What Causes Firm Profitability Variation in the EU Food Industry? A Redux of Classical Approaches of Variance Decomposition

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What causes firm profitability variation in the EU food industry? A redux of classical approaches of variance decomposition

Since the 1980's economic researchers have applied variance decomposition methods such as ANOVA or components-of-variance (COV) in order to determine the importance of different effects for firm profitability variation. Nevertheless, these studies either focus on entire manufacturing sectors or on the U.S. food sector. This article, therefore, aims to determine the sources of firm profitability variation for EU food processors using the classical approaches of hierarchical ANOVA and COV. The paper also highlights a lack of the hierarchical ANOVA effect introduction pattern that occurs throughout previous literature. The results suggest that firm-related effects are the main profit driver while industry, year and country effects are negligible.

Key words: Food industry, competition, variance decomposition, COV, ANOVA

[L10; L25; C33]

1. Introduction

Initiated by Schmalensee (1985) and Rumelt (1991) the identification of the driving forces of variation in firm profitability has become an important and yet unresolved research question. The standard neoclassical model of perfect competition assumes that above or below average profitability is instantaneously eroded by perfect competition. This implies that profit deviations from the competitive norm are not obtainable within this approach (Carlton & Perloff, 2005). Nevertheless, past empirical research indicates that profits differ heavily across firms in different industries and also across firms within the same industry (e.g. Roquebert et al., 1996; McGahan & Porter, 1997; Goddard et al., 2009). The majority of these studies either use hierarchical ANOVA, the components of variance (COV) technique, or a combination of both in order to determine whether the divergence of firm profits occurs at the industry- or at the firm level.

This study aims at contributing to the classical research of firm profit variance decomposition by providing evidence on the drivers of firm profits in the EU food industry using the approaches of COV and ANOVA. To the best of our knowledge this is the first study applying COV and ANOVA to the EU food industry. Therefore, a second purpose of this study is to provide a basis for comparison between the food industry and other industrial sectors that have been analyzed by means of COV and ANOVA in previous studies.

While earlier studies based on COV and ANOVA (e.g. Schmalensee, 1985) show that industry effects are the prime driver of profit variation more recent studies show that the driver of profit differences is more likely the firm itself (e.g. Hawawini et al., 2004; Makino et al., 2004). Some studies have also measured the impact of year effects on the variation in firm profits (e.g. McNamara et al., 2005), or - if many countries are included in the analysis - of country effects (e.g. Goddard et al., 2009). Nevertheless, both country and year effects have only marginally impacted profitability in those studies. Other studies have focused on the impact of firm and industry effects on the capital structure of firms. E.g., Degryse et al. (2012) analyzed small and medium-sized Dutch firms and found that firms use profits in order to decrease short-term debt while firm growth leads to an increase in long-term debt. Degryse et al. (2012) also found that industry structure is an important determinant of a firm's capital structure. A rather new strand of research uses hierarchical linear modelling (HLM) and incorporates, besides entire effect classes, also structural firm- and industry specific variables such as firm size or industry concentration into the analysis (e.g. Hough, 2006; Misangyi et al., 2006; Short et al., 2006). Based on HLM Chaddad and Mondelli (2013) and Hirsch et al. (2014) have found that food industry firm size positively influences firm profits while the impact of industry concentration is negligible.

While the studies mentioned so far focus on cross sectional data or on data with rather short time series dimensions, a complementary field of research called profit persistence literature has emerged - beginning with Mueller (1990). Within this strand of research the persistence of firm profits over longer periods of time is analyzed by means of econometric panel models. The majority of these studies is based on simple autoregressive models of order one that are estimated by means of Ordinary Least Squares (OLS) regressions (e.g. Kambhampati, 1995; Goddard & Wilson, 1999; McGahan & Porter, 1999, 2003; Yurtoglu, 2004; Gschwandtner, 2005; Schumacher & Boland, 2005a; McMillan & Wohar, 2011). However, since OLS provides biased estimates for panel data (Baltagi, 2008) some recent studies have improved the methodology by applying the unbiased General Method of Moments (GMM) estimator (Goddard et al. 2005; Gschwandtner, 2012; Hirsch & Gschwandtner, 2013). The results of these studies point towards a low degree of firm profit persistence in the food industry compared to other manufacturing sectors (e.g. Hirsch & Hartmann, 2014). Few studies also perform detailed historic case studies in order to analyze firm profit persistence over longer time spans such as 50 or more years (e.g. Cable & Mueller, 2008). However, the drawback of those studies is that the focus is only on a small number of firms.

The empirical research on firm profitability described above has mainly focused on the quantification of effect sizes within entire manufacturing sectors or entire economies. Thus, there is an apparent lack of research that particularly focuses on profit variance decomposition in the food and agribusiness sector. One exception is Schumacher and Boland's (2005b) analysis of firms in the U.S. food economy. Their study provides evidence for strong firm effects that contribute around 50% to the profit variance of U.S. food economy firms.

As the EU food industry[1] is the most important manufacturing sector by contributing 14.9% to total manufacturing turnover (Eurostat, 2012) and has specific structural characteristics, a separate analysis of this sector appears worthwhile. 287,230 firms were active in the EU-27 food industry in 2010 creating a turnover of €954 billion and providing employment for 4.3 million people (Eurostat, 2012). In addition, an important issue that strongly affects EU food processing firms is the extremely strong competition in the downstream sector. For many EU countries the CR5 of the food retail sector exceeds 70% (e.g. Wijnands et al., 2007) - a fact that likely decreases bargaining power, particularly of smaller firms, which make up the majority of EU food processors (95%)[2] (Eurostat, 2012).

Although the large fraction of small firms is an important structural characteristic of the EU food industry (Wijnands et al., 2007; Hirsch & Gschwandtner, 2013) those firms are excluded in previous literature, as those studies mostly analyze data from publicly quoted and thus large firms (e.g. the Compustat database used by McGahan and Porter (1997) or Schumacher and Boland (2005b)). This issue is reinforced in studies focusing on the US manufacturing sector because the ratio of large multinational firms is significantly higher in the US food industry than in the EU food industry (13.7 % in the US vs. only 0.86 % in the EU) (US Department of Commerce, 2014; Eurostat, 2012). Contrarily, the database used in the present study (AMADEUS) provides balance sheet data for a variety of firm types (limited partnerships, private, publicly quoted, and coorporatives) and has no size restriction for firms included in the database (BvDEP, 2007). This implies that - besides large multinational firms - the significant fraction of small firms (i.e. those with fewer than 50 employees and total assets of less than EUR 10 million) present in the population is adequately reflected by the dataset.

This study contributes to the literature on firm profit variance decomposition in several ways. First, we quantify the impacts of firm, industry, country and year effects on corporate profitability in the EU food industry. Second, contrary to most previous studies, we also

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[1] Manufacture of food products and beverages excluding tobacco in the EU-27. According to NACE Rev. 1.1 division DA15 or NACE Rev. 2.0 divisions C10 and C11. NACE (Nomenclature generale des activites economiques dans les commumautes Europeeanes) is the statistical classification of economic activities in the European Community.

[2] According to the EU definition (European Commission, 2005), small firms are defined as having fewer than 50 employees and total assets of less than EUR 10 million.

consider several two-way interactions of the four main effects. Third, this study is the first to thoroughly consider all possible combinations of effect class introduction and provides algebraic proof of how the effect introduction patterns used in previous literature are not entirely methodologically sound.

2. Theoretical Background

The standard neoclassical textbook model of perfect competition assumes that profits above or below the competitive level[3] are instantly eroded by perfect competition. If profits in a market exceed the competitive level of the economy new firms will enter the market in order to tap these profits. As a consequence, however, competition in the market will increase and profits are driven back to the competitive level. Similarly, if profits are below the competitive level firms will exit the market and move their capital to more profitable markets. This implies that competition in the market will decrease and profits will be forced back to the competitive level. It can be assumed that this process affects all markets in an economy in a similar manner, resulting in a general equilibrium in competitive profits across all markets in the economy. Therefore, under the premise that the process of entry and exit can occur indefinitely fast, profit deviations from the competitive level are not possible within this approach (Carlton & Perloff, 2005). However, as indicated above, empirical literature has shown that profits can heavily differ either across entire industries or even across firms in the same industry. Although industries are virtually never characterized by perfect competition in the neoclassical way, the model of perfect competition provides the basis for more elaborate theoretical models and can serve as a benchmark model for the empirical analysis of real markets (Hirsch, 2014).

From a theoretical point of view, differences that occur between industries can be explained by industrial organization (IO). The core of classical IO is the structure-conduct-performance (SCP) model. The SCP model postulates that the structure of an industry influences the conduct of actors within the industry, which in turn determines their performance (Bain, 1956; 1968). However, as the classical SCP model is based on the perception that the influence of conduct is negligible, a direct connection between the industry structure and the performance of its members can be assumed. Therefore, in this framework, structural characteristics of an industry (i.e. the degree of competition, the number and size

[3] It is usually assumed that the competitive profit-level equals zero.

distribution of firms or entry and exit barriers) determine the performance of industry members. It can be assumed that these industry characteristics affect all firms in an industry in an equal way. Thus, as the firm and its unique resources are not considered in the SCP model, it follows that all firms in the industry will generate an identical degree of profits that depends on the industry's structure. However, due to different industry structures, profit levels can differ between industries. According to classical IO theory industry effects should be the main force of firm performance.

Tirole (1988), however, states that classical IO theory - particularly the SCP model - although plausible, is often based on loose theories. Nevertheless, Tirole (1988) has emphasized the importance of empirical industry studies based on the SCP model. Initiated by Bain (1951) several studies have empirically analyzed the relationship between profits, and structural industry characteristics, such as concentration and barriers to entry. Bain (1951) finds that profitability rates are higher in industries with more pronounced concentration ratios. In a later study, Bain (1956) shows that profitability is higher in industries characterized by strong concentration and high barriers to entry - thus providing empirical support for the validity of the SCP model. Subsequent empirical studies (e.g. Salinger, 1984), however, only find weak evidence for the connection between industry concentration and profitability (Carlton & Perloff, 2005).[4] Carlton and Perloff (2005) demonstrate that the majority of those studies are based on biased concentration measures such as the four-firm concentration ratio. Starting with Cotterill (1986) subsequent studies have therefore employed the Herfindahl-Index as a more adequate measure for industry concentration (e.g. Hirsch & Gschwandtner, 2013). Nevertheless, it remains a questionable assumption of most studies that concentration is an exogenous variable, which would imply that concentration is a driver of profitability and not vice versa. However, it is also likely that higher firm profits lead to firm growth and to stronger concentration. Subsequent theoretical research has therefore incorporated dynamic extensions to the classical SCP model in order to better capture the causality between variables (Hirsch, 2014).

In contrast to the classical SCP, approaches from strategic management, such as the market-based view (MBV) or the resource-based view (RBV), focus more on the firm itself than on industry structure as the driver of firm performance. The MBV can be seen as a dynamic extension of the classical SCP model, where firms can influence the structural characteristics of the industry and, thus, the forces of competition, through their strategic

[4] See e.g. Viaene and Gellynck (1995) for an empirical SCP study of the European food industry.

actions (Porter, 1980; 1981). Penrose (1959) interprets firms as bundles of physical and intangible resources whereat the management of a firm regards to the management of those resources. Differences between firms, therefore, emerge due to differences in resource endowment and to the productive services that are implemented based on these resources. According to Penrose (1960) firm growth arises as a consequence of a creative and dynamic interaction between firms' resources and the given market conditions. The RBV postulates that unique and strategically important resources that are valuable, rare, imperfectly imitable and non substitutable are the determining factor that enables specific firms to generate persistent profits above the competitive level (Barney, 1991). Thus the MBV as well as the RBV allow for differences in performance between firms within the same industry. According to the MBV and the RBV, firm effects should be the determining force of firm profitability.

The influence of country- and industry-specific country effects (which are captured by country*industry interactions and can be treated as comparative advantages) on variation in firm performance can be explained by models developed in trade theory. Previous literature has paid little attention to the theoretical foundations of year effects, which capture macroeconomic fluctuations. While macroeconomic fluctuation may equally affect all actors in an economy, it may also be limited to subsets of firms that are active in specific industries or countries. Industry- and country-specific macroeconomic fluctuations can be captured by industry*year and country*year interactions, respectively. Such asymmetric shocks or cycles (Buti and Sapir, 1998) 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 industry or country, or an unexpected shortage in the supply of a crucial input. Thus, one can interpret country*year and industry*year interactions as national and industry-specific business cycles.

3. Data

The data source used for this analysis is AMADEUS (BvDEP, 2010), a firm balance sheet database provided by Bureau van Dijk. As a measure of firm profitability, return on assets (ROA) is used. ROA is calculated for each firm and year by dividing firms' profit/loss before taxation, plus interest[5], by total assets. It must be pointed out that profit measures such as ROA, which are based on accounting data, can be biased, as issues such as profit-smoothing and cross-subsidization are not incorporated in their calculation. Therefore, ROA

[5] To make ROA independent of the source of funds used, interest has to be included in the numerator.

can be a distorted measure that does not adequately reflect real economic performance of firms.[6] However, alternative measures of performance, such as Tobin's Q or economic value added (EVA) developed by Stern Steward & Co, which measures the economic returns generated for shareholders, are not free from distortions, either. Biddle et al. (1997) prove that EVA is outperformed by earnings as a performance indicator. Therefore, to assure comparability to previous literature which mainly uses ROA as a profit indicator, and due to data availability, ROA was chosen as the best available option to measure firm performance in the present study[7]. (Hirsch & Gschwandtner, 2013)

All firms listed in any of the 33 four-digit industries between NACE-1511 and NACE-1598 for which complete ROA data for the years 1996 to 2008 were available are included in the sample. In a first attempt, similar to many previous studies (e.g. Schiefer & Hartmann, 2013), firms operating in the miscellaneous industry NACE-1589 were deleted from the sample, as this industry is classified as 'Manufacture of other food products not elsewhere classified' and likely contains a variety of heterogeneous firms. The presence of many heterogeneous firms in an industry might lead to less distinct industry effects. Therefore, inclusion of NACE-1589 was expected to cause a downward bias of industry effects. Surprisingly, including this industry to the estimation did not alter the results. It, therefore, appeared meaningful to keep NACE 1589 in the final sample particularly due to the fact that the superordinated 3-digit industry NACE 158 is already underrepresented in all countries (cf. Table 1). Furthermore, other industries such as the 'Production of meat and poultry meat products (NACE-1513)' or 'Processing and preserving of fruit and vegetables not elsewhere classified (NACE-1533)' are likely characterized by a similar degree of firm heterogeneity.

Data availability turned out to be best for Belgium, France, Italy, Spain and the UK. Although only five out of 27 EU member states could be included in the analysis these five countries constitute a significant part of the EU-27 food industry with 54% of its turnover in 2010. Other important countries that could not be included in the analysis due to a lack of

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[6] See Fisher and McGowan (1983) as well as Long and Ravenscraft (1984) for an extensive discussion on the usefulness of accounting profits in reflecting real economic profit.

[7] However, in several subsectors of the food industry such as 'meat production & processing' or 'fruit and vegetable processing' firms are characterized by rather high current asset intensity. The average ratio of current assets to total assets across all firms over the analyzed time span is 0.61. Therefore, in order to account for fluctuations in inventories and receivables, we have also considered to estimate each model with ROA adjusted by current assets (That is with profit/loss divided by fixed assets as the dependent variable). However, as fixed assets in each year of the analysis are highly correlated with total assets (>0.97) the results only change marginally and are therefore not reported here.

available data were Germany, the EU leader regarding food industry turnover with a contribution of 18%, the Netherlands (contribution of 6%), and Poland (contribution of 5%) (Eurostat, 2012). There is specifically a lack of data for Germany because the majority of non-publicly quoted firms was not legally obligated to publish financial data until the year 2007 (Hirsch, 2014). Compared to the US food industry which generated a turnover of €621 billion in 2011 the five analyzed EU food industries generate - with a turnover of €515 billion - a comparable amount. However, due to the significantly larger fraction of multinational firms the number of food processors in the US (30,384) is significantly smaller than the number of food processors in the five analyzed EU counties (160,504). (Eurostat, 2012; US Department of Commerce, 2014)

As pointed out above AMADEUS contains balance sheet data from firms of all size classes. This is an important feature of the database, as 95% (Eurostat, 2012) of the firms operating in the analyzed sector are small-sized. Small-sized firms were neglected by most previous studies, as those studies are restricted either to publicly quoted firms (e.g. Schumacher & Boland, 2005b) or only focused on firms of specific size (e.g. McGahan and Porter (1997) who only included firms with at least $10 million in total assets and sales).

In order to delete outliers in the data, the top and bottom 2.5% of the observations in each year were deleted from the sample.

The final sample contains 5,494 EU food processors with a total of 71,422 ROA observations. The present sample is one of the largest analyzed in this strand of literature. This is even more significant considering that the data set only contains observations from the food industry while other studies that analyze a sample of comparable size focus on entire economies (i.e. manufacturing, retail/wholesale and the service sector) (e.g. Waring 1996, McGahan & Porter 2003, Goddard et al. 2005). Studies that only focus on specific sectors are generally based on a sample containing around 500 firms (Hirsch, 2014)[8]. For example, in Schumacher and Boland's (2005a) analysis of the US food sector, a sample of 465 firms was used. Table 1 contains the descriptive statistics and provides a comparison of the sample with the population. Mean ROA of all firms over all years is 5.9%, with a standard deviation of 6.5 percentage points. It can be observed that Italian firms are underrepresented and that, despite a minimum size criterion, micro firms are still underrepresented in Italy and the UK. Regarding the representation of NACE industries, an underrepresentation of the 'Manufacture

[8] See Hirsch (2014) for a detailed literature overview that also provides information on sample sizes.

of other food products (NACE 158)' can be detected for all countries. This holds particularly true for Italy and leads, in turn, to an overrepresentation of other industries in this country - such as 'Meat production and processing (NACE 151)' and 'Manufacture of dairy products (NACE 155)'.

Insert Table 1 here

4. Methodology

The hierarchical ANOVA is based on the following descriptive model:

$$r_{tkic} = \gamma + \varpi_t + \alpha_k + \mu_i + \chi_c + \varphi_{it} + \eta_{ct} + \phi_{ic} + \varepsilon_{tkic} \qquad (1)$$

where r_{tkic} is year t ROA of firm *k* which is active in industry *i* of country *c*. In (1) γ is the grand mean across all ROA observations in the sample, while ϖ_t, α_k, μ_i and χ_c are year, firm, industry and country effects, respectively. Besides the four main effects, similar to Goddard et al. (2009), two-way interactions of year, industry and country effects are introduced, whereat φ_{it} and η_{ct} are transient industry and country effects, respectively. The industry*country interaction is captured by ϕ_{ic}. The term ε_{tkic} represents the residual variation in ROA. As AMADEUS only provides information on the corporate level and not at the level of individual business units, in contrast to the majority of most previous studies (e.g. Rumelt, 1991; Roquebert et al., 1996; Hawawini et al., 2003), firm effects cannot be split into business unit and corporate effects. Strictly speaking, the firm effect in the present analysis therefore reflects the corporate effect estimated by previous studies. However, as the majority of firms in the present sample are small and, therefore, rarely diversified, it is likely that the corporate effects are similar to business unit effects in this study.

As the hierarchical ANOVA results can strongly depend on the order of effect introduction (effects are in general larger the earlier they are introduced), we design a rotation scheme for all effect classes contained in the model based on Schmalensee (1985). The result is an effect-introduction pattern (Figure 1) which includes all reasonable combinations[9] of effect class introduction. In accordance with Hough (2006), in the first step of the nested ANOVA a 'null model' is estimated with ROA as dependent variable and the grand mean as explanatory variable. In the next step the 'null model' residuals are regressed on a first main effect (i.e. year, country or industry). Gradually, effects are introduced by regressing the latest residuals on a new effect until all effects have been added to the model, according to Figure 1. In each estimation step, the F-Test indicates if the latest effect has a significant impact. The contribution of the introduced effect to the model's explanatory power can be measured by the increment to R^2. Therefore, the average increment to R^2 over all steps in which a specific effect significantly increases explanatory power can serve as an indicator of its overall magnitude.

Insert Figure 1 here

The present study is the first to consider all combinations of effect introduction that are possible according to Figure 1. Previous literature (e.g. Schmalensee, 1985; Hough, 2006) ignores the limitation that the residuals that remain, for example, after the introduction of industry and country effects, depend on the order in which these effects have been introduced. That is, the residuals that remain when industry effects are introduced prior to country effects are not necessarily equal to the residuals that remain when country effects are introduced before industry effects. The remaining residuals after the introduction of two or more different effects are only independent of the order of introduction if collinearity between the considered effects is zero. This, however, is usually not the case (Misangyi et al., 2006). Therefore, in order to get a correct picture of effect magnitudes, all possible combinations of effect introduction according to Figure 1 have to be considered.[10]

[9] Although the rotation design leaves some room for maneuver, it is subject to some logical constraints. For example, two-way interactions cannot be considered before the introduction of their respective main effects. 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. Due to extremely long computation times firm effects were only considered in the last step of the introduction pattern (the estimation of firm effects at any stage of effect introduction takes up to two hours with an up to date computer). While Figure 1 already leads to 19 different models where firm effects are introduced, the consideration of firm effects in all other estimation steps would have led to non-manageable computation times. However, the results in the following section, which show that firm effects are the strongest effect class, justify the sole introduction in the last step. Nonetheless, this implies that firm effects might be slightly downward biased.

[10] Thus, according to Figure 1 55 different ANOVA models had to be estimated.

For the COV approach, it is assumed that the effects are random variables with expected values of 0 and constant variances σ_r^2, σ_ω^2, σ_α^2, σ_μ^2, σ_χ^2, σ_φ^2, σ_η^2 and σ_ϕ^2. Residuals are assumed to be uncorrelated, with expected values of 0 and constant variances. Furthermore, we assume that all effect classes are uncorrelated with each other and with the residuals. Similar to Makino et al. (2004), the total variance in ROA is decomposed according to equation (2) using restricted maximum likelihood (REML) techniques (Norusis, 2008). The standard maximum likelihood estimator does not adjust for the degrees of freedom which may result in a downward bias of the estimates. We, therefore, employ the REML estimator as it corrects for this bias and is, therefore, generally considered as superior (Liao & Lipsitz, 2002)[11]:

$$\sigma_r^2 = \sigma_\omega^2 + \sigma_\alpha^2 + \sigma_\mu^2 + \sigma_\chi^2 + \sigma_\varphi^2 + \sigma_\eta^2 + \sigma_\phi^2 + \sigma_\varepsilon^2 . \qquad (2)$$

5. ANOVA and COV estimation results

The ANOVA results are reported in Table 2. First, the contribution of each effect when introduced as a single effect class is presented. Regarding the main effects, the year only accounts for a proportion of 2.1% of the variance in profitability. Similarly, the contributions of industry (1.9%) and country effects (4.1%), as well as the interaction terms (5.2% to 6.8%), are rather small. Firm effects are the strongest effect class, explaining 36.8% of the variation in profitability. According to the F–Tests all effects have a significant impact when introduced as a single effect. Table 2 also shows the mean increments to R^2 of each effect arising from the combinations of effect introduction as depicted in Figure 1. The results show that when controlling for other effects the firm remains the strongest effect class contributing on average 34.3% to the variation in profitability. The average impact of year, country and industry effects remains marginal. Furthermore, the mean contribution of the interaction terms is considerably smaller in comparison with the introduction in the first step due to the fact that the corresponding main effects have been introduced previously. The impact of all effects remains significant, independent of the step of their introduction. The final models (with all effects introduced), on average, explain around 42.4% of the variance in profitability.

[11] See, e.g., Rao (1997) and Searle et al. (2006) for in-depth explanations of COV and its estimation methods.

Insert Table 2 here

COV results are depicted in Table 3. All effect classes together account for 34.9% of the variance in ROA. The results provide strong evidence for the predominance of firm effects, which are responsible for 27.0% of the variation in ROA.[12] While country effects account for 3.6% of the variation in ROA, industry effects and year effects are negligible with a contribution of 0.6% and 1.4%, respectively. Regarding the interaction terms industry*country, year*industry and year*country are marginal with a contribution of below 1% each.

Insert Table 3 here

The results seem to be mostly consistent across the two methods used. While firm effects are the strongest effect class, with an average contribution of 34.3% in the ANOVA framework and 27.0% in the COV framework, the contribution of industry effects, which is around 1% in both procedures, seems to be negligible. The same holds for year and country effects, which contribute between 1.4% and 3.6% across the two models. However, the interaction terms turn out to have a negligible impact in the COV framework, while their impact in the ANOVA model (when introduced as a first effect class) tends to be larger. This result is indicative for the presence of non-negligible idiosyncratic business cycles across the five analyzed countries and the 33 NACE industries, as well as country specific industry variation.

The question as to which of the above mentioned theoretical frameworks are supported by the results can be summarized as follows. First, as the firm turns out to be the determining effect class, the results provide strong support for the MBV, the theoretical view by Penrose (1959, 1960) and the RBV as theoretical underpinnings for the description of firm performance. Second, industry, country and year effects only contribute marginally, which implies that there is weak support for classical IO-, macroeconomic- or trade theory as theoretical frameworks for the analysis of firm performance. Third, interaction effects with a contribution of below 1% are negligible in the COV framework. However, their impact in the ANOVA model (when introduced as a first effect class) is more pronounced (between 5.2% and 6.8%). For industry*country interactions, this implies that comparative advantages of

[12] This implies that firm effects make up 77.4% of the total variance explained by the model.

specific industries are present between the five analyzed countries. Buti and Sapir (1998) suggest that year*country and year*industry interactions are an indication of asymmetric shocks or cycles in consequence of abrupt changes in aggregated supply or demand. These shocks or cycles can occur due to the imposition of a consumption tax affecting a certain country/industry, or an unexpected shortage in the supply of a crucial input that effects some countries/industries more than others. Furthermore, Artis et al. (2004) analyze the European business cycle and find evidence for idiosyncratic business cycles across European countries. They identify a high correlation between the cycles of a core group of countries - such as Belgium, France and Italy - while the UK's business cycle progresses independently.

The results are also mostly in line with previous studies for entire manufacturing sectors with regard to the dominance of firm effects and the negligible impact of year and country effects. Regarding industry effects, results of previous studies are not as unequivocal. While earlier studies (e.g. Schmalensee, 1985; Rumelt, 1991) find industry effects of up to 20%, later studies find - despite dominating firm effects - industry effects that range from 0.2% (Hawawini et al., 2003) to 10.3% (McGahan & Porter, 2002). This divergence might be a consequence of different industry classification systems. It can, therefore, be assumed that a narrower classification than the one used in the present study (four-digit NACE) would have led to stronger industry effects, as firms in each industry would have been more homogeneous. Regarding the agribusiness sector, Schumacher and Boland (2005b) find strong firm effects of around 50% for the U.S. food economy. However, while industry effects turn out as negligible in their ANOVA framework, their COV estimation leads to industry effects that contribute 20%. As Schumacher and Boland's (2005b) study is based on four–digit SIC (which is a narrower classification system than four-digit NACE) more pronounced industry effects might result. This fact is also pronounced in Schumacher and Boland's (2005a) study of profit persistence in the US food industry wherein firms classified on the basis of 49 4-digit SIC industries were analyzed (as opposed to 33 4-digit NACE industries in the present study). The database used in Schumacher and Boland's (2005a) study also has the advantage that data is reported for each business segment of a firm and not solely as aggregated firm level data as in the case of the AMADEUS database used in the present study.

As indicated by Table 1, the present sample consists of firms of different size classes with a prevalence of small and micro sized firms. In order to estimate the impact that firm size has on firm profitability, we additionally estimate an ANCOVA model that incorporates the effect of firm size as a covariate while controlling for all four effect classes and the interaction terms. Similar to previous studies (e.g. Gschwandtner 2005, 2012) firm size is measured by the logarithm of total assets. As Table 4 demonstrates, firm size has a significantly positive impact on firm profitability, which is likely due to a positive cost-scale effect (e.g. Ollinger et al. 2000; Hirsch & Hartmann, 2014). Furthermore, the result is in line with those of previous studies for the EU food industry. Hirsch and Gschwandtner (2013) as well as Hirsch et al. (2014) state that the positive impact of firm size in the EU food industry is due to the fact that larger firms are in a better bargaining position towards the highly concentrated food retail sector.

Insert Table 4 here

6. Conclusions

This study has shown that based on the classical approaches of variance decomposition - hierarchical ANOVA and COV - the firm itself seems to be the driving force of EU food processors' performance. The influence of structural industry characteristics, country-specific effects, and macroeconomic fluctuations on food industry profitability turns out to be negligible.

Identification of the drivers of variance in firm profitability is an important field of empirical economic research that has, as of yet, been widely ignored for the European food industry. Despite this fact, several important issues that are not covered by this study need to be pointed out. It has to be questioned if the negligible impact of industry effects is a result of the industry classification system on which AMADEUS is based. As mentioned above, some studies that are based on narrower classification systems, such as four-digit SIC, find non-negligible industry effects of up to 10.3% (McGahan & Porter, 2002). It would, thus, be interesting to see if industry effects increase when less aggregated data is used. Moreover, the usefulness of the NACE industry classification system for the estimation of industry effects has to be questioned as several 4-digit industries, such as the 'Production of meat and poultry meat products (NACE 1513)' or 'Processing and preserving of fruit and vegetables not elsewhere classified (NACE 1533)', are likely characterized by strong firm heterogeneity. Firms in other 4-digit industries, e.g. 'Manufacture of sugar' (NACE 1583), are likely more homogeneous. The less pronounced industry effects might, therefore, be a consequence of the rather imprecise industry classification system.

Furthermore, the given data only allows for analysis of a core group of EU member states. However, it would be worthwhile to analyze how the magnitude of country effects would change if particularly important countries such as Germany, the Netherlands, or new member countries in the eastern area of the EU were considered by the analysis. Unfortunately, due to poor data availability, incorporating these countries in this study was not possible.

Moreover, while this study makes an attempt to improve the methodology by estimating all possible combinations of the ANOVA effect introduction pattern, the COV approach, however, is based on the doubtful assumption that correlation between effects is not present. Future research in the field of profit variance decomposition should, therefore, take more sophisticated econometric approaches into consideration such as hierarchical linear modeling (HLM), which accounts for the dependency of effects by modeling complex error structures for each effect level. HLM also allows to analyze the impact of structural variables, such as firms size, on the respective effect class (i.e. firm effect), while ANOVA only allows to estimate the impact of firm size in general. Approaches of dynamic panel estimation, such as GMM regressions, can be used in order to estimate the persistence of profits over longer time periods. Nevertheless, this is a complementary field of research, while the aim of the present study was to provide a basis for comparison between the EU food industry and earlier COV and ANOVA studies that analyze other manufacturing sectors and the US food economy.

While the described limitations might serve as a basis for further research, it will be interesting to evaluate how the developments in the retail sector, which have recently drawn attention of antitrust policy in several countries due to high concentration levels, will influence the development of firm performance in the food industry (European Competition Network, 2012).

Tables and Figures

Table 1. Descriptive statistics of ROA and representation of the population by the sample.

	No. of obs.	Mean	Stdv.	Min.	Max
ROA	71,422	5.94%	6.46%	-89.65%	72.22%

	Belgium	**France**	**Italy**	**Spain**	**UK**
# obs. in the sample in 2008	841	2,786	596	1,043	228
# obs. in the population in 2008	7,834	63,704	69,523	28,632	7,439
Size class[a] shares in % (2007[b])	**Belgium**	**France**	**Italy**	**Spain**	**UK**
Large	4.7 (0.8)	3.6 (0.5)	5.5 (0.2)	5.2 (0.8)	30.7 (5.0)
Medium	6.5 (3.1)	5.8 (1.5)	35.4 (1.1)	14.9 (3.4)	30.7 (11.4)
Small	18.9 (15.8)	16.7 (8.7)	51.5 (9.3)	37.0 (18.4)	32.0 (28.0)
Micro	69.8 (80.4)	73.9 (89.3)	7.6 (89.4)	42.9 (77.4)	6.6 (55.6)
Shares of firms by 3-digit NACE in % (2008)					
151 Meat production & processing	14.0 (10.9)	27.3 (14.0)	19.1 (6.2)	29.1 (14.8)	12.3 (15.9)
152 Fish production & processing	1.3 (0.7)	1.4 (0.7)	1.8 (0.6)	7.0 (2.5)	3.5 (4.6)
153 Fruit and vegetable processing	2.7 (2.4)	2.4 (2.0)	6.7 (2.8)	8.1 (4.5)	11.8 (6.0)
154 Manufacture of oils & fats	1.0 (0.4)	0.2 (0.3)	2.0 (5.3)	0.3 (5.0)	1.3 (0.6)
155 Manufacture of dairy products	7.1 (5.6)	4.8 (2.0)	22.8 (5.7)	4.5 (5.1)	10.5 (7.3)
156 Manufacture of grain mill products	5.5 (1.4)	5.9 (0.8)	7.7 (1.9)	4.5 (1.9)	5..3 (1.8)
157 Manufacture of animal feeds	3.1 (1.9)	4.3 (0.8)	4.0 (0.9)	6.0 (2.9)	11.8 (5.7)
158 Manufacture of other food products	56.5 (73.8)	43.4 (75.3)	12.8 (72.3)	22.8 (47.3)	20.6 (45.2)
159 Manufacture of beverages	8.8 (2.8)	10.4 (4.2)	23.0 (4.1)	17.6 (15.9)	22.8 (12.8)

Source: Own calculations based on AMADEUS and Eurostat (2012).
Note: Shares for the population in parentheses are derived from Eurostat (2012).
[a] Size classes according to the SME definition of the European Commission (2005): Micro: < 10 employees and total assets < EUR 2 million; Small: < 50 employees and total assets < EUR 10 million; Medium: < 250 employees and total assets < EUR 43 million. Due to data availability, firms in the population are size-classified according to the number of employees, while firms in the sample are classified by their total assets.
[b] Comparison based on 2007 data as data for the population is not available for 2008

Table 2. ANOVA results (Contribution of effects to R^2 and adj. R^2).

Effect class	Contribution of effect when introduced first		Mean contribution[a]	
	R^2	Adj. R^2	R^2	Adj. R^2
Year	0.021***	0.021	0.022	0.022
Industry	0.019***	0.019	0.014	0.013
Country	0.041***	0.041	0.035	0.035
Y-I interactions	0.052***	0.047	0.013	0.008
Y-C interactions	0.068***	0.067	0.006	0.005
I-C interactions	0.058***	0.057	0.009	0.008
Firm	0.368***	0.315	0.343	0.288

[a] Average contribution of the effect to R^2 and adj. R^2 over all steps in which it is introduced according to Figure 1.
*** significant at the 1% level or less.

Table 3. COV results[a].

Variance component	%
Year	1.4%
Country	3.6%
Industry	0.6%
Firm	27.0%
I-C interactions	0.6%
Y-I interactions	0.9%
Y-C interactions	0.8%
Error	65.1%

[a] Estimated using the restricted maximum likelihood (REML) method.

Table 4. ANCOVA results with firm size as covariate

Variance component	Sum of Squares	F-value
Year	0.509	15.73***
Country	0.000	n.a. [a]
Industry	0.062	22.94***
Firm	92.376	6.36***
I-C interactions	0.000	n.a. [a]
Y-I interactions	3.194	3.53***
Y-C interactions	1.343	10.38***
Firm size	0.042	15.67***
R^2	0.407	
Adj. R^2	0.353	

[a] Dropped from the estimation due to multicollinearity.
*** significant at the 1% level or less.

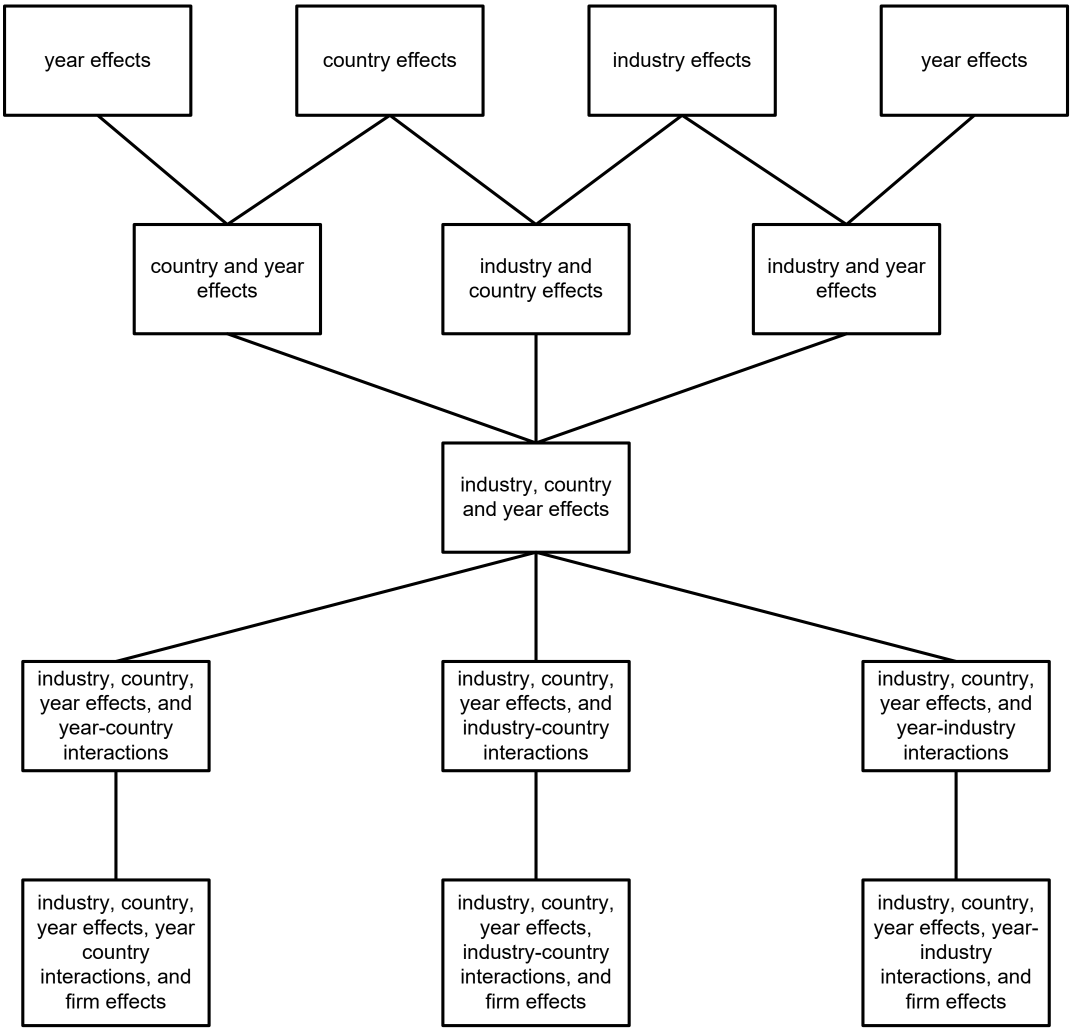

Figure 1. Nested ANOVA effect-introduction pattern.

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