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Industry, firm, year, and country effects on profitability in EU food processing

This paper decomposes the variance in food industry return-on-assets into year, country, industry, and firm effects. Besides these main effects, we include several interactions and discuss their theoretical foundations. After determining effect significance in a nested ANOVA with a rotating pattern of effect introduction, we estimate effect magnitude using components of variance in a large sample of corporations. The results show that firm characteristics are more important than industry structure in determining food industry profitability in Europe. Main effects and interactions of year and country membership are weak, indicating that performance differentials can poorly be explained by macroeconomic and trade theory.

Key words: ROA, decomposition, variance components, MBV, RBV.
Running head: Industry, firm, year, and country effects on profitability
JEL: L00, C22

Introduction

'There are many theories because each is based on different assumptions about the world; it is their relevance rather than their logic which is in dispute.' (Cook, 1958: 16).

In a perfectly competitive market, firm performance that deviates from the average should not exist in the long run. However, such deviations are not an exception to the rule but in fact the norm, especially in industries characterized by high sunk costs or other impediments to competition as the food sector seems to be. The ability of firms to earn returns persistently above the norm has been widely analyzed. [1] While the so-called 'market-based view', which draws heavily on Industrial Organization (IO) theory, mainly attributes such 'abnormal' profits to industry characteristics, proponents of the 'resource-based view' assume that performance differentials can be better explained by firm properties. [2] In order to resolve this debate, a series of contributions following Schmalensee's (1985) seminal paper has used components-of variance analysis (COV) and nested (i.e. hierarchical) analysis of variance (ANOVA) techniques to decompose the variation in firm profitability into firm and industry specific effects. Subsequent papers have also looked at the impact of year and, more recently, of country effects on firm profitability. While the influence of country and country-industry interactions on the variation in profitability can be explained by models developed in trade theory, the aforementioned body of literature has paid little attention to the theoretical foundations

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[1] (e.g. Barney 1991, Bowman and Helfat 2001, Brush, Bromiley and Hendrickx 1991, Geroski and Jaquemin 1988, Gschwandtner 2005, Goddard and Wilson 1999, Mahoney 1995, McGahan and Porter 1997, 1999, 2002, 2003, Mueller 1977, 1986, 1990, Odagiri and Maruyama 2002, Roquebert, Phillips and Westfall 1996, Rumelt 1991, Schmalensee 1985, Teece, Pesano and Shen 1997, Waring 1996, Werenfelt 1984).

[2] Examples for studies that support the 'market-based view' are: Caves and Porter (1977), McGahan and Porter (1999), Schmalensee (1985), Slater and Olson (2002), Waring (1996).

Examples for studies that support the 'resource-based view' are: Barney (2001), Bowman and Helfat (2001), Brush, Bromiley and Hendrickx (1999), Conner (1991), Hawawini, Subramanian and Verdin (2003), Levinthal (1995), Lippman and Rumelt (1982), Mahoney and Pandian (1992), Peters and Waterman (1982), Prahalad and Hamel (1990), Roquebert, Phillips and Westfall (1996), Rumelt (1991), Teece, Pisano and Shuen (1981), Wernerfelt (1984), Winter (2003), Yurtoglu (2004).

of year effects, as well as the impact of year-country, year-industry and year-country-industry interactions. Two exceptions for year effects should be mentioned here: Rumelt (1991) introduces year-terms in the regression in order to deal with year-to-year variations in overall returns and year-to-year variations in industry-specific returns. He claims that this is an important improvement on Schmalensee 's (1985) seminal contribution, which uses only one year of data because it takes business cycle effects into account and makes it possible to distinguish between stable and transient industry effects and between stable and transient business unit effects. He shows in his widely cited study that 'the variance among stable business-unit effects is six times as large as the variance among stable industry effects', and that the time dimension is therefore crucial. McGahan and Porter (1997) on the other hand, using a similar methodology but a different dataset, show that manufacturing, which has been the focus of most previous studies, is an outlier and that generalizations about the economy as a whole that are based on those results understate the importance of industry effects. They also use year effects in their study. In general, evidence for the agribusiness sector is as yet sparse (some notable exceptions are Sutton 1991, Sexton 2000, Schumacher and Boland 2005, Weiss and Wittkopp 2005, Szymański *et al*. 2007, and Dorsey and Boland, 2009) since past research has focused on other sectors or tried to quantify effect sizes within the general economy. In addition, the majority of studies have either focused on the US or (in order to estimate country effects) had a worldwide scope. Nevertheless, the increasing relevance of integrated economic areas, such as the EU or NAFTA, provides an interesting, but as yet neglected opportunity to disentangle the profitability effects of country from area-wide economic fluctuation.

In order to fill these gaps, this study aims to quantify firm, industry, year, and country effects on corporate profitability in the EU food industry. In contrast to its antecedents, it is also the first study to analyze thoroughly all possible interactions between industry, year, and country and to discuss the theoretical foundations for these effects.

The paper is structured as follows. After providing a brief overview of the theoretical explanations for performance differentials, we introduce the methodology used to estimate effect relevance. Here, we identify and replicate best-practices applied in previous papers in order to compare our results to earlier work. This is followed by the presentation of our empirical result based on nested ANOVA and COV analysis. [3] In the final section, we compare our results to earlier work, discuss our findings and draw conclusions.

1. Theoretical explanations for performance differentials

In perfect competition, goods are perfect substitutes, and suppliers are price takers with identical cost curves. In this situation, all firms produce equal amounts of output at equal costs and sell this output at equal prices. Consequently, intra-industry variation in profitability cannot exist in the long run. With the additional assumption of general equilibrium across more than one perfectly competitive market, and costless entry and exit, inter-industry variation in profitability cannot exist in the long run either. This is the case since investors will switch markets if their capital can be used more productively, which will gradually lead to the levelling of profitability across industries.

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[3] Unfortunately the multi-level approach used for example in Misangyi et al. (2006), cannot be used here since Amadeus does not differentiate between 'business unit' and 'corporate unit'.

Since the neo-classical standard model offers no explanations for the phenomenon of variation in profitability (i.e. economic as opposed to accounting profit), numerous other models have been developed to deal with this issue. Within Industrial Organization (IO) and its neoclassical antecedents, most models focus on the characteristics of industries as the main determinants of performance differentials. This perspective is summarized in the structure-conduct-performance model. In this paradigm, it is assumed that performance mainly depends on the conduct of suppliers (e.g. their inclination to invest, to innovate and to collude) which is in turn determined by industry structure (e.g. concentration, product differentiation, and vertical integration). In addition, structure, conduct and performance, are influenced by a set of basic industry conditions including demand elasticity and technological features such as economies of scale. Since performance in this model ultimately depends on industry-level characteristics, IO theory generally asserts a rather deterministic link between industry membership and economic return.[4] Usually, this notion is referred to as the 'industry view' (IV) on above-normal returns.[5]

During the 1980s and 1990s, a similar perspective, called the 'market-based view' (MBV) has been developed within the realm of strategic management. According to Porter (1980), who laid the cornerstones of this concept, firms can achieve above-average profits if they manage to position themselves in an attractive industry. While

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[4] However, the fact that IO and neoclassical literature also comprise models that allow for performance differential within the same industry is often neglected. (e.g., locational models of product differentiation and models with Stackelberg competition).

[5] Sexton (2000) provides an excellent survey of the SCP and the NEIO empirical literature within the food sector.

this assumption is consistent with the IV, Porter (1980) also assumes that the choice of strategy within a given market has a strong influence on corporate performance by creating cost and/or differentiation advantages.[6] Therefore, although industry attractiveness is perceived to be an important element in the determination of performance, the MBV also recognizes the importance of strategic positioning within the market as a cause of persistent firm-specific deviations from average industry profitability.

While the MBV has long been the leading paradigm in the academic and practitioner management literature, during the 1990s the attention turned to a competing school of thought known as the 'resource-based view' (RBV).[7] Proponents of this viewpoint expect industry membership to have little explanatory value for performance differentials since the factors responsible for superior profits are believed to be connected to the firm and its resources. Based on the general assumption of heterogeneity in resource endowment, superior profits are assumed to result from the utilization of tangible and intangible resources that are rare and costly to copy or imitate (Barney, 1991).[8] Due to the difficulty of coping with such advantages, the RBV

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[6] Similar to the notion of entry barriers in IO, strategy-related advantages that lead to superior profitability are assumed to persist due to mobility barriers, which make the switch from one strategic group to another costly (Tremblay, 1985: 184).

[7] Usually, Barney (1991) is credited as the intellectual father of the RBV. Other important theoretical contributions to the RBV include Day and Wensley (1988) as well as Hunt and Morgan (1995).

[8] Drawing on similar ideas, Prahalad and Hamel (1990) introduced the terms 'capabilities', which are defined as complex combinations of resources. Since, as a result of their complexity, such capabilities are difficult to imitate, above-average profits are believed to persist in the long-run.

primarily predicts persistent firm-specific deviations from the general level of industry economic return.

Sutton (1991) analyzes twenty food and beverage industries in six countries in terms of market structure. He introduces the notions of exogenous and endogenous sunk costs and shows that in industries with endogenous sunk costs (such as the advertising/sales ratio, brand name and consumer loyalty) the returns to scale increase and the lower bound of market concentration is higher. Therefore, competition among the few emerges and game theoretical models are better suited to analyze the market outcome than the classical perfect competition model. Some of these game theoretical models are summarized under the notion NEIO (new economy industrial organization) and they are usually implemented empirically by means of structural econometric models. Bresnahan (1989) provides an excellent summary of some of these models. While price-cost margins are observable in classical SCP models, in the NEIO they are in most cases estimated. Usually, these studies use prices instead of profits as dependent variables. In general they estimate a demand and a supply function from observed prices and quantities of the specific firms. The prices are functions of various explanatory variables such as the market share of the firm or the concentration ratio of the industry. Often demand and supply elasticity are estimated. This has the advantage that under appropriate conditions, structural conduct parameters can be estimated and inferences about performance can be made. The principal advantage of the NEIO approach to the measurement of market power is the fact that it is built on the foundation of a clearly specified optimization problem. However, as Connor (1981) points out, its major disadvantage is that the analyst must first specify that optimization problem in terms of one particular objective function to the exclusion of others. The literature started with Porter ' seminal contributions (1983, 1984, 1985), which analyzed market power in the railroad cartel but soon expanded further to other industries with market power. Other studies which are often cited are those by Bresnahan (1981) and Bresnahan and Rice (1985) from the automobile industry, the one by Slade (1987) from the retail gasoline sector, several studies about the electricity sector summarized, for example, in Gilbert and Kahn (1996) or more recently in Wolfram (1999), and the study by Suslow (1986) concerning the aluminium industry, to mention just a few. Soon this branch of literature also expanded to the food sector since this is often characterized by substantial market power, as Sutton (1981) pointed out. Pagoulatos and Sorensen (1981) use a system of three simultaneous equations to analyze 47 U.S. food processing industries in the year 1967, Lopez' (1985) study focuses on the food processing sector in Canada while Cotterill (1986) investigates market power in the food retail sector and brings evidence from Vermont local markets; Angrist, Graddy and Imbens (2000) analyze the demand for whiting in the Fulton fish market, Karp and Perloff (1989) study the oligopolistic rice export market, Wann and Sexton (1992) analyze multiproduct food industries with application to pear processing in California, and Nevo and Wolfram (2002) examine the effect of coupons in the US breakfast cereal market, to name just few examples. However, as Bagwell (2007) points out, '....the approach has limitations: the estimated conduct parameter might not correspond to any particular model of firm behaviour....' and 'comprehensive data about output and prices needed to estimate the demand and supply functions might not be available. 'Reiss and Wolak (2004) mention that the absence of relevant data can considerably complicate estimation and limit what it is that the researcher can estimate with the available data. As Bresnahan (1989) puts it in his comprehensive analysis of empirical studies of industries with market power: 'A single industry case cannot paint a broad picture, it can only reveal the nature of industry conduct and performance in the industry studied.' Notwithstanding, the importance and the advantage of structural models with a special focus on various specific food sectors, given the available data, we would like to draw a broader picture of the European Food Market in the present paper.

While the disagreement between the aforementioned schools of thought is mainly on inter- vs. intra-industrial variation in profits, only few of them provides justification for systematic differences in profitability between countries.[9] Trade theory suggests that if capital can move freely, the rate of return will be equal between countries, as capital will flow to where its return is greatest. However, this process can be impeded by national borders, which can act as barriers to capital mobility and hinder the flow of information on differences in profitability. According to trade theory, a distinction can be made between economy-wide and industry-specific differences in national profitability levels. While industry-specific variation can arise from absolute cost advantages, e.g. due to a larger domestic market (resulting in external economies of scale), economy-wide differences in performance can be explained by different institutional arrangements and/or different levels of technical sophistication. The latter is emphasized by the technological gap theory, which assumes that nations with innovative capabilities are able to capture monopoly rents constantly (Posner 1961).

Besides variation across countries, profitability can also vary systematically over time. Numerous earlier papers have incorporated a general 'year' effect in their modelling approaches and referred to it as a component capturing the economic cycle (e.g. Rumelt 1991, McGahan & Porter 1997, Makino et. al 2004). Some authors (e.g. Rumelt 1991,

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[9] One notable exception should be mentioned here: Makino, Isobe and Chan (2004) analyze Japanese multinational corporations and find that country effects are as strong as industry effects in explaining the variation in the performance of their foreign affiliates and therefore, the choice of the host country is at least as important as the choice of industry.

Roquebert et al. 1996, Schumacher & Boland 2005) have also considered industry-specific year effects. However, the theoretical underpinnings for these inclusions have not been laid out in much detail. Moreover, in an international context, allowing effects other than industry effects to change over time is equally justifiable from a theoretical viewpoint. Therefore, we aim to discuss the theoretical contributions of macroeconomic theory as a basis to explain these effect classes. As macroeconomic fluctuation can be decomposed into long-term growth and short-term fluctuations, we will first use the neoclassical growth model to establish a general link between growth and profitability. Afterwards we will consider the link between profits and short-term fluctuation. [10]

In the neoclassical growth model, it is assumed that there are only two factors of production, labour and capital. Since these factors are substitutable, an increase in the availability of capital relative to labour will lead to an increase in the level of capital intensity. Assuming that there are no changes in technology, this will result in an increase in the marginal product of labour leading to rising wages. At the same time, the marginal value of capital will decline and so will the return on capital. Thus, in this model, changes in profitability over time may be the result of changes in the relative use of production factors.

With regard to short-term fluctuations, the relationship between profitability can be demonstrated by looking at the level of capacity utilization. While capacity utilization is usually high during economic growth, the opposite holds true in times of recession. Since this situation requires fixed costs to be distributed among less output, profitability will decrease.

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[10] However, in general year effects have been found to be fairly small compared with other effects.

While economic fluctuation may affect all actors in an economy equally, its effect may also be limited to subsets of firms active in certain geographical locations and/or engaged in specific industries. These phenomena, referred to as asymmetric shocks or cycles (Buti and Sapir, 1998: 24), are usually the result of abrupt changes in aggregated supply or demand, e.g. due to the imposition of a consumption tax in a certain region or an unexpected shortage in the supply of a crucial industry input. Country-specific shocks have already been addressed by a stream of research dealing with the synchronization of business cycles in economic unions (e.g. Clark and Wincoop, 2001; Ramos *et al*., 2003; Artis *et al*., 2004). With regard to the EU as our frame of reference, four possible macroeconomic effects can be distinguished: (1) EU-wide fluctuations, (2) national fluctuations, (3) EU-wide industry–specific fluctuations, and (4) national industry–specific fluctuations.

To summarize this chapter, possible explanations for performance differentials stem from a variety of economic disciplines which either focus on effects that are due to country membership, industry structure, idiosyncratic advantages of individual firms, or dependent on time. In the following, we will test the contribution of each explanation in determining corporate profitability and thereby assess the relevance of each school of thought in this regard.

2. Model, estimation, and data

In total, eight types of effects can be induced from the above discussion. We use the following model as a basis to test their significance and estimate their importance:

(1) $$r_{tjik} = \mu + \alpha_t + \beta_j + \gamma_i + \delta_k + \varphi_{tj} + \chi_{ti} + \psi_{ji} + \omega_{tji} + \varepsilon_{tjik},$$

where r_{tjik} is the accounting return-on-assets (ROA) of corporation *k*, which operates in industry *i* of country *j*, in year *t*. On the explanatory side, μ is the intercept, α_t are year effects, β_j are country effects, γ_i are industry effects and δ_k are firm effects. In addition to these main effects, the model includes the terms φ_{tj}, χ_{ti}, ψ_{ji}, ω_{tji} which represent all possible two and three-way interactions between year, country and industry. Finally, ε_{tjik} is the error term.

With regard to the relevance of each main effect in the specified model, proponents of the IV and MBV would expect relatively large industry effects, while according to the RBV, firm effects should dominate. Year effects, representing EU-wide economic fluctuations, can be seen as an indicator for the relevance of macroeconomic theory. In turn, country effects reflect the importance of trade theory in explaining differences in ROA. Finally, the error term corresponds to the unexplained variance that remains within the firm (over time).

While the interpretation of the main effects is relatively straightforward, there are several possible ways to interpret the interaction terms (a fact that has been largely neglected in previous papers). Industry-country interactions have mostly been treated as comparative advantages and were thus assumed to support the importance of trade theory in explaining performance differences (e.g. Hawawini *et al.*, 2004). However, if borders isolate nations from international competition to a certain degree, large industry-country interactions may also originate from substantial differences in (national) industry structure and thus support the IV. Likewise, one can interpret year-country and year-industry interactions as national and industry-specific business cycles and consider them to be indicators for the relevance of macroeconomic theory in explaining ROA variation. In turn, assuming that comparative advantages (e.g. due to superior technology) and industry structure (e.g. concentration) are at least to a certain degree volatile, these effects can be explained by trade theory and IO as well. Finally, three-way interactions can be interpreted as business cycles in industries that are rather isolated from international competition, but there are other possibilities as well. Hence, due to these ambivalences, sufficient care must be given to the interpretation of the results.

Previous papers have used nested analysis of variance (ANOVA) and/or components of variance (COV) to partition the observed variance in ROA into effect-specific components. Since both COV and ANOVA have certain advantages, neither method is superior to the other on conceptual grounds. A main disadvantage of ANOVA is that it relies on the assumption that each effect class contains a certain amount of effect levels, which are all present in the data. In turn, COV assumes that the effect levels of each effect class in the data set are randomly drawn from a finite population of effect levels. Due to this underlying random-effects assumption, COV results allow for a generalization of the results to a larger group of effects, not necessarily present in the data (Searle *et al*., 2006: 3). Therefore, in the given case, COV is superior since we aim to infer from firm effects in a sample of firms to the size of firm effects in general, from a selection of accounting periods to all year effects, from a subset of industries to every industry within food processing, and from an incomplete list of member states (17 countries) to the EU as a whole.

However, the main shortcoming of COV is that (unlike in the ANOVA case) no statistical method exists that can be used to test for the significance of the effect classes. Therefore, we follow most previous papers (e.g. Schmalensee, 1985; Rumelt, 1991; McGahan and Porter, 1997; Hawawini *et al*., 2004; Schumacher and Boland, 2005;

Szymański *et al.*, 2007) by singling out significant effect classes using ANOVA, and estimating their size with COV.

For the significance test, we use a nested ANOVA that relies on the following iterative procedure. Starting with a 'null model', which contains the ROA observations (r_{tjik}) as dependent variable, and the grand mean as a single explanatory variable, we estimate the model and store the residuals (i.e. the part of ROA not explained by the intercept). Then, with these residuals as the dependent variable and a first effect class (e.g. year effects) on the explanatory side, we estimate a second one-way ANOVA, run an F-test, and store the residuals. Since this model contains one effect class only, we can use the F-statistic to determine whether the newly introduced effect class significantly increases explanatory power. Subsequently, we continue in this manner using the newest residuals as the dependent variable, and testing further effect classes until all have iteratively been introduced.

Although this technique is appealing since it allows significance testing while simultaneously controlling for all previously introduced effect classes, its main drawback relates to the question as to which effect is to be introduced first and which ones are to follow. Despite the fact that nested ANOVA results can strongly depend on this decision, most of the previous papers using this method lack a solid design with regard to the sequence of effect introduction. Therefore, we use Schmalensee (1985) as a benchmark and extend his approach (designed for three effect classes), into a tailored rotation scheme for all effect classes contained in the model. This made it necessary to compute a large number of individual ANOVA models. Due to considerable computing times, we reduced the size of our samples (presented below) for the nested ANOVA to 20,000 observations (by means of a random draw). In the estimation, we use a General

Linear Model with Type III Sums of Squares since we were dealing with an unbalanced data set.

Before we estimated effect sizes, we eliminated all effects and interactions from model (1) that do not significantly contribute to explanatory power in the ANOVA. For the COV approach, it is assumed that the effects are random variables with expected values of 0 and constant variances $\sigma_r^2, \sigma_\alpha^2, \sigma_\beta^2, \sigma_\gamma^2, \sigma_\delta^2, \sigma_\varphi^2, \sigma_\chi^2, \sigma_\psi^2, \text{and}\, \sigma_\omega^2$. Residuals are assumed to be uncorrelated, with expected values of 0 and constant variances. Further on, we assume all effect classes to be uncorrelated with each other and with the residuals. As in the previous papers, we then decompose the total variance in r_{tjik} into the following variance components (Norusis, 2008: 192):

(2) $$\sigma_r^2 = \sigma_\alpha^2 + \sigma_\beta^2 + \sigma_\gamma^2 + \sigma_\delta^2 + \sigma_\varphi^2 + \sigma_\chi^2 + \sigma_\psi^2 + \sigma_\omega^2 + \sigma_\varepsilon^2$$

As the method of estimation, the majority of contributions either used MINQUE (e.g. Vasconcelos, 2006) or (restricted) maximum likelihood (REML/ML) techniques (e.g. Makino *et al*., 2004). Like Roquebert *et al*. (1996), we employ both ML and MINQUE (minimum norm quadratic unbiased estimation) and interpret differences in the results as an indicator of robustness (cf. Rao, 1997 or Searle *et al*., 1992 for in-depth explanations of COV and its estimation methods).

AMADEUS, a commercial pan European balance sheet database compiled by Bureau van Dijk Electronic Publishing, will be used as the data source. We employ the (pre-tax, pre-interest) ROA as the most common indicator of profitability. Since asset values are snapshots of points in time, but profits are realized during periods of time, we relate profits in accounting period *t* to average asset values over *t* and *t-1*. The analysis is based on the 2002-2006 ROA, since the availability of the necessary financial statements was best for this period.[11] Like Makino *et al*. (2004: 1033) we only consider firms with complete ROA data across the full period under study.

The industry classification systems used by the preceding papers were 4-digit SIC[12] (e.g. Rumelt, 1991; McGahan and Porter, 1997), 3-digit SIC (e.g., Hawawini *et al*., 2004), and 3-digit NACE (e.g., Szymański *et al*., 2007). As AMADEUS provides information at the NACE-4 level, we define industry membership along this level of aggregation, which is between 3 and 4-digit SIC. We consider all firms with main activities in any official NACE-4 food processing industry (32 categories between NACE-1511 and NACE-1599). Following Schmalensee (1985) and Rumelt (1991), we eliminate one 'miscellaneous' category (NACE 1589: manufacture of other food products not elsewhere classified), because the enterprises that fall under this category may be active in very different industries. In addition, since AMADEUS does not provide data at the level of individual business units but on corporations as a whole, we also removed firms active in more than one NACE-4 industry from the database. This was necessary because we use corporate ROA to estimate industry effects and secondary activities would therefore bias the estimation results of this effect class.

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[11] Previous panel studies on this topic (Rumelt, 1991; Roquebert *et al*., 1996; Hawawini *et al*., 2004; Makino *et al*., 2004; Brito and Vasconcelos, 2006; Szymański *et al*, 2007) were based on four to seven years of data.

[12] SIC (Standard Industrial Classification) is a US classification system whereas NACE (Nomenclature statistique des activités économiques dans la Communauté européenne) is used in the EU.

With regard to firm size, some previous studies have either used a minimum size criterion (McGahan and Porter, 1997; Brito and Vasconcelos, 2006; Schmalensee, 1985; Rumelt, 1991) or considered all firms regardless of size. The size restriction can be justified by the fact that by taking all firms into account, the estimation results will mainly depend on the huge number of small firms, whose economic relevance is, however, relatively small.[13] Furthermore, it is important to consider the fact that small corporations can bias the proportion of countries in the sample since there are substantial international differences in small firm's obligations to disclose annual accounts. In turn, by dropping small firms (which represent the majority of enterprises) we lose a substantial amount of information. Therefore, in order to identify the bias connected to the inclusion of small firms, we followed Rumelt (1991) by constructing two samples, one with and one without a size restriction. As a cut-off value, we adhere to the European Commission's threshold of micro-sized enterprises.[14] Hence, in the sample referred to as 'sample A' we eliminate enterprises with less than two million

[13] When considering the EU food industry as an example, micro enterprises represent 79% of all food industry ventures but contribute only 16% to industry employment and 7% to industry turnover (Eurostat, 2008).

[14] As a cut-off point, McGahan and Porter (1997) as well as Brito and Vasconcelos (2006) used US$10 million in assets. Schmalensee (1985) and Rumelt (1991) eliminated observations with less than 1% in industry turnover.

Euros in average assets while 'sample B' considers all size classes.[15] Because of the size restriction, only 25% of all firms in sample B are contained in sample A. However, 96% of total assets in sample B remain in sample A.

Estimating all interactions requires a minimum amount of observations in every category. Therefore, like Schumacher and Boland (2005: 101), we eliminated industries within countries that contained less than three corporations. Afterwards, in order to be able to distinguish country and industry effects from their interactions, we iteratively eliminated (1) countries with data on less than three industries and (2) industries occupied in less than three countries. This procedure led to 16 EU member states included in sample A and 17 in sample B. Moreover, four NACE-4 categories were eliminated from sample A (1562, 1594, 1595, and 1597). Since these industries and countries were relatively small, the loss in sample size caused by this procedure was moderate (about 8%).

With a final number of 6,282 enterprises in sample A (31,410 observations across the five years of ROA data) and 24,960 enterprises in sample B (124,800 observations), this paper uses the largest sample among of any preceding paper of which we are aware.

To assess whether the samples adequately represent the population of EU food processing firms, we compare the shares of countries and industries in the samples with those in the population. Table 1 shows that German firms are significantly

[15] Since the AMADEUS data is rounded to the nearest thousand, integer-related problems force us to impose a minor size restriction (ten thousand Euros in average assets) on sample B as well. This is the case since the rounding of low values can cause significant leaps in ROA over time (increasing intra-firm volatility), although the changes in assets or profits may have been very small.

underrepresented in both samples. This is caused by the fact that during the period under study the majority of German firms were not obliged to disclose annual accounts or failed to comply with their obligations since this was rarely penalized.[16] Due to the above-average availability of small business annual accounts from France and Romania, enterprises from these countries are overrepresented in sample B. Spain is also overrepresented in both samples. Spain has a lower share of food-discounters (10% as compared to 40% in Germany) and private labels (34% as compared to 40% in Germany). At the same time the level of vertical integration in some food sectors seems to be higher (for example pork). As a result, the competitive pressure in Spain, even if increasing, seems to be lower than in other European countries. Therefore, the present results, if anything, rather understate the competitive forces in the European food sector. These facts have to be kept in mind when interpreting the results. All in all, country shares in the population seem to better be reflected by the size-restricted sample (sample A).

Insert Table 1 around here

With regard to shares of observations by industry, sample B better represents the population (cf. Table 2). This is largely due to the fact that enterprises active in NACE 158 (manufacture of 'other' food products) [17] are severely underrepresented in

[16] For the same reason, the Austrian sample was too small to be considered in the analysis.

[17] In this category, we find the largest deviation within NACE 1581 (manufacture of bread; manufacture fresh pastry goods and cakes). This activity is dominated by many small retail or artisan bakeries, as well as franchisees, many of whom are not included in the size-restricted sample.

sample A, while the opposite holds for most other industries. In sample B, the underrepresentation of NACE 158 is moderate, and NACE 151 and 159 are overrepresented.

As neither of the two samples clearly represents the population better than the other, the results obtained for both samples will be given equal attention in the discussion and similarity in the results will be used to assess robustness.

Insert Table 2 around here

3. Nested ANOVA results

Table 3 shows the first step results of the nested ANOVA approach. For each model, differences between individual firm profitability and the grand mean were used as the dependent variable. The F-test results show that the introduction of every individual effect class (as a first effect) leads to a highly significant increase in explanatory power over the null model. R^2 and adjusted R^2, which can be used as a preliminary indicator of effect size, are by far the highest in the model with firm effects, where they explain more than one half (sample B) and two thirds (sample A) of the variation in the null model residuals. In general, results for the two samples are similar, but explanatory power is higher when the size restriction is in place (sample A).

Insert Table 3 around here

Figure 1 and 2 depict all further ANOVA steps, i.e., the stepwise introduction of effects beginning from models that include the intercept and either year, country, or industry effects. Since insignificant effect classes are eliminated, the final model includes all significant effects. Although the design in the rotation leaves some room for manoeuvre, it is subject to some logical constraints. For example, two-way interactions cannot be considered before the introduction of their respective main effects in order to obtain meaningful results. The following example serves to illustrate this: if one first introduces industry-country interactions and stores the residuals, these correspond to differences from average ROA in each industry-country combination. Since the mean of all residuals in such a combination is zero, the mean residuals for each industry (and country) will also be zero. For this reason, industry (and country) effects cannot be significantly different from zero after the introduction of their interactions. For the same reason, firm effects cannot be added before industry effects, three-way interactions before two-way interactions and so on. The following figures depict the pattern of introduction that takes into consideration all constraints.

Insert Figure 1 around here

The results of the ANOVA are depicted in Figure 1 (sample A) and Figure 2 (sample B). Numbers in ovals correspond to F-test significance levels and are printed in bold if they are smaller than 0.1%. Both figures show that year, country, and industry effects still significantly enhance explanatory power when every other main effect is introduced beforehand. With the exception of industry-country interactions, none of the two-way interactions remains significant when the main effects are controlled for. Likewise, three-way interactions are not significant after the introduction of the significant two-way interactions. Firm effects, however, stay significant even after controlling for all other significant effect classes. Each of these findings holds for both samples.

Insert Figure 2 around here

R^2 and adjusted R^2 values were calculated for models that contain the newly introduced effect classes as well as all other effects introduced previously. With an R^2 of 0.68 in model 13, all significant effects explain almost two-thirds of the total ROA variation in sample A (cf. figure 1). With the size restriction not in place (sample B) total explanatory power decreases to 54% (cf. figure 2).

Increments in explanatory power from one model to another can be used as a first indicator for the relevance of the newly introduced effect classes. For each significant effect, Table 4 lists the average changes in adjusted R^2 caused by the effect's introduction across all relevant models. [18] With a mean increase in explanatory power of 0.491 in sample A (0.385 in sample B), firm characteristics account for a share of 83% (91%) in the total explained ROA variation. Industry-country interactions, industry effects, and country effects follow in importance but are much smaller. Year effects are significant, but negligible.

Insert Table 4 around here

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[18] We use adjusted R^2 instead of R^2, since the addition of independent variables does not necessarily lead to an increase in its value.

4. COV results

All COV results are depicted in table 5. In case of the size-restricted sample, about 60% of the total ROA variation is explained by the five significant effect classes that remain in the model. Without size restriction (sample B), the error variance is larger and thus the explanatory power of each effect class is decreased relative to sample A. In addition, for all weaker effect classes, the order of effect magnitude depends somewhat on sample type and estimation technique. However, some general findings are very robust against such differences. These can be summarized as follows: while all other effects are weak, firm effects account for the largest share (85-92%) in the explained variation in corporate ROA. Shares for industry and country effects range between 2 and 4%, while year effects (1-1.5%) are the weakest effect class. With a share of 5% in the explained variation of sample A, and 1% of sample B, industry-country interactions are stronger in the size-restricted sample.

Insert Table 5 around here

5. Discussion and Conclusions

Our results suggest that food industry ROA is significantly influenced by industry, firm, year, and country effects, as well as industry-country interactions. While these effects explain about 40% of the variation in profitability, explanatory power rises to 60% if micro-sized firms are excluded. With a share of up to 90% in the explained variance, firm effects considerably outweigh all other effect classes. Country effects as well as industry effects and industry-country interactions are small, but larger than year effects whose contribution is negligible. None of the year interactions significantly contribute to explanatory power. Generally, these findings are robust to (1) method (COV vs. ANOVA increment to R^2), (2) estimation technique (MINQUE vs. ML), and (3) sample type (A vs. B). [19]

Previous findings were confirmed in our analysis with regard to the dominance of firm effects, as well as the relatively small contributions of year effects (e.g. McGahan and Porter, 1997; Schumacher and Boland, 2005), country effects (e.g. Makino *et al*., 2004; Brito and Vasconcelos, 2006), and two-way interactions (e.g. Hawawini *et al*., 2004; Schumacher and Boland, 2005).[20] However, there is less agreement on the relevance of industry effects. Similarly to our analysis, a number of studies found that industry effects account for less than 5% in ROA variation (e.g. Hawawini *et al*, 2004; Brito and Vasconcelos, 2006; Szymański *et al*., 2007). Others estimated this effects class to be larger than 18% (McGahan and Porter, 1997; Schumacher and Boland, 2005). As some authors focused on specific sectors, and others looked at the general economy, this variation may partly be due to differences in industry heterogeneity.[21] In addition to this, industry effects seem to be smaller if their estimation is based on a broader industry classification system, and on corporate-level rather than business-unit data. This seems to be the case here when compared with for example Schumacher and Boland (2005). The comparison with this important study deserves particular attention. While in the

[19] Moreover, the COV results were stable across the five subsamples of sample B.

[20] Three-way interactions were not considered in any previous paper.

[21] However, for the US, Schumacher and Boland (2005), who looked at the food economy, also found large industry effects.

present study a very large number of firms (up to 24 960) is classified according to a relatively small number of industries (up to 32) in the Schumacher and Boland (2005) study - a much smaller number of corporations (465) is classified according to almost twice as many industries (57). Therefore, our classification is much broader and the industry effects appear less significant. The competition process and the effects associated with it seem to be far more localized than at the 2-3 digit level. We suggest, like McGahan and Porter (1997), that the influence of industry might have been stronger if data of finer grain had been available. McGahan and Porter (1997) use the model of Rumelt (1991) on their data and show how differences in sectoral coverage can influence the results. The dataset they use comes from Compustat and covers activity in all sectors of the economy, whereas the FTC data used in Rumelt's study covers only the manufacturing sector. They show that the greater the diversity of industries covered is, the higher the industry effects. Therefore, the differences between the two studies might be partly due to the different definitions and classifications of the industry. Moreover, the differences might arise because of differences between the US and the European food market in general. Sexton and Lavoie (2001) point out for example that the 'vertical organization of food marketing channels varies widely by type of industry and country' and that the marketing in the US seems to have its own specificities with 'very little intervention by market intermediaries' as opposed to other countries where the same markets involve several intermediaries. It can be also assumed that the European food market is much more country specific and therefore much more heterogeneous than the US food market. Much less clear-cut industry effects are therefore to be expected. The claim that the industry effects might be less significant and therefore different in the European market than in the US market is also suggested by the study of Bunke, Droge and Schwalbach (2000). The authors analyze 237 German firms over the period 1987-1997 using ANOVA and VCA with fixed and random effects. Moreover, they apply several robustness checks and they improve the methodology used previously by properly considering the different sizes of the companies. They find 'an optimal arrangement in groups' of firms within an industry sector that leads to a risk reduction of the variance differences. The alternative approaches used in this study for the statistical analysis all lead to the same result: the predominance of firm over industry effects. The question whether the lower significance of industry effects can be attributed to differences in industry measures or to differences between the US and the European food market or to other reasons is left unresolved in this study and might be an interesting avenue of research for future studies. [22]

While a comparison of the results for sample A with those of sample B suggests that small-firm bias was not an important issue in this study, the main sources of distortion in studies that use accounting ROA as the dependent variable relate to common practices and systems used in corporate financial reporting.[23] Most importantly, these distortions include the following: first, during profitable periods, the firms' tendency to create hidden reserves or reduce existing hidden charges (accumulated during less profitable times) leads to a smoothing effect on the ROA time series, which may result in an underestimation of error components, year effects and year interactions as well as

[22] Nevertheless, in our sample context, single-industry (e.g., food processing), industry effects are likely to be fairly small since different types of industries within food processing are likely to be more similar compared to other industries from outside food processing.

[23] Although the possible distortions may be substantial, this issue has largely been ignored by earlier papers.

an overestimation of firm effects. Although the size of this bias is unknown, firm effects strikingly outweigh all other effect classes in almost all previous papers, so that it is unlikely that large firm effects are a mere product of this source of bias. Second, in an international context, differences in the national reporting regulations and practices can bias the estimation of country effects. For instance, firms in market-oriented financial systems (e.g. the United Kingdom), as opposed to banking-oriented economies (such as France) tend to appraise performance more positively, which may lead to an overestimation of profitability in those countries and hence country effects. Since we concluded that country effects were small, given this sort of bias, they may thus be even smaller in reality.

Regarding the contribution of the theoretical viewpoints above discussed on the driving forces of performance differentials, our results led to the following conclusions. First, all effect classes that represent macroeconomic fluctuation were weak or insignificant, indicating that macroeconomics provide little potential to serve as a basis for explaining performance differentials in the food industry.[24] However, the fact that EU-wide fluctuations (year effects) were significant while national and industry-specific fluctuations were not suggests that business cycles are by and large synchronized within the EU-27. Second, as most effect classes emphasized by IO and trade theory were weak or insignificant, while firm effects were strong, our results provide evidence for the relevance of firm-specific characteristics as determinants of superior performance in food processing. As discussed above, firm determinants do seem to play a crucial role in

[24] However, it must be noted that the time series analyzed in our model was fairly short, potentially limiting generalization.

the European food sector. Gschwandtner and Hirsch (2011) for example, in their analysis of the performance of the food sector in five European countries, identify several firm characteristics related to profit persistence. The firm's size and the firm's growth, among others, seem to have a significant positive impact on the firm's performance in the food industry. Due to the fact that price competition is the dominant competition strategy among food processors, achieving economies of scale through sufficient firm size is expected to be a crucial matter. Ollinger et al. (2000), for example, show that US chicken slaughtering plants which are two times larger than the average-sized plant have 8% lower per unit costs. Furthermore, it can be assumed that the complex set of EU legislations regarding food safety, animal welfare, additives and residues, packaging and labelling or pre-market approval puts a somewhat heavier administrative burden on smaller firms than on firms of larger scale. In particular, pre-market approval for new additives, novel foods, genetically modified organisms (GMOs) and health claims are out of reach for the majority of small food processors in the EU. In addition, being of larger size might well increase the ability to counter the bargaining power of retailers. Many studies have shown, that especially within the food sector, advertising intensity acts as a barrier to entry that leads to higher firm profit margins and is therefore a crucial firm characteristic (see Comanor and Wilson 1967, Sigfried and Weiss 1974, Pagoulatos and Sorensen 1981, Sutton 1991 and others). Since competition within the food sector is very high and the consumers are conservative regarding their intake, advertising their products is an important firm task. While the evidence in the present study further supports a resource-based view on above-normal returns, we acknowledge that it would be misleading to deny the influence of the industry dynamics and competitive context in which firms operate.

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Tables

Table 1. Shares of observations by country within samples A and B and in the population (%)

Country	*Sample A (N = 6,282)*	*Sample B (N = 24,960)*	*Population [a] (N = 309,209 [b])*
Italy	30.5	10.6	24,7
Spain	22.3	19.1	10,2
France	21.1	38.6	23,7
United Kingdom	6.6	2.2	2,5
Poland	4.8	1.6	5,9
Belgium	3.6	5.0	2,7
Romania	2.9	14.9	3,8
Greece	2.5	1.2	5,3
Portugal	2.0	1.5	3,6
Finland	1.0	1.4	0,6
Sweden	0.8	2.3	1,2
Netherlands	0.6	0.2	1,6
Slovenia	0.4	0.2	0,3
Estonia	0.3	0.8	0,1
Germany	0.3	0.1	11,4
Ireland	0.2	0.1	0,2
Bulgaria	-	0.2	2,0

Note: 'Population' refers to all EU-27 firms active in the manufacturing of food products and beverages (according to Eurostat, 2008).
[a] Share in the countries listed below
[b] EU-27

Table 2. Shares of observations by industry within samples A and B and in the population (%)[a]

	Share in sample and population (%)		
(NACE Code), industry description [a]	*Sample A (N = 6,282)*	*Sample B (N = 24,960)*	*Population (N = 309,209)*
(151) Production, proc. & pres. of meat & meat prod.	22.2	20.2	15.0
(159) Manuf. of beverages	20.0	11.1	7.4
(158) Manuf. of other food prod.	17.7	45.1	60.9
(155) Manuf. of dairy prod.	13.2	7.3	4.3
(153) Proc. & pres. of fruit & vegetables	8.6	4.5	3.4
(157) Manuf. of prepared animal feeds	5.9	2.8	1.7
(156) Manuf. of grain mill prod., starches & starch prod.	5.4	4.8	2.8
(152) Proc. & pres. of fish & fish prod.	4.9	2.6	1.3
(154) Manuf. of vegetable & animal oils & fats	2.0	1.6	3.1

Note: 'Population' refers to all EU-27 firms active in the manufacturing of food products and beverages (according to Eurostat, 2008). Proc. & pres. = processing and preserving; Manuf. = manufacturing; Prod. = products

[a] For the purpose of clarity, population and sample shares are compared at NACE-3, instead of NACE-4 level (nested ANOVA and COV relied on NACE4 classifications).

Table 3. First step ANOVA results for samples A and B

	Sample A			Sample B		
Model with	*Sign.*[a]	*R^2*	*adj. R^2*	*Sign.*[a]	*R^2*	*adj. R^2*
year effects α_t	***	0.005	0.005	***	0.004	0.004
country effects β_j	***	0.024	0.024	***	0.015	0.014
industry effects γ_i	***	0.033	0.032	***	0.014	0.012
firm effects δ_k	***	0.670	0.587	***	0.536	0.419
year-country interactions φ_{tj}	***	0.032	0.028	***	0.023	0.019
year-industry interactions χ_{ti}	***	0.045	0.038	***	0.024	0.017
Industry-country interactions ψ_{ji}	***	0.107	0.097	***	0.052	0.040
three-way interactions ω_{tji}	***	0.152	0.102	***	0.092	0.031

Note: Models contain null model residuals as dependent and single effect classes as independent variable.
[a] F-test significance. Triple asterisk (***) denotes significance at the 0.1% level

Table 4. (Mean) increment to adjusted R^2 by type of effect and sample (A and B)

Effect class	From model … to model… [a]	Increment to adj. R^2 A	Increment to adj. R^2 B	Average [b] A	Average [b] B	Share in total adj. R^2 [c] A	Share in total adj. R^2 [c] B
year effects	0 to 1	0.005	0.004	0.004	0.004	0.7%	0.9%
	2 to 5	0.004	0.004				
	3 to 7	0.004	0.004				
	6 to 8	0.004	0.004				
country (C) effects	0 to 2	0.024	0.014	0.020	0.013	3.4%	2.9%
	1 to 5	0.023	0.014				
	3 to 6	0.017	0.011				
	7 to 8	0.017	0.011				
industry (I) effects	0 to 3	0.032	0.012	0.028	0.011	4.8%	2.5%
	2 to 6	0.025	0.009				
	1 to 7	0.031	0.012				
	5 to 8	0.025	0.009				
I-C interactions	8 to 10	0.049	0.013	0.049	0.013	8.3%	3.1%
firm effects	10 to 13	0.491	0.385	0.491	0.385	82.8%	90.6%

Note: [a] Model numbers as depicted in Figure 1 and 2 (black fields). Zero denotes the null model.
[b] Mean increment to adj. R^2 across all models into which the effect was introduced.
[c] Adj. R^2 of model 13

Table 5. Components of variance results for sample A and sample B

Variance component	Sample A *ML*	Sample A *MINQUE (0)*	Sample B[a] *ML*	Sample B[a] *MINQUE (0)*
year effects	0.6%	0.6%	0.6%	0.6%
country effects	2.5%	1.1%	1.6%	1.7%
industry effects	2.3%	2.1%	0.9%	0.7%
I-C interactions	3.6%	2.7%	0.4%	0.5%
firm effects	51.9%	53.3%	38.1%	37.8%
error term	39.2%	40.1%	58.5%	58.6%

Note: [a] Average values across five subsamples: Due to computational constraints and the large number of observations (124,800), sample B could not be processed in one simultaneous run. As did Roquebert *et al*. (1996), we therefore split the sample into equal-sized subsamples (five subsamples generated by random draw without replacement) and analyzed each subsample separately. Individual results (which can be obtained from the authors upon request) were robust across subsamples.

Figures

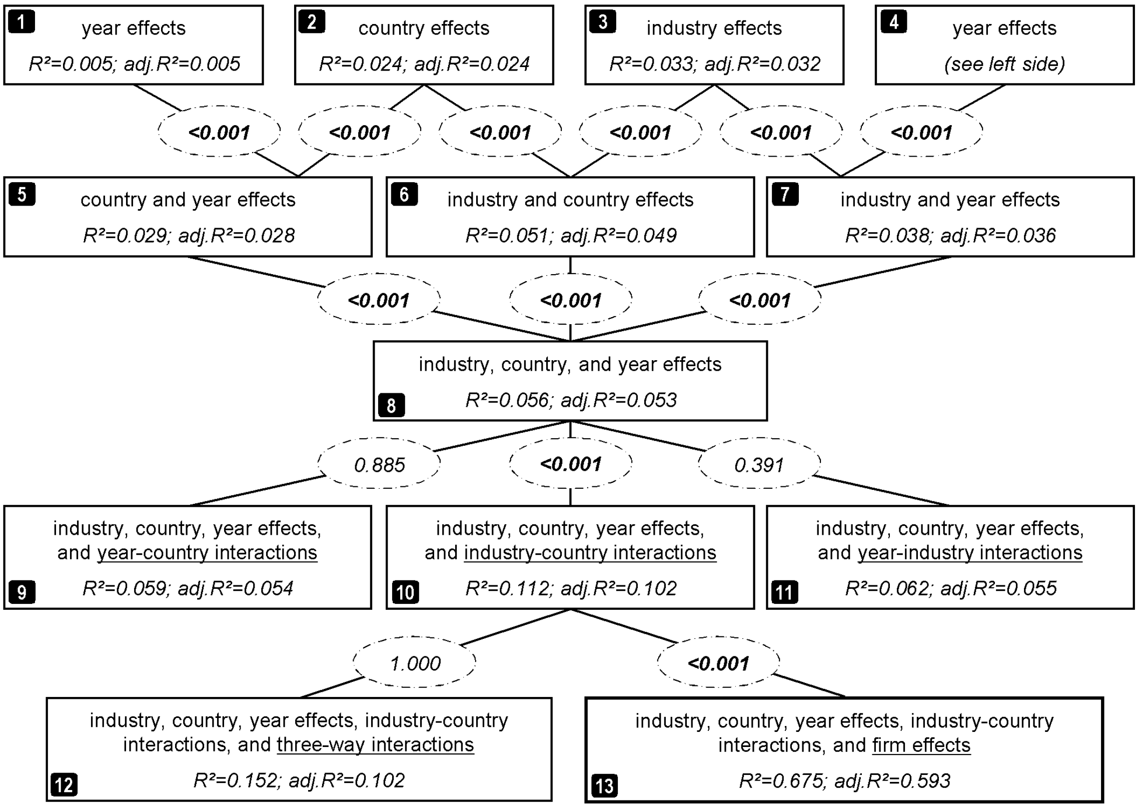

Figure 1. Nested ANOVA results for sample A

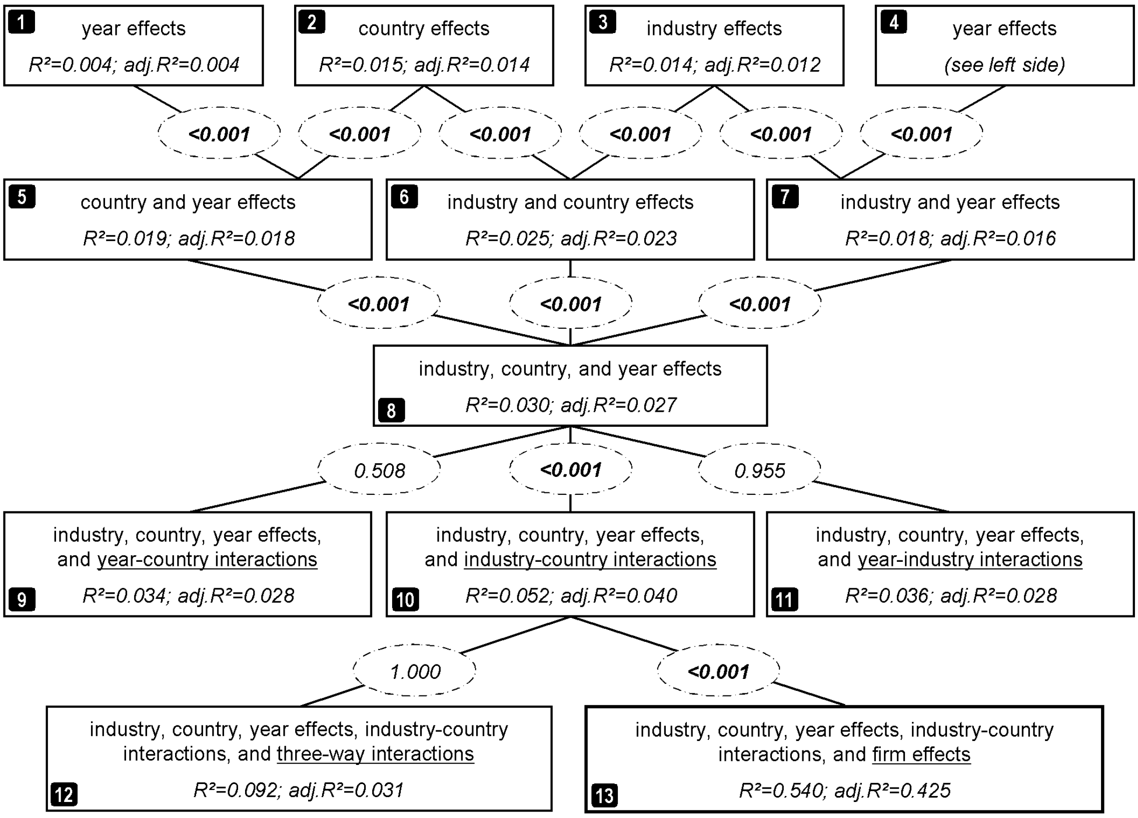

Figure 2. Nested ANOVA results for sample B