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

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We decompose the variance of food industry return-on-assets into industry, firm, year and country effects. After determining significance in a nested ANOVA, we estimate the magnitude using components of variance in a large sample of corporations. As a robustness check, we estimate a multilevel model that additionally allows us to estimate the impact of several covariates at each level. The results show that firm characteristics are more important than industry structure in determining food industry profitability. In particular, firm size seems to be an important driver of profitability while firm risk, age and, surprisingly market share have a negative influence.

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1. 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 characteristics.[2] In order to resolve this

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[1] e.g. Mueller (1977), (1986), (1990); Teece (1981); Werenfelt (1984); Schmalensee (1985); Geroski and Jaquemin (1988); Barney (1991); Rumelt (1991); Roquebert et al. (1996); Waring (1996); McGahan and Porter (1997), (1999), (2002), (2003); Brush et al. (1999); Goddard and Wilson (1999); Bowman and Helfat (2001); Odagiri and Maruyama (2002); Gschwandtner (2005).

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

Examples for studies that support the 'resource-based view' are: Teece *et al.* (1981); Peters and Waterman (1982); Lippman and Rumelt (1982); Wernerfelt (1984); Prahalad and Hamel (1990); Conner (1991); Rumelt (1991); Mahoney and Pandian (1992); Levinthal (1995); Roquebert *et al.* (1996); Brush *et al.* (1999); Barney (2001); Bowman and Helfat (2001); Hawawini *et al.* (2003); Winter (2003); Yurtoglu (2004); McNamara *et al.* (2005) and Goddard *et al.* (2009).

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 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) study, 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 and business unit effects. Rumelt shows 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 which are based on those results understate the importance of industry effects. They also use year effects in their study. A rather new strand of research addresses the disadvantages of classical COV and ANOVA and uses the multilevel approach of hierarchical linear modelling (HLM) in order to decompose the variance in profitability. Similar to recent analysis based on COV and ANOVA the majority of these studies finds evidence for stronger firm effects compared to industry effects.[3] However, a crucial advantage of theses mixed models is that the magnitude and significance of the effects as well as the influence of specific covariates can be determined by means of a single estimation.

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 entire manufacturing 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 so far 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 effects and to estimate additionally the impact of specific firm and industry covariates.

The paper is structured as follows. After providing a brief overview of the theoretical explanations for performance differentials, we introduce the methodology used. Here,

[3] Examples for studies based on HLM are: Hough (2006), Misangyi *et al.* (2006) and Chen (2010).

we identify and replicate best-practices applied in previous papers in order to compare our results to earlier work and employ the rather new approach of HLM. This is followed by the presentation of our empirical results based on nested ANOVA, COV analysis and the HLM method. In the final section, we compare our results to earlier work, discuss our findings and draw conclusions.

2. 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.

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 Bain's (1956, 1968) 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 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.

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[4] However, the fact that IO and neoclassical literature also comprise models that allow for performance differentials 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 (new economy industrial organization) empirical literature within the food sector.

[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).

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). Due to the difficulty of coping with such advantages, the RBV 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

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[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).

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's 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 Reiss (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 *et al.* (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.[8] 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

[8] One notable exception should be mentioned here: Makino *et al.* (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.

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 (Feenstra 2004). 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, 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. [9]

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

In the neoclassical growth model (e.g. Carlton and Perloff 2005), 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.

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. Furthermore we assess the impact of several firm- and industry-specific variables on profitability. In order to avoid repetitions the theoretical underpinnings of these variables will be described when introduced in chapter 6.

3. 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. 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 testing the significance of each effect class 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 which includes all possible combinations of effect class introduction.

Insert Figure 1 around here

As Figure 1 illustrates, this made it necessary to compute a large number of individual ANOVA models. In the estimation, we use a General Linear Model with Type III Sums of Squares since we were dealing with an unbalanced data set.

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 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).

Due to the apparent deficiencies of both ANOVA and COV as a means for variance decomposition we additionally estimate a multilevel hierarchical linear model (HLM). In contrast to classical COV HLM addresses the correlation between effect classes through complex error structures within each effect class (Hough 2006). In addition, while ANOVA and COV only offer a descriptive framework of variance decomposition HLM provides the possibility to analyze the effect of structural variables by modelling relationships at each level of the analysis. We estimate a three-level model which partitions the total variance in ROA into a time, a firm and an industry component[10] according to the multilevel approach by Raudenbush and Bryk (2002)[11]. At the first level ROA at each time period is modelled as mean ROA over time plus a random error:

(3) $$r_{tki} = \pi_{oki} + e_{tki}$$

with the indices *t, k* and *i* denoting time, firms and industries respectively. π_{oki} is mean ROA over time of firm *k* in industry *i* and e_{tki} is the random time-level error which is normally distributed with mean zero and variance σ^2. σ^2 therefore represents variance across time. This variance is only assumed to be equal among the observations of each of the *k* firms.

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[10] Since we only have 5 countries and 5 years of data available we limit the HLM estimation to the firm and industry level. Additionally there are no explanatory variables for the year and country level.

[11] A detailed description of the model can also be found in Misangyi et al (2006).

At the second level mean firm ROA over time π_{oki} is modelled as an outcome varying randomly around some industry mean:

(4) $$\pi_{oki} = +\beta_{00i} + \alpha_{ki}$$

where β_{00i} is the mean ROA of firms in industry *i*. α_{ki} is the random firm-level error and is assumed to be normally distributed with mean zero and variance τ_{π} which therefore reflects between-firm variance. It is assumed that this variance is equal only for firms within the same industry.

At level three mean ROA of firms in industry *i* (β_{00i}) is modelled as an outcome varying randomly around the grand mean:

(5) $$\beta_{00i} = \gamma_{000} + \mu_i$$

where γ_{000} is the grand mean of all ROA observations. μ_i is the random industry error which is normally distributed with a mean of zero and variance τ_{β} which therefore reflects between-industry variance. The amount of variance ascribed to each effect can be calculated as $\sigma^2 / \sigma^2 + \tau_{\pi} + \tau_{\beta}$ for variance across time, $\tau_{\pi} / \sigma^2 + \tau_{\pi} + \tau_{\beta}$ for variance between firms and $\tau_{\beta} / \sigma^2 + \tau_{\pi} + \tau_{\beta}$ for variance between industries. The variance components are estimated using the restricted maximum likelihood (REML) technique.

In order to estimate the effect of specific structural factors on ROA firm and industry characteristics are incorporated at their appropriate level of analysis meaning that equation (4) becomes:

$$\pi_{oki} = +\beta_{00i} + \beta_{01i}(F_1)_{ki} + \beta_{02i}(F_2) + \ldots + \beta_{0ni}(F_n)_{ki} + \alpha_{ki}$$

where F_l with $l = 1,2,...,n$ are n firm characteristics such as firm size or risk. These characteristics are assumed to be fixed effects meaning that: $\beta_{01i} = \gamma_{010}$, $\beta_{02i} = \gamma_{020}$, ..., $\beta_{0ni} = \gamma_{0n0}$.

Respectively the level three equation (5) becomes:

$$\beta_{00i} = \gamma_{000} + \gamma_{001}(I_1)_i + \gamma_{002}(I_2)_i + ... + \gamma_{00m}(I_m)_i + \mu_i$$

where I_l with $l = 1,2,...,m$ are m industry characteristics such as concentration or industry size.

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 2004-2008 ROA, since data availability was best for this period.[12] Like Makino *et al*. (2004: 1033) we only consider firms with complete ROA data across the full period under study. As AMADEUS provides information at the 4-digit NACE level, we define industry membership along this level of aggregation.[13] We consider all firms with main activities in any official 4-digit NACE food processing industry (32

[12] 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.

[13] NACE (Nomenclature statistique des activités économiques dans la Communauté européenne) is the industry classification system used in the EU.

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.

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.[14] 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

[14] 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).

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 (European Commission, 2005).[15] Hence, in the sample referred to as 'sample A' we eliminate enterprises with less than two million Euros in average assets while 'sample B' considers all size classes.[16] 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 17 EU member states included in both samples.

With a final number of 6,293 enterprises in sample A (31,465 observations across the five years of ROA data) and 25,579 enterprises in sample B (127,895 observations), this paper uses the largest sample among all preceding papers that we are aware of.

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[15] 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.

[16] 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.

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 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.[17] 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 (26% as compared to 35% in Germany) (Wijnands *et al.* 2007). 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 be better 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

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

158 (manufacture of ‘other’ food products)[18] are severely underrepresented in 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 slightly 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

4. Nested ANOVA results

Table 3 shows the first step results of the nested ANOVA approach which can be used as a first indicator for the relevance of the effect classes. 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. The contributions of the remaining main effects as well as the two- and three-way interactions are negligible. In general, results for the two samples are similar, but explanatory power is higher when the size restriction is in place (sample A).

[18] 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.

Insert Table 3 around here

Figure 1 depicts 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 models include 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 results of the nested ANOVA are summarized in Table 4 which shows the mean increment to R^2 as well as adjusted R^2 for all significant effects across all relevant models in both samples. Independent of the stage of their introduction all main effects significantly increase explanatory power over the previous model. The same holds for the two-way interactions with the exception of year-industry interactions in sample B. Three-way interactions become insignificant after industry-country interactions have been introduced. When all significant effects are introduced the final models explain on average 0.68 of the total ROA variation in sample A (cf. Table 4, bottom line). With the size restriction not in place (sample B) total explanatory power decreases to 54%.

For the main effects Table 4 resembles the results when each effect is introduced in the first step (cf. Table 3). However all two-way as well as the three-way interactions add on average less to explanatory power compared to their introduction as a single effect. With a mean increase in explanatory power of 0.531 in sample A (0.405 in sample B), firm effects on average account for a share of 83% (91%) in the total explained ROA variation.[19]

Insert Table 4 around here

5. COV results

All COV results are depicted in table 5. In case of the size-restricted sample, about 55-60% of the total ROA variation is explained by all effect classes. Without size restriction (sample B), explanatory power is reduced to 44%. In addition, for all weaker effect classes, the order of effect magnitude depends somewhat on sample type and estimation technique. However, some general findings can be summarized as follows: while all other effects are weak, firm effects account for the largest share (80-94%) in the explained variation in corporate ROA. Shares for industry and country effects range between 0.1 and 9%, while year effects with about 1% in each model are the weakest effect class. While two-way interactions account for 0.1-3% in the explained variation in corporate ROA three way interactions contribute slightly more with about 1.1-4.5%

Insert Table 5 around here

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[19] Here we use adjusted R^2 since we consider models with a different number of independent variables.

6. HLM results

Table 6 provides the results for the HLM estimation. Due to limitations in available data on the structural industry and firm characteristics we had to restrict the HLM estimation to the five countries Belgium, France, Italy, Spain and the UK.[20] The results indicate that firm and industry effects are statistically significant with the firm explaining 47.2 % and industry 1.3 % of the variance in ROA.

Insert Table 6 around here

Beyond the main effects the following structural industry and firm characteristics[21] could be included in the model at the firm level of analysis:

Market Share (MS) is measured as firm *i*'s total sales divided by total sales in the 4-digit NACE industry to which the firm is assigned by AMADEUS. Surprisingly its impact on ROA is negative. While most previous studies find a positive effect on profitability (e.g. Szymanski *et al.* 1993) the impact has not always been entirely unambiguous. Prescott *et al.* (1986), for example, show that the impact may depend on the environment in

[20] We also estimated all ANOVA and COV models solely for these five countries. The results resemble the ones for the entire sample (A and B) which justifies the reduction to the five countries. In addition the five countries account for 59% of the enterprises and 51% of turnover of the EU-27 food industry in 2007 (Eurostat 2010) meaning that still a high share of the industry is covered by the analysis.

[21] These variables were chosen due to data availability and were constructed by means of AMADEUS and the Eurostat (2010) database.

which firms operate. Since EU food producers are active in a wide range of different environmental structures a negative relationship can result.

Firm age (Age) can account for life-cycle effects. Usually costs are expected to decreases with aging due to learning effects leading to higher profits for more mature firms. However, the impact on ROA is significantly negative. As Loderer and Waelchli (2010) show, a negative relationship between firm age and ROA can occur if corporate aging is attended by organizational rigidities, slower growth and assets which become obsolete with time.

Firm size (Ln TA) is measured as the logarithm of total assets. While many previous studies find a positive impact (e.g. Hirsch and Gschwandtner, 2012), there is also evidence for the inefficiency of large firms in the case of diseconomies of scale (e.g. Goddard *et al.* 2005). However, within the food industry firm size has a significant positive impact on ROA. Due to the fact that price competition is the dominant competition strategy among food processors, achieving economies of scale through sufficient firm size seems to be a crucial matter.[22] Furthermore large firms tend to be more efficient and better off in countervailing the superiority of a highly concentrated retailing sector. Furthermore, it can be assumed that the administrative burdens inherent with rather complex EU legislations regarding food safety, additives, packaging and labelling or pre-market approval put heavier administrative burdens on smaller firms than on firms of larger scale.

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[22] 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.

The impact of firm growth (Gr. TA) measured as the growth rate of a company's assets is significant negative. As Dorsey and Boland (2009) show, if food economy firms aim to grow through diversification outside the food economy because they have exhausted growth in their original field of action, a negative impact of growth on ROA may result.

Two proxies for firm risk were constructed from AMADEUS. Short-run risk (1/Curr) measured by the ratio of current liabilities to current assets[23] and long-run risk measured by the firm's gearing ratio (Gear) defined as the ratio of non-current liabilities plus loans to shareholders funds. While risk theory states that firms with higher risk should on average achieve higher profit levels within the strategic management literature a negative relationship known as the Bowman's (1980) 'risk-return paradox', is a long-established fact (e.g. Andersen *et al.* 2007). In contradiction with risk theory but reinforcing Bowman's 'risk-return paradox', both risk proxies have a significant negative impact on ROA.

Regarding industry characteristics concentration (HHI) measured by the Herfindahl-Hirschman Index[24] is expected to have an essential impact on ROA. Firms in industries characterized by high concentration might have the ability to prevent entry, leading to higher profit levels. As expected the effect is positive and significant.

Industry size (NF) is measured by the number of firms in an industry, and industry growth (Gr. NF) is measured by the corresponding growth rate. The respective net effect on ROA is, however, not totally unambiguous. On the one hand, in larger

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[23] This quotient is the reciprocal of a firm's current ratio.

[24] The Herfindahl-Hirschman Index is calculated as the sum of the squared market shares of the fifty largest firms in each 4-digit NACE industry.

industries with rapid growth, the ability of incumbents to maintain their market shares might decrease, leading to a reduction of oligopolistic discipline with stronger competition and a decrease in firm profits. On the other hand, if industries grow and reach a particular size due to increasing demand, the pressure for firms to reduce prices in order to reach an increase in sales is reduced and therefore high firm profits might result. The results show that during times of growth lower profits can be expected however, reaching a specific industry size has a positive impact.

Research and development (R&D) measured by the 'share of R&D expenditure in total industry value added' is expected to be a basis for product differentiation and for the creation of entry barriers and should therefore have a positive impact on ROA. Surprisingly the impact is insignificant for the European food industry. However, R&D in the food industry has a different character from R&D in e.g. the electronics industry. As Stewart-Knox and Mitchell (2003) show, only 7-25% of the newly launched food products in the EU can be considered as being truly novel and the vast majority of the new introductions (72-88%) fail. Hoban (1998), however, shows that the failure rate of truly new products is only 25%, leading to the conclusion that the insignificant coefficient of R&D is a result of the large share of small and rather unsuccessful innovations. [25]

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[25] Many other variables could be related to profitability by previous studies such as advertising, import and export activity or merger activity. Especially within the food sector, advertising intensity can act 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). However due to data limitations these variables could not be considered in our study.

7. Discussion and Conclusions

Our results suggest that food industry ROA is significantly influenced by industry, firm, year, and country effects, as well as two- and three way interactions of these effects. While these effects explain about 44% of the variation in profitability, explanatory power rises to 60% if micro-sized firms are excluded. With a share of up to 94% in the explained variance, firm effects considerably outweigh all other effect classes. Country and industry effects as well as the interactions are small, but larger than year effects whose contribution is negligible. Generally, these findings are robust to (1) method (COV and HLM vs. ANOVA increment to R^2), (2) estimation technique (MINQUE vs. ML), and (3) sample type (A vs. B).

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).[26] 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

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

variation may partly be due to differences in industry heterogeneity.[27] 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 present study a very large number of firms (up to 25,579) 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

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

'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 also be 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 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.[28]

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.[29] 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

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[28] 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.

[29] 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 on the driving forces of performance differentials, our results led to the following conclusions. First, all effect classes that represent macroeconomic fluctuation were weak, indicating that macroeconomics provide little potential to serve as a basis for explaining performance differentials in the food industry.[30] 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 the HLM method shows several firm characteristics are related to profitability. Especially firm size seems to be a very important driver for firm performance in the food industry. While the evidence in the present study supports a resource-based view on above-normal returns, we acknowledge

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

that it would be misleading to deny the influence of the industry dynamics and competitive context in which firms operate. As the HLM estimation indicates, several industry characteristics are related to profitability such as industry concentration and industry size which have a positive impact on ROA and industry growth which has a negative impact.

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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 = 6,293)*	*Sample B (N = 25,579)*	*Population* [a] *(N = 309,209* [b]*)*
Italy	32.9	14.0	24.7
Spain	15.4	14.6	10.2
France	22.5	39.5	23.7
United Kingdom	6.8	2.2	2.5
Poland	6.1	2.4	5.9
Belgium	3.9	5.6	2.7
Romania	2.6	12.1	3.8
Greece	2.7	1.3	5.3
Portugal	2.8	3.0	3.6
Finland	1.2	1.6	0.6
Sweden	1.0	2.4	1.2
Netherlands	0.3	0.1	1.6
Slovenia	0.6	0.3	0.3
Estonia	0.6	0.8	0.1
Germany	0.2	0.1	11.4
Ireland	0.3	0.1	0.2
Bulgaria	0.1	0.1	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 = 6,293)*	*Sample B (N = 25,579)*	*Population (N = 309,209)*
(151) Production, proc. & pres. of meat & meat prod.	20.1	18.9	15.0
(159) Manuf. of beverages	23.1	12.2	7.4
(158) Manuf. of other food prod.	17.9	45.6	60.9
(155) Manuf. of dairy prod.	12.4	7.4	4.3
(153) Proc. & pres. of fruit & vegetables	8.3	4.5	3.4
(157) Manuf. of prepared animal feeds	6.2	3.2	1.7
(156) Manuf. of grain mill prod., starches & starch prod.	5.9	4.4	2.8
(152) Proc. & pres. of fish & fish prod.	4.1	2.4	1.3
(154) Manuf. of vegetable & animal oils & fats	2.1	1.5	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 NACE-4 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	***	0.003	0.003	***	0.005	0.005
country effects β_j	***	0.021	0.021	***	0.011	0.010
industry effects γ_i	***	0.022	0.021	***	0.008	0.007
firm effects δ_k	***	0.641	0.551	***	0.534	0.418
year-country interactions φ_{tj}	***	0.028	0.025	***	0.021	0.018
year-industry interactions χ_{ti}	***	0.030	0.026	***	0.016	0.012
Industry-country interactions ψ_{ji}	***	0.080	0.071	***	0.043	0.034
three-way interactions ω_{tji}	***	0.119	0.075	***	0.079	0.033

Note: Models contain null model residuals as dependent and single effect classes as independent variable. Due to considerable computing times, we reduced the size of sample B for the nested ANOVA to 30,000 observations by means of a random draw.

[a] F-test significance. Triple asterisk (***) denotes significance at the 1% level.

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

Effect class	Mean Increment to R^2 [a]		Mean Increment to adj. R^2 [a]	
	A	B	A	B
year (Y) effects	0.003	0.005	0.003	0.005
country (C) effects	0.019	0.010	0.018	0.009
industry (I) effects	0.020	0.007	0.019	0.006
Y-C interactions	0.004	0.006	0.001	0.003
Y-I interactions	0.006	n.s.	0.002	n.s.
I-C interactions	0.043	0.027	0.034	0.018
Y-C-I interactions	0.077	0.054	0.031	0.007
firm effects	0.625	0.524	0.531	0.405

[a] Mean increment to adj. R^2 across all models into which the effect was introduced.

n.s. = not significant due to ANOVA F-Test

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

	Sample A		Sample B[a]	
Variance component	*ML*	*MINQUE (0)*	*ML*	*MINQUE (0)*
year effects	0.6%	0.0%	0.3%	0.3%
country effects	5.3%	0.7%	1.5%	0.5%
industry effects	0.9%	1.2%	0.4%	0.0%
Y-C interactions	0.3%	0.4%	0.5%	0.2%
Y-I interactions	0.4%	0.5%	n.s.	n.s.
I-C interactions	1.8%	1.6%	0.1%	0.1%
Y-C-I interactions	2.7%	0.0%	0.5%	1.4%
firm effects	47.9%	51.6%	40.3%	41.2%
error term	40.1%	44.3%	56.3%	56.3%

[a] Due to computational constraints and the large number of observations (127,895), sample B could not be processed in one simultaneous run. We therefore reduced the size of sample B for the nested ANOVA to 30,000 observations by means of a random draw.

Table 6. HLM estimates of industry and firm effects and structural variables

Variables			Variance components	
Firm level			Time (level 1)	0.001719
			Firm (level 2)	0.001576***
MS	-0.00000***	(0.00000)	Industry (level 3)	0.000044***
Age	-0.00014***	(0.00005)		
Ln TA	0.00314***	(0.00048)		
Gr. TA	-0.00260**	(0.00132)		
Gear	-0.00001***	(0.00000)		
1/Curr	-0.00152***	(0.00026)		
Industry level				
HHI	0.02487**	(0.01100)		
NF	0.00000***	(0.00000)		
Gr. NF	-0.00841***	(0.00179)		
R&D	-0.00161	(0.00107)		

Dependent variable: Return on Assets (ROA)
Industry variables: HHI = Herfindahl-Hirschman Index; NF = number of firms in industry; Gr. NF = Growth rate of the number of firms in the industry; R&D = Share of R&D expenditure in industry value added. Firm variables: MS = firm sales/industry sales; Age = firm age; Ln TA = natural logarithm of total assets; Gr.TA= growth rate of total assets; Gear = gearing ratio; 1/Curr = 1/current ratio.
All variables are averages over the sample period.
***, **, * significant at the 1%, 5%, 10% level respectively.

Figures

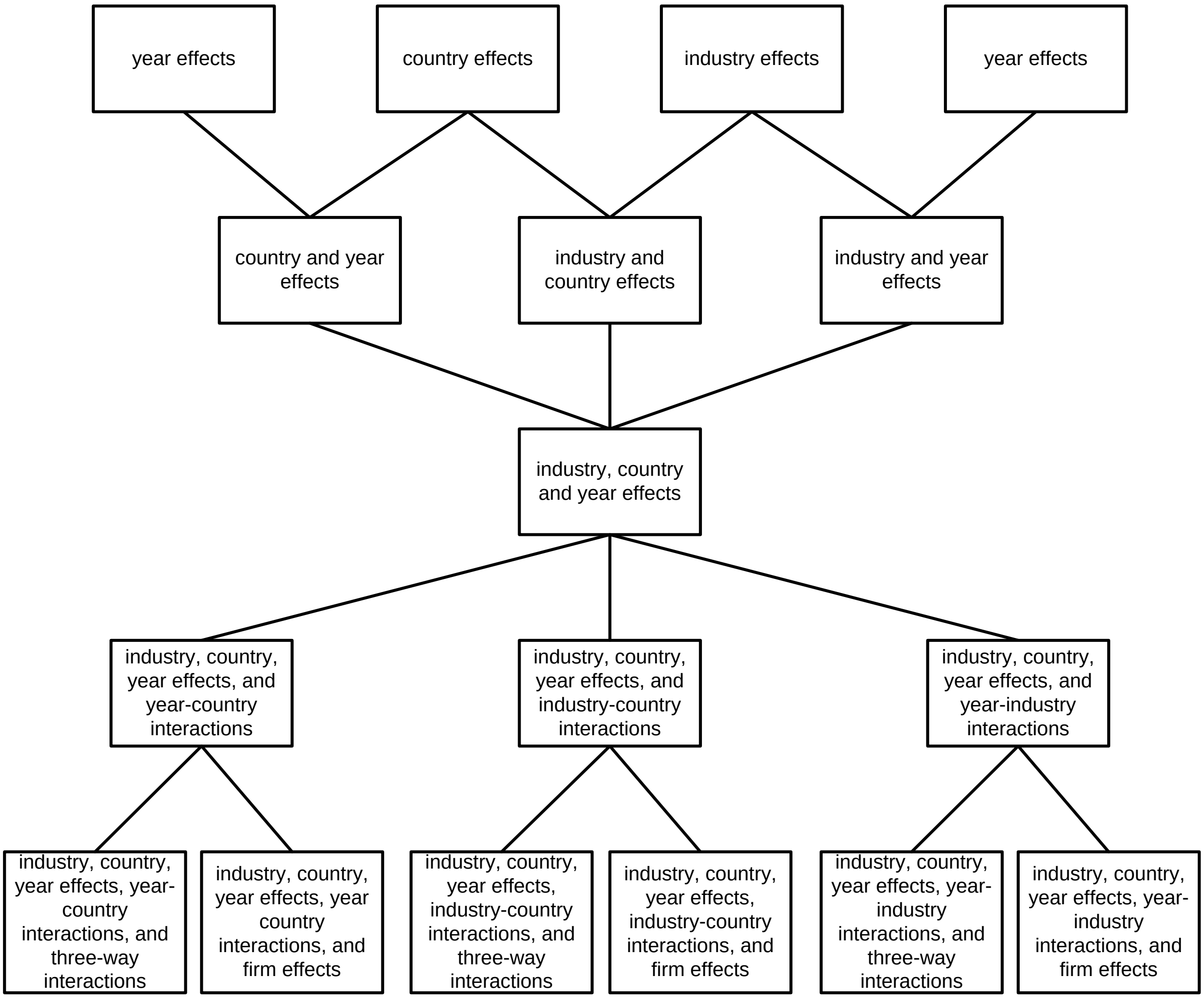

Figure 1. Rotation scheme for nested ANOVA