm and industry effects sensitive to a group of methodological issues (outliers, industry classification and time period)?

(2) Have any of the potential biases derived from these issues favoured one of the theoretical approaches – IO and RBT- over the other?

By answering these research questions, the study makes the following contributions to the literature: First, the biases in the results as a consequence of three methodological relevant concerns (outliers, sector classification and time period) are studied. Partial sensitivity analyses related to these variables are conducted and it is found that, starting from a first result of predominance of the firm effect, two of them give rise to results more favourable to the industry effect than to the firm effect, while with the third the predominance of the firm effect remains unaltered. As a consequence of the importance of the biases observed, it is concluded that researchers should be aware of the variability of their results that could be caused by changes in the idiosyncratic characteristics of their sample design. Second, new evidence favourable to the IO perspective is provided, which could have been biased and underestimated by the literature, since most of the analyses do not consider the methodological issues studied in this paper. In addition, the existing research is enriched with a wide sample, which does not focus exclusively on large listed manufacturing companies, as has been the case in previous studies. Thus, our sample integrates manufacturing and services, listed and non-listed firms, and all firm sizes (large, medium-sized, small, and micro), and therefore reflects more closely a country's business reality.

2. Underlying theoretical frameworks

The firm-industry effect debate has arisen as the result of two distinct conceptual frameworks, IO (Audretsch, 2018; Shepherd, 2018) and RBT (Barney, 2018; Foss, 2004), and their attempts to support the industry and firm effects respectively. In the 1980s the basic tenets of competitive advantage were rooted in the structure-conduct-performance paradigm due to the influence of IO on strategic management. IO considers barriers to entry, the number and size of firms in the sector, the degree of concentration, product standardization, and the elasticity of demand as factors capable of influencing firm performance (Spanos and Lioukas, 2001). Consequently, the structure of the sector will determine how firms behave and the strategies they adopt, and, as such, will be capable of explaining how firms perform within their respective markets (Porter, 1981).

The prevalence of IO within the field of strategic management paved the way for a wide range of concepts and techniques that were, in the main, aimed at the competitive analysis of industry. These advances helped to better understand the factors capable of generating competitive advantage and, in consequence, organisational performance. In parallel, this conceptual framework gave rise to a significant number of empirical studies on the profitability of firms from different countries and sectors (e.g., McGahan, 1999; McGahan and Porter 1999).

The alternative and/or complementary perspective of IO with respect to strategic management is the firm resources perspective (Barney, 2018; Nason *et al.*, 2018), which considers that competitive advantage may be explained by the heterogeneous endowment of resources for each organisation (Barney 1991). Based on this heterogeneity, it is possible to distinguish among firms according to the resources they have and/or control and their ability to harmonize these in order to generate capabilities (Grant, 1991; Bowman and Ambrosini, 2003). Thus, the range of product-market strategies adopted will be determined by each firm's own endowment of resources. This means that the ability to maintain the heterogeneity of resources over time will facilitate the generation of a sustainable competitive advantage (Huang *et al.,* 2015) and, as a result, the generation of long-term rents (Black and Boal, 1994).

In short, the dominance of the sector over the firm effect in explaining organisational performance over time means that the homogeneity of firms and their similarities are due to conditions inherent in the sector. In contrast, if the firm effect were stronger than the industry effect, it would imply that firms were heterogeneous. This heterogeneity might be explained by the firms' different levels of resource endowments which, in turn, would explain the different levels of organisational performance within the same sector (Rumelt, 1991).

3. Empirical background

The relative importance of a firm's idiosyncratic resources and the industry structure are features that help explain firm performance. The testing of the firm and industry effects is now a classic, well-consolidated line of research. As an indicator of the dynamism of this line of research, there are attempts to integrate the two theoretical perspectives (RBT and IO) by looking at the firm-industry interaction effect (Eriksen and Knudsen, 2003; Arend, 2009; Bamiatzi and Hall, 2009) and how interdependency affects firm and industry profitability (Lenox, Rockart and Lewin, 2010). Other incremental explanatory factors are explored such as the industry life cycle stage (Karniouchina *et al.,* 2013), the effect of strategic groups

(González-Fidalgo and Ventura-Victoria, 2002), the business domain effect (Houthoofd, Desmidt and Fidalgo, 2010), or the influences of industry and firm effects on information technology diffusion (Neirotti and Paolucci, 2014). Methodologies as alternatives to the variance component analysis, which is the most common, are also proposed. Other empirical approaches include the two-stage regression (Brush, Bromiley and Hendrickx, 1999), multilevel analysis (Hough, 2006), structural equation models (Bou and Satorra, 2007), non-linear methods (Eriksen and Knudsen, 2003; Arend, 2009), and hierarchical regression analysis (Galbreath and Galvin, 2008).

However, as for the methodological features that are strictly relevant to our research (outliers, industry classification and time period), it should be stressed that very few studies contain references to them. These features are related to sample attributes that should be specifically analysed because they might give rise to differences in empirical results. They are addressed in the following subsections.

3.1. Outliers

There is a lack of studies in which the implications of outliers in the generation of robust evidence have been methodically addressed. The studies that deal with this topic usually stress the importance of eliminating outliers in order to avoid an undesirable influence on the analysis, but, in most of them whether or not maintaining these values leads to different results is not tested (Roquebert *et al*., 1996; McGahan and Porter, 1997; Eriksen and Knudsen, 2003). The failure to investigate this issue in detail has significant implications for the debate around the firm-industry effect. The apparent trend in the literature, in which the results support the primacy of the firm effect, constitutes the main line of defence in favour of RBT to the detriment of IO. However, the scant attention paid to outliers casts doubt upon the reliability and validity of this argument.

Despite of contradictory evidence, economic rationale suggests that the inclusion of high and low performers for each sector will exert a certain influence on the weights of the firm and industry effects. As the number of atypical performers increases with respect to the average for the sector, so will the degree of intra-sector dispersion, leading to a decrease in the industry effect (Hawawini *et al*., 2003). In other words, by eliminating the superior firms, the analysis becomes centred upon those companies whose performance is closest to the average within the sector. It would seem reasonable to assume that these firms are more heavily influenced by the defining characteristics of the sector, magnifying the weight of the industry effect. Similarly, the elimination of organisations with exceptional results, whose differential characteristics might justify this performance, would reduce the firm effect. Consequently, we propose conducting a first partial sensitivity analysis in order to measure the scope of the variation in the weights of the variance components of return on assets (Kim and Patel, 2017) in the presence or absence of extreme values in each sector.

3.2. Industry classification

One of the most commonly cited obstacles to fully accepting the results of the analyses of firm and industry effects is the definition of what constitutes a sector. For example, there might be sectors which are extremely generic in that they are made up of firms whose activities are so diverse that they are not strictly competing against one another (Powell, 1996); or, conversely, others which are so specific that they include very few firms (Rumelt, 1991; McGahan and Porter, 1997).

When the range of activity of firms working within the same industry is particularly wide as the result of an excessively broad classification, this might negatively bias the importance of the industry effect (McGahan and Porter, 1997). McGahan and Porter (2005) argue that aggregation increases intra-industry while decreasing inter-industry variation by dragging it towards the mean. This makes the estimated variance for the industry effect artificially low and, thus, its contribution to total variance is underestimated. As a result, we propose a second partial sensitivity analysis to study the stability of the weights of the variance components of return on assets (ROA) related to the level of industry disaggregation.

3.3. Time period

At a theoretical level, the length of the period analysed is assumed to be a relevant factor when studying industry and firm effects. According to Mauri and Michaels (1998), different theoretical approaches might explain different results when temporal frameworks vary in length. IO argues that, in the long-term, levels of competition tend to become less intense than in the short-term. This allows a certain equilibrium to develop within the sector which would explain an increase in the industry effect when compared to shorter time periods. In contrast, from a Schumpeterian perspective, an increase in the time period would elevate the likelihood of a certain revolution which might intensify competition. This would explain a decrease in the industry effect. However, scholars do not generally consider the time period used in the analysis to be of paramount importance. Further, there seems to be no move towards the standardization of the time period adopted. This is reflected in the wide-ranging variability in the time periods used (from one to seventeen years), which is almost certainly due to the availability of data.

However, it is not trivial that the temporal series used as a sample in an analysis either includes or excludes one or various complete economic cycles (Hawawini *et al*., 2003), or that a period of growth or recession is circumscribed. Therefore, in order to optimize the potential generalization of these results, we will try to examine the effect that different time periods might exert on the behaviour of firm and industry effects. To this end, we propose a third partial sensitivity analysis to identify to what extent the weights of the variance components of ROA differ when several stages of the economic cycle are considered in the time period.

4. Empirical study

4.1. Data

We use a sample of 14,204 Spanish firms, for the years 1995–2004, obtained from Sistema de Análisis de Balances Ibéricos - Iberian Balance Sheet Analysis System (SABI) which collects information from the Spanish Official Register. This database is published by Bureau van Dijk Electronic Publishing and contains information on firm accounts (balance sheet and profit and losses statements), main and secondary activities (four-digit NACE), location (province, NUTS III), and other characteristics such as year of birth, exporter/importer status, and shareholder capital distribution. It contains information for over 1 million Spanish companies from all the autonomous regions of Spain and of every size (i.e., micro, small, medium, and large). Further, almost all sectors are represented within the sample[1]. As for the selection of this ten-year time period (1995-2004), it presents the advantage of being one of the longest period of uninterrupted growth of Gross Domestic Product (GDP) of the Spanish economy. It takes in the expansive phase of an economic cycle, but the intensity of GDP growth over this period varies. Hence, one can observe an initial phase of strong growth and high volatility corresponding to the 1995–1999 period. The rhythm of GDP growth decelerates until 2002 and subsequently bounces back until 2004, in a second discernible stage. We refer to this second phase, the five-year period (2000–2004), a period of moderate growth.

The selection of Spain is particularly interesting because of the high presence of small firms in the Spanish economy which can enrich the scope of the firm-industry debate. Small firms constitute around 88% of the final sample. Compared with other studies (e.g., Mauri and Michaels 1998; McGahan and Porter 1999; Hawawini et al., 2003), the source of information is markedly different, mainly in terms of the size of the firms. For example, Compustat or Stern Stewart Data, two databases frequently cited in this literature, work with companies that in most of cases are large and, in comparative terms, produce samples very different to the one used in this study.

4.2. Model and methodology

The model estimation has been carried out using ROA as the dependent variable. This is defined as the ratio between gross profit and the firm's total assets.

[1] The only sectors that are not represented in the sample are "L Public administration and defence; compulsory social security", "P Activities of private households as employers and undifferentiated production activities of private households", and "Q Extraterritorial organisations and bodies".

The model is the one proposed by Rumelt (1991), albeit adapted in the sense that we use a single measure of the firm effect. Thus, the model contemplates five sources of variation in organisational performance: the firm effect, the stable industry effect, the industry-year interaction effect (transitory industry effect), the influence of the economic cycle per year, and the random error.

Formally:

$$r_{ijt} = \mu + \alpha_i + \beta_j + \gamma_t + \delta_{it} + \varepsilon_{ijt} \qquad (1)$$

where:

r_{ijt}: firm j's ROA in the sector i in year t.

μ: independent term in the model representing a global mean; that is, the average return of the sample of firms in the period being considered.

α_i: industry effect, which reflects how the defining characteristics of the sector of activity influence the firm's return.

β_j: firm effect, which reflects firms' heterogeneity, even when these are in the same sector, and is given by their resource endowments.

γ_t: temporal effect that captures the annual macroeconomic factors.

δ_{it}: industry-year interaction effect, that takes in the impact of the economic cycle on the sector in which the firm's activity is carried out.

ε_{ijt}: random error term.

In line with Rumelt (1991), this study applies decomposition of the variance components of the dependent variable with random effects. The estimations are carried out by means of the *lme4* library of the statistical language *R* (Bates and Maechler, 2009; R Core Team, 2014). The estimation of parameters is carried out via the optimization of the objective function. Given the potential enormity of the solution, *lme4* reformulates the problem of least squares estimation as a problem of penalized weighted least squares so that the optimization process is more stable and uses efficient methods for the Cholesky decomposition of sparse symmetric and positive definite matrices.

5. Results and discussion

This section presents and examines the results obtained from the proposed model. First, the base results are given, that is, the results that correspond to the application of the model to the full sample of firms grouped within the three-digit NACE sectors. Subsequently, each subsection contains the partial sensitivity analyses carried out. Each of these looks at the degree to which the base results are affected when a specific criterion of the sample is modified.

5.1. Base results

Table 1 contains the results when the model is applied to the whole sample. The basic characteristics of the model are as follows: 14,204 firms, none of which were excluded due to atypical performance; classified to three digits into NACE sectors; with performance data relative to the 1995–2004 ten-year period.

Insert Table 1 about here

The table reflects the higher relative impact for the firm effect whose weight is almost four times greater than that of the stable industry effect. The table also reveals the almost negligible relevance of the industry-year interaction and time period effects. In addition, it highlights the strength of the random error, which indicates that more than 80% of the variance of Spanish firms' ROA cannot be explained by the model.

As mentioned previously, the dominance of the firm effect over the industry effect is a frequent result in the empirical literature. With respect to the random error, the level tends to vary depending on the study, and usually falls within the 20-80% range. The value obtained in this study is, without doubt, one of the highest observed in the literature and might indicate a misspecification in the model, in the sense that there are other important explanatory factors or effects that have not been considered. This point will be studied in greater depth below.

5.2. Outlier analysis

In this analysis, extreme values are deemed to be those that are at a distance of two or three times the standard deviation with respect to the group mean (McNamara *et al*., 2005; Roquebert *et al*., 1996). This is done to study the effect of being more or less strict with respect to extreme values. Specifically, if all firms with an average ROA for the period, greater, in terms of absolute values, than *n* times the standard deviation of the average for the sector, 624 firms would be omitted (4.39% of the sample's observations) if n=2, and 232 firms (1.63%) if n=3[2].

[2] 2,331 firms would not be taken into account (16.41% of the sample) if n=1; most of which, in our opinion, cannot be considered to be outliers.

As one can see from Table 2, the elimination of the extreme values whose average ROA exceeds three times the standard deviation increases the value explained by the effects by a little over 6%, giving a value of 23.20%. In short, the level of error falls from 83.12% to 76.80%. Similarly, it may be observed that there is a slight improvement when the criteria become a little stricter and the number of standard deviations is reduced from three to two: the residual variance goes from 76.80% to 73.74%. However, the empirical evidence indicates that there are few atypical firms in most sectors (Hawawini *et al.*, 2003), which suggests that the application of three standard deviations should be sufficient for the screening of the sample. Two standard deviations would almost certainly involve eliminating firms which were not particularly atypical.

Insert Table 2 about here

Another consequence of eliminating atypical firms is that the intra-sector dispersion decreases, which increases the industry effect and slightly decreases the firm effect. The change is such that the ranking of the relative importance of both effects changes: when the outliers are not included, the sector factor explains more than the firm factor; in contrast, the weight of the firm factor is far greater than the sector factor when the outliers remain in the sample.

It is our belief that these results are consistent from an economic point of view. Maintaining those firms whose performance is not exceptionally high or low, but rather gravitates around the average for the sector, means focusing on firms that obtain similar results, maybe as a consequence of having similar assets and capabilities, and therefore, it might be reasonable to expect that their performance is highly conditioned by their sector. As Hawawini *et al*. (2003) indicate, it may also be concluded that exceptionally good or poor management leads to performance that is also extraordinarily high or low, irrespective of the structure of the sector. However, this structure is particularly relevant to those firms that come close to the mean, i.e., the unexceptional performers. Thus, this first partial sensitivity analysis shows that the weights of the components of variance for ROA are significantly different in the presence or absence of extreme values for each industry.

5.3. Industry classification analysis

The second partial sensitivity analysis tested whether the weights of the components of the variance are significantly different or not when the levels of industry disaggregation change. This was analysed by grouping the firms in the sample in three different ways, aiming for a progressively higher degree of refinement or sectoral disaggregation: classifications to levels of two, three and four-digit NACE.

Table 3 gives the results obtained from applying the model to the three versions of the sample set up. These results show that there are only slight variations in the relative importance of the effects in explaining economic performance at greater levels of disaggregation. There is a minor and not significant reduction in the firm effect and a slightly more significant increase in the industry effect. At the same time, there appears to be no uniform pattern since, although the industry effect increases when going from two to three NACE digits, it decreases when the jump is from three to four. This irregular behaviour can also be observed in the firm effect. It is our view that these results may be because the four-digit level of disaggregation might be excessive. This would be because certain sectors will be composed of only a few firms and, consequently, the representativeness of each sector decreases significantly. In contrast, a high level of aggregation would lead to excessively heterogeneous sectors, and this might explain the low weight of the industry effect when grouping together firms according to the two-digit NACE classification. This leads to the conclusion that the three-digit classification might be suitable for our sample and is why we use this classification level to obtain the base results. The number of digits aside, there is no observable significant alteration in the explanatory capacity of the model, given that the random error hardly varies in the three analyses.

Insert Table 3 about here

5.4. Time period analysis

The model is applied to three different periods: the stage of strong growth (1995–1999), the stage of moderate growth (2000–2004) and the full period (1995–2004). The results are provided in Table 4.

Insert Table 4 about here

With regard to the complete period 1995–2004, the explanatory capacity of the firm effect is found to be significantly higher than that observed for the industry effect; specifically, four times greater. On analysing what happens when disaggregating the sample into temporal phases, the first of these reflects the same level of error and results that are, in general, similar to those for the complete period. Now, however, the firm effect is the only significant result in the model.

In contrast, the results from the second phase are vastly different. For the period 2000–2004, first, the model's explanatory power improves notably and the error falls from 83.12% to 53.58%. Second, the firm effect improves slightly during this phase with respect to the first, increasing from almost 15% to nearly 17%. This might be explained by the fact that, during periods of economic growth, the differences in performance among firms decrease. That is, firms that perform worse tend to benefit from the surplus demand that the superior performers are incapable of satisfying. In periods of low growth, therefore, one should expect greater differences with respect to performance (Eriksen and Knudsen, 2003). Third, the weight of the industry effect increases exponentially, rising from 0.77% in the first phase to 29.41% in the second. However, the most remarkable feature of this comparison is the dominance of the industry effect over the firm effect during the moderate growth phase in the Spanish economy.

It might be argued, therefore, that during phases in which economic growth is strong, firms probably enjoy a wider range of strategic choices given that demand will lead to greater strategic flexibility. This, in turn, would explain the greater importance of the firm effect during such periods. In contrast, in periods in which economic growth is lower, firms will have fewer strategic alternatives at their disposal in their sector of activity. This would help to explain the greater weight of the industry effect during such periods.

All of these considerations derived from the partial sensitivity analysis allow us to highlight that the weights of the components of variance for ROA vary significantly depending on the phase of the economic cycle. A comparison of our results can be made if we look at the work of Mauri and Michaels (1998). It can be found that, with a long time period (15 years) the model error is greater than when the period is shorter (five years). In consonance with our results, these authors also find that a longer time period provokes a reduction in both the firm and industry effects, although the firm effect remains significantly higher than the industry effect. Nevertheless, it must be taken into account that Mauri and Michaels (1998) only carry out two tests, one for the total period and one for the second. No test is carried out for the first one. On carrying out a comparison between the first sub-period and the full period, we find that the results are practically identical. The random error is 83% and the firm effect is much stronger than the industry effect, which is weak. However, if the comparison is made using the second of the sub-periods and the complete period, the results are very different: the sub-period gives a much lower random error, the firm effect is greater, and the weight of the industry effect is much greater at almost double that of the firm effect. Therefore, it may be asserted that, depending on the time period used, the results might be very dissimilar.

Our results show that the different phases of the economic cycle might be just as important as the length of the time period. Further, the results obtained from two long, different periods of the same duration, do not necessarily have to coincide if one of these periods contains the complete economic cycle and the other does not. It would seem logical therefore, that in analyses of this type, the period studied should be the longest possible, and this in turn should be divided into two or more stages in which the pattern of economic growth varies significantly.

6. Conclusion

It was stated in the introduction that two research questions were addressed in this work. The first one was whether, given a specific sample, the firm and industry effects were sensitive to a group of methodological issues (outliers, industry classification and time period). From the results and discussion, it is clear that they are sensitive to some of them and even their relative importance to determine the differentials of organizational performance is altered. Thus, starting from a first result of clear predominance of the firm effect, obtained with sample characteristics typical of previous studies, the sensitivity analysis shows us that the industry effect was capable of explaining a great deal, more than the firm effect, when the period analysed was a phase of moderate economic growth and when the exceptionally high or low performers from each sector were excluded. However, changes in the level of industry disaggregation did not affect the primacy of the firm effect or the persistence of a low explanatory capacity for the industry effect. From this, it follows that researchers should be aware of the variability of their results that could be caused by changes in the idiosyncratic characteristics of their sample design.

The second research question was whether any of the potential biases derived from these issues has favoured one of the theoretical approaches – IO and RBT- over the other. We believe this to be the case. The primacy that the firm effect has held for years in the empirical literature has given strong support to the RBT, to the detriment of the IO, which would have been supported by a greater relative importance of the industry effect. Our results suggest that the construction of the samples may have skewed some results of previous works, denying greater support to the IO, which therefore may have been unjustly underestimated. More precisely, it is possible that in some cases the analyses may have kept the industry effect hidden. For instance, this can happen when outliers are not excluded or the intensity of GDP growth varies throughout the time period.

The aim of this study is to provide researchers in this area with a simple first approach to the analysis of the biases that may arise in the samples, as a preamble to the application of their models. This way of proceeding would prevent unnecessary biases and make the models more robust. However, we are aware that the analysis we have conducted, although revealing some of the biases derived from the sample construction, is relatively simplistic and, therefore, it suffers from clear limitations. Future studies could consider using other methods of estimation of the effects, complementary to the variance component analysis, such as hierarchical linear modelling (HLM), or carrying out a global sensitivity analysis instead of a partial one (the latter limits the generalization of results). Another limitation arises from the sample used, which considers only firms from one country. Future work should, therefore, test these effects in other countries to provide a more generalizable foundation for understanding these relationships. Nonetheless, generalizations of the findings may be applicable in countries that are in a similar stage of development and experience structural characteristics comparable to those in Spain.

Moreover, we think that biases in some published results may arise from other sample characteristics, such as an excessive orientation towards organizations of a certain size (large) or a certain sector (manufacturing). This opens an interesting line of research that studies the firm and industry effects separately in large, medium, and small firms, as well as in manufacturing versus services organizations. Such research could potentially lead to greater support for the IO. Future research could also consider the use of different indicators of organizational performance such as market share, sustainable profitability, Tobin´s Q, net profit margin (NPM), economic value added (EVA), corporate social performance (CSP), or sales growth. Finally, in addition to test these effects in other countries, it would be interesting to replicate our work using more recent data and check the robustness of our findings. Ultimately, we hope this study will contribute to a better understanding of the firm-industry effect debate and stimulate more research in this area.

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Table 1 Variance component analysis of ROA.

Effects	**Estimate**	**(%)**
Firm	26.84	12.71
Industry-year	0.73	0.34
Industry	7.08	3.35
Year	1.00	0.48
Error	175.49	83.12
Total	211.14	100.00

Note: 14,204 firms grouped in three-digit NACE industries. Period 1995–2004

Table 2 Variance component analysis of ROA with and without outliers.

Effects	**+/- 2 standard dev. (*)**		**+/- 3 standard dev. (*)**		**Full sample**	
	Estimate	**(%)**	**Estimate**	**(%)**	**Estimate**	**(%)**
Firm	9.52	9.34	13.13	10.61	26.84	12.71
Industry-year	0.81	0.80	0.92	0.74	0.73	0.34
Industry	15.79	15.48	13.85	11.18	7.08	3.35
Year	0.65	0.64	0.83	0.67	1.00	0.48
Error	75.20	73.74	95.08	76.80	175.49	83.12
Total	101.97	100.00	123.81	100.00	211.14	100.00
Sample	13,580	95.61	13,972	98.37	14,204	100.00

Note: (*) "Outlier" firms excluded from the sample. Outliers are those firms with an average ROA in the period greater – in absolute value – than n times the standard deviation of industry's average ROA, where n={2,3}; Firms grouped in three-digit NACE industries; Period 1995–2004

Table 3 Variance component analysis of ROA with different industry classifications

	Two-digit NACE		**Three-digit NACE**		**Four-digit NACE**	
	Estimate	**(%)**	**Estimate**	**(%)**	**Estimate**	**(%)**
Firm	27.85	13.44	26.84	12.71	26.91	12.98
Industry-year	0.72	0.35	0.73	0.34	0.81	0.39
Industry	1.96	0.95	7.08	3.35	3.30	1.59
Year	1.07	0.51	1.00	0.48	0.99	0.48
Error	175.57	84.75	175.49	83.12	175.38	84.56
Total	207.17	100.00	211.14	100.00	207.39	100.00

Note: 14,204 firms. Period 1995–2004

Table 4 Variance component analysis of ROA in different periods.

Effects	1995–1999 Estimate	(%)	2000–2004 Estimate	(%)	1995–2004 Estimate	(%)
Firm	39.87	14.87	33.12	16.70	26.84	12.71
Industry-year	0.55	0.20	0.33	0.16	0.73	0.34
Industry	2.07	0.77	58.34	29.41	7.08	3.35
Year	1.98	0.74	0.30	0.15	1.00	0.48
Error	223.65	83.42	106.29	53.58	175.49	83.12
Total	268.12	100.00	198.38	100.00	211.14	100.00

Note: 14,204 firms grouped in three-digit NACE industries