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The Eastern European Automotive Industry in a Post-Pandemic World: What Drives Performance?

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Abstract

The automotive industry is one of the key drivers of economic growth in countries in Central and South-Eastern Europe, with contributions of up to 15% of gross domestic product. At the same time, the automotive industry is at the heart of key transformations: new technologies on the horizon at the verge of the global "green deal"; supply chain uncertainties because of the effects of pandemics in Asia; and unpredictable demand side factors ranging from purchasing power to consumer preferences. These aspects, coupled with large, fixed investments and costly distribution channels, put the industry at the core of (radical) change initiatives. Ahead of these changes, our paper investigated the presence of firm, industry, and country effects on the profitability of firms in the automotive industry in Central, Eastern and South-Eastern European countries, considering different industry definitions and firm size. We found that firm effects are significant for profitability variation across companies, but differ in intensity based on the size of the company, which signals that firm size matters significantly as a driver of operational profitability, as it is converted into sustained competitive advantages. While industry effects bear very little significance for profitability variation in the automotive industry, our most surprising finding was that country effects are important for profitability and have more of an impact for smaller companies. This may be the consequence of "historical" factors that led to large Original Equipment Manufacturers setting up their manufacturing facilities in the region, but also of specific economic policies in the form of state aid addressed to the automotive industry.

Keywords: automotive industry, profitability, Central and South-Eastern Europe, variance components, industry effects, country effects

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1. Introduction

One of the most important missions in terms of business strategy is the analysis of the final source of differences in performance among companies [1]. More specifically, it is important to analyse why companies achieve different levels of profitability or what differentiates them on the market. A good analysis of the differences between companies thus emphasizes the need to identify and properly manage the internal

performance areas of a company that are reflected in increasing its competitiveness and profitability. Many of the previous studies have focused on analysing the importance of enterprise, industry/sector and country effects on firm profitability, the most important debates referring to the effects that industries and countries have on firm profitability. As Porter's Diamond points out in terms of country-industry interaction, firms can obtain different economic profit in the same industry, but in different countries [2]. Countries have many attributes that can influence the company's performance, while the structural characteristics of the industry determine the viable strategies of the company and its financial performance [3]. The literature has been built on three directions of research, thus demonstrating that although industry-specific factors [4–6] and country-specific ones [7, 8] are relevant, the highest importance in terms of firm profitability lies with firm-specific factors [9, 10]. However, we believe that it is still necessary to study the relevance of firm, industry, and country effects on business performance in various economic conditions. In the present study, we seek to obtain new results that confirm or refute previous findings, focusing on the three perspectives (industrial, country and resources) for a sample of 478 companies in the automotive industry in EU member states located in South-Eastern Europe, given the inauspicious conditions brought about by the COVID-19 crisis. The poor performance of firms has been visibly linked to periods of recession [11, 12], so it is worth noting whether the interaction between firm and industry or country effects is a determinant vector of financial performance for companies in the automotive industry during the COVID-19 crisis. One contribution of this study is that we have examined how the relative importance of enterprise, industry, and country effects of in explaining EBIT (Earnings before interest and taxis) margin may vary depending on the definition of industry and the size of the firm. Moreover, although this line of research contains numerous studies using new and more appropriate techniques, these recent papers do not take into account the three perspectives in the automotive industry, few of which also use conventional variance decomposition techniques for more reliable estimation of the relevance of these perspectives. Our study is structured as follows. After reviewing the main studies in the literature, the next section presents the methodological approach, followed by the presentation and analysis of our results. We conclude with a section that also highlights several paths that may guide our or others' future research.

2. Literature Review

The literature concerning the country, industry and country-industry interaction effects in relation to firms' performance starts from the predisposition to investigate why firms are different in terms of profitability. The term "return" describes the assets and return on equity, while the term "profitability" is used when analysing profitability sales reports [13]. Therefore, given the competitive and dynamic conditions of the modern market, it is essential to analyse both the profitability of the sales ratio and the return on assets and equity ratios. There are various guidelines for analysing the factors that explain the achievement and maintenance of performance diversity among firms. One of the approaches assumes that different aspects related to the structure of the industry, such

as barriers to entry or the level of concentration, will determine the level of competition and profitability of companies. Another approach assumes that the company's resources will distinguish a company from the rest. Thus, the theoretical framework focuses on the one hand on the structure (organization) of the industry, and on the other hand on the endowment with resources.

A company's performance is influenced by a wide range of attributes. How each country uses its resources to develop unique industrial skills is essential to the performance of a firm [8]. They demonstrate that the context of the general economic environment is most critical in determining the role of enterprises, industry and the country's effects on firm profitability and confirm that country-level effects are more pronounced in emerging economies than in developed ones due to the presence of internal market structures, developed to avoid institutional inefficiencies. This perspective is consistent with that of Goldszmidt et al. (2011), whose ranking focuses on competitiveness as a means of economic development and uses aggregate indicators rather than firm profitability. Thus, countries with more imperfect markets would provide better opportunities for economic gains, to the detriment of economic development. A justification in this regard refers to the duration of creating a new company as a proxy for the level of bureaucracy of an economy and shows that countries that have shorter time to create new companies are more competitive. Thus, a complex process of creating a new business can be detrimental to economic development and can also act as a barrier to entry and increase the profitability of existing companies [14]. Ghemawat (2003) outlines the idea of companies' dependence on the economic environment of the country of origin and highlights that the phenomenon of globalization does not have a major impact on national borders in terms of business performance [15]. This study is in line with another one that also showed that some firms manage to stay in the market due to the national environment characteristics which acts as a limiting factor for foreign firms competing in the market [16]. On the other hand, other studies have indicated that the importance of country factors is low and company-specific factors dominate in terms of firm performance. The suggestion is that firms need to expand their thinking beyond national borders when it comes to competition, capacity, and customers, so their skills to be a product of management's decision to build capacity globally, and not just a result of the home country context [17]. This is also confirmed by another analysis carried out for publicly traded companies in France in order to identify common features that are associated with their performance and growth during a period of recession. The findings point towards the crucial role of financial health, internationalization, and the size of the company in terms of financial performance [18].

The country – industry interaction effect is an important component in understanding the performance of companies internationally. In this way, a study analyses the relative importance of firm resources and industry effect in explaining firm profitability and notes that the relevance of firm effect to total industry effect decreases as the definition of industry becomes narrower. Moreover, although the firm effect is higher than the industry effect, their results reveal a more significant industrial effect for large and medium-sized firms than for small ones [19]. These results come in line with [20, 21]. Also, in an attempt to reveal the relative importance of the factors responsible for

changing firm performance, another analysis notes that although firm-specific effects remain the dominant and have the most important impact on firm performance, the effects shaping firm performance are interdependent [22]. The industry effects make a greater contribution than the country ones, although qualitatively both sets of effects are smaller in relation the company effects and the corporate group. This suggests that the industry effect contains a significant transitional component and that the structural industries characteristics should not be treated as fixed or exogenously determined [23]. Zeli and Mariani (2009) analysed the determinants of profitability and productivity for large Italian companies operating in industrial sectors and note that companies classified in mature sectors (low-tech) are open to international competition and have low productivity, high profitability and a good financial situation, while those operating in traditional sectors ("Made in Italy") have more problems of profitability and debt ratio with different productivity situations [24]. On the other hand, the results of a study suggest that firm-related effects are the main determinant of profit, while industry and country effects are negligible. The study shows that the company itself seems to be the driving force behind the performance of EU food suppliers, the influence of the structural characteristics of the industry, the country-specific effects, and macroeconomic fluctuations on the profitability of the food industry being negligible [25]. Using a similar variance decomposition method to investigate the variance of dividend payment ratios at the firm and industry level, another study also notes the importance of firm effects and insignificant variations at the industry level [26]. Studying several strategic implications for firm survival in newly deregulated industries, Silverman et al. (1997) outline that the managers who focus on maximizing profitability by limiting growth does not guarantee the greatest survival chances. Also, strategic management should focus on all the influences contingent on the firm's characteristics at the beginning of the deregulation process. Thus, when deregulation occurs, a firm with high revenues would maximize its survival chances, for example, by focusing on profitability and efficient alignment of its debt-to-equity. At the opposite pole, a smaller firm might maximize its survival chances by growing rapidly even if at the cost of low profitability [27].

To our best knowledge, the research presented in this paper is the first that investigates the automotive industry in European countries, and more specifically in Eastern and South-eastern Europe. Understanding the main sources of performance behind profitability for an industry that has tremendously developed in this region as a result of multinational enterprises investments is, in our opinion, important for its future expansion and impact on local enterprises that are part of the automotive supply-chain.

3. Research Methodology

Our research includes companies that operate in the broad automotive sector in eight South-Eastern European countries, of which seven are EU members - Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, and Slovenia – and Serbia. We have not included Slovakian companies due to low data availability. The two main NACE 2-digit activity codes for these companies are C29 (Manufacture of motor vehicles, trailers and motorcycles) and G45 (Wholesale and retail trade and repair of motor vehicles and

motorcycles), but companies are divided into 6 NACE 3-digit codes (3 for C29 and 3 for G45) and 9 NACE 4-digit codes (4 for C29 and 5 for G45). We considered relevant an analysis that considers both sides of the automotive industry (manufacturing and distribution), given that countries in the region are important manufacturing locations for Original Equipment Manufacturers (OEMs), but also rising markets for distribution of vehicles.

For each company we collected data on EBIT (Earnings before interest and taxes) margin - EBITmg, which designates operational profitability, as well as on Operating revenue (Turnover) and Average Number of employees between 2011 and 2019 (annual frequency), alongside information on the country of headquarters, from the ORBIS – TP Catalyst data. The initial sample resulted in 5,282 companies of very large, large and medium size, but we have restricted the presence of a company in the final sample to the existence of full nine years of data on all the above-mentioned indicators. Hence, the final sample includes 471 companies, of which 67 in manufacturing and 411 in distribution.

Table 1 offers several descriptive statistics of the final sample for the three indicators in 2019 considering the three levels of aggregation based on NACE codes number of digits. We observe the quite high variation across industry divisions, regardless of the level of aggregation, for all three indicators: EBIT margin, Turnover and Employees. Overall, firms in the trade division have demonstrated higher profitability, as an average of 2011 and 2019, than firms in the manufacturing sector, and lower volatility in profitability, except for G4519 division (Sale of other motor vehicles). At the same time, mean EBITmg between 2011 and 2019 recorded rather small values: the highest EBITmg was 6.748% for G4519 (Sale of other motor vehicles) and -0.581% for C2910 (Manufacture of motor vehicles). The turnover generated by manufacturing automotive companies was, on average, 10 times higher than the turnover of trade firms, despite a rather similar number of employees per firm, indicating a better labour productivity in the manufacturing part of the automotive industry than in the trade part, or perhaps specific business models in distribution (e.g., commissionaire).

When automotive firms are split according to their country of incorporation – see Table 2 -, the mean 2011-2019 EBITmg varies between 2.696% in Slovenia and 6.281% in Bulgaria, showing values above the full sample mean of 3.751% in 5 countries (Bulgaria, Czechia, Poland, Romania, and Serbia) and below the mean in 3 countries (Croatia, Hungary, and Slovenia). The interesting point is that the variation in EBIT margin across countries does not seem to be correlated with a higher proportion of trade firms in the sample, which opens the door for the presence of country effects in profitability. Another noteworthy observation is that mean turnover varies quite heavily among the eight countries; Poland dominates the sample with a mean turnover of 443,622 thousand euros generated by only three companies, while Bulgaria is at the other end with a mean turnover of its automotive firms of only 5,263 thousand euros. At the same time, the variation across countries in number of employees is significantly smaller compared to the variation in turnover, adding to differences in labour productivity depending on industries differences based on firm's location in CEE countries or potentially differences in business models across countries.

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TABLE 1: Descriptive statistics of variables based on NACE codes – mean values over 2011-2019

	Number of firms	EBIT margin (%)					Turnover (thousand euros)					Employees (number)				
		Mean	Median	Min	Max	SD	Mean	Median	Min	Max	SD	Mean	Median	Min	Max	SD
Full sample	471	3.751	2.871	-21.226	46.557	4.478	21384.4	4058.4	131.4	2641909.6	141104.6	678.5	267.9	1.0	7096.3	1024.3
NACE 2-digit																
C29	62	2.837	3.698	-21.226	19.307	6.819	98729.4	9764.1	294.5	2641909.6	378931.7	603.1	233.1	5.6	2942.7	802.1
G45	409	3.890	2.786	-1.525	46.557	4.000	9659.7	3848.9	131.4	219032.4	20524.3	689.9	271.6	1.0	7096.3	1054.3
NACE 3-digit																
C291	10	-0.581	2.320	-12.996	7.252	7.417	495094.6	28430.5	294.5	2641909.6	871329.2	194.5	168.8	18.9	332.3	94.8
C292	11	1.834	3.117	-10.550	10.785	5.378	17489.7	6189.7	801.0	132460.7	38529.7	688.0	430.0	43.4	2905.1	910.7
C293	41	3.940	4.321	-21.226	19.307	6.845	23851.0	13231.1	561.2	147851.3	30673.9	680.0	334.6	5.6	2942.7	849.7
G451	203	3.108	2.174	-1.525	46.557	3.958	9989.8	4954.9	465.9	158083.3	17231.7	644.9	257.3	2.3	7096.3	1028.2
G452	105	4.742	3.070	-1.359	24.433	4.465	5916.6	1969.4	131.4	96925.0	13836.3	762.1	317.3	3.1	5237.1	1093.4
G453	101	4.574	4.143	-1.164	18.496	3.230	12887.7	3902.3	269.1	219032.4	29905.2	705.3	248.9	1.0	6818.1	1070.6
NACE 4-digit																
C2910	10	-0.581	2.320	-12.996	7.252	7.417	495094.6	28430.5	294.5	2641909.6	871329.2	194.5	168.8	18.9	332.3	94.8
C2920	11	1.834	3.117	-10.550	10.785	5.378	17489.7	6189.7	801.0	132460.7	38529.7	688.0	430.0	43.4	2905.1	910.7
C2931	11	4.694	5.163	-1.842	9.029	3.133	16701.3	15336.7	730.4	52476.7	17818.9	563.2	406.4	38.0	2337.3	658.8
C2932	30	3.663	3.971	-21.226	19.307	7.807	26472.6	12912.1	561.2	147851.3	34085.1	722.8	282.3	5.6	2942.7	916.0
G4511	182	2.688	2.007	-1.016	13.225	2.307	9903.8	4945.1	465.9	158083.3	17532.4	627.0	256.6	2.3	6796.4	949.8
G4519	21	6.748	3.981	-1.525	46.557	9.723	10735.4	5950.2	533.2	67710.0	14714.1	799.6	275.0	21.8	7096.3	1576.6
G4520	105	4.742	3.070	-1.359	24.433	4.465	5916.6	1969.4	131.4	96925.0	13836.3	762.1	317.3	3.1	5237.1	1093.4
G4531	57	4.665	4.376	-1.164	18.496	3.190	17768.5	5164.5	595.9	219032.4	37777.6	754.6	286.0	5.1	6818.1	1147.7
G4532	44	4.456	3.923	-0.901	14.187	3.313	6564.9	1437.4	269.1	53844.3	12195.3	641.5	225.7	1.0	4343.8	970.8

Note: Min is minimum value, Max is maximum value and SD designates standard deviation
Source: Authors' calculations

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TABLE 2: Descriptive statistics of variables based on countries of headquarters – mean values over 2011-2019

	Number of companies	EBIT margin (%)					Turnover (thousand euros)					Employees (number)				
		Mean	Median	Min	Max	SD	Mean	Median	Min	Max	SD	Mean	Median	Min	Max	SD
Full sample	471	3.751	2.871	-21.226	46.557	4.478	21384.4	4058.4	131.4	2641909.6	141104.6	678.5	267.9	1.0	7096.3	1024.3
Bulgaria	81	6.281	5.192	-0.869	46.557	6.172	5263.2	1245.7	131.4	52476.7	9700.1	710.8	289.6	3.1	5237.1	1023.9
Croatia	112	2.952	2.567	-21.226	15.257	4.383	9064.2	3176.7	294.5	96925.0	16760.0	725.7	381.6	2.3	6818.1	1075.7
Czechia	5	6.038	7.844	0.524	11.206	4.680	20424.1	12649.3	4861.0	45182.8	15953.6	250.7	101.0	5.6	1002.2	422.7
Hungary	62	3.186	2.376	-12.910	13.225	3.505	62024.3	8950.3	1145.0	2641909.6	334473.1	725.2	211.1	24.0	7096.3	1200.1
Poland	3	4.349	4.920	1.353	6.774	2.755	443622.6	71431.9	13249.3	1246186.5	695649.3	428.0	559.0	18.9	706.2	361.9
Romania	31	4.018	3.141	-0.977	12.618	3.176	26990.2	15111.6	912.4	219032.4	41626.1	512.3	209.3	12.6	5106.3	961.2
Serbia	53	4.299	3.702	-10.550	19.307	5.329	21585.0	2838.0	470.6	852898.4	116608.0	676.3	312.5	15.0	4377.3	942.2
Slovenia	124	2.696	1.948	-2.970	12.765	2.581	11059.3	3745.0	682.1	158083.3	25116.0	657.1	246.1	1.0	5173.2	969.7

Source: Authors' calculations

Our analysis of profitability in the automotive sector in South-eastern European countries is built on a model that considers EBIT margin in year 2019 as dependent variable and profitability indicator, alongside one continuous variable that captures firm effects and two categorical variables that designate industry and country effects, respectively. Although previous research focuses mostly ROA as an indicator that captures variation in profitability among firms – [14, 21, 28], to name just a few - we have used EBIT margin since it is closer to the idea of operational profitability. Moreover, given that EBIT is calculated before financial expenses and taxes, it offers a better understanding of the intrinsic firm attributes that differentiate in terms of performance. We have applied a variance components model based on ANCOVA methodology, which is a mixture between the traditional analysis of variance (ANOVA) and a regression. We have estimated the following model:

$$Y_{i,t} = \alpha_0 + \beta_1 R_{i,t0..t-1} + \beta_2 I_i + \beta_3 C_i + \beta_2 I_i C_i + \varepsilon_i \quad (1)$$

where $Y_{i,t}$ is the EBIT margin (EBITmg) for company *i* in years 2015-2019, subsequently, and $R_{i,t0..t-1}$ is the cumulative EBIT margin in the 2011-2018 period, before year t; for example, if EBITmg_{2019} is the dependent variable, then cumulative EBITmg will cover years 2011-2018, and if EBITmg_{2018} is the dependent variable, then cumulative EBITmg will encompass years 2011-2017, and so on. This approach is useful to investigate the dynamics over time of firm versus industry and country effects in EBITmg variation. I_i designates the industry where the company operates and is a categorical variable constructed on the number of divisions according to the level of disaggregation in NACE codes (2 for 2-digit codes, 6 for 3-digit codes and 9 for 4-digit codes). C_i is the variable that captures the country effect and represents the country where the company is incorporated (values from 1 to 8, for the eight countries included in the model). $I_i L_i$ is the interaction between industry and region or location effects, and ε_i is the error term. The coefficients have been estimated using an ANCOVA model with type III sum of squares, where the independent variables are the cumulative EBITmg that is considered a covariate and average industry and country EBITmg between 2011 and 2018 as fixed effects [20].

It is important to mention that we do not identify causal relationships between variables with the model described in Equation 1, but we are interested in the relative importance that firm, industry and country effects have on the variation in EBITmg. The model assumes independence between the three effects, which makes the EBITmg variance equal the sum of each factor's variance.

We do not specifically include a size factor in our model, but besides the base-case model we estimate EBITmg variance components depending on firm size. Thus, we divided automotive firms in CEE in three main size categories – large, medium and small – based on the average turnover between 2011 and 2019; we end up with 157 firms in each category.

4. Results and Discussion

We present in Table 3 the mean and standard deviation (SD) of EBIT margin for each year between 2011 and 2019, as well as for cumulative EBITmg over the period, starting with the 2011-2013 period. Moreover, Table 2 shows the correlation coefficients between them, that are all statistically significant at 5% level. Mean EBIT margin demonstrated an upward trend between 2011 and 2015, followed by downward trend until 2019, which might be an indication of an erosion of automotive firms' competitive advantages in CEE countries after 2015 or changing business patterns. EBITmg volatility over time does not seem to present a significant trend, which may suggest a variable performance of automotive firms in the region and the presence of a significant firm effect. Cumulative EBITmg has increased every year between 2011 and 2018, which is a sign of small, but robust profitability over time, propelled by the expansion of multinational companies with steady business models in the automotive sector in the CEE region and the integration of local companies in the formers' supply chain, but also by higher purchasing power of customers driven by solid economic growth.

The presence of higher standard deviations for cumulative EBITmg compared to EBITmg annual values may indicate a decline in the systematic or market effect, given that cumulative EBITmg is formed using profitability over at least three years. The correlations between annual EBITmg and cumulative EBITmg, in the right side of Table 2, are all positive and range between 0.102 and 0.997. This confirms the existence of a systematic effect in automotive firms' profitability that does not disappear with the passing of time. When keeping the year for EBITmg constant, correlations tend to decrease when they encompass a higher number of years – for example, the correlation between EBITmg in 2019 and in 2018 is 0.563, but between EBITmg in 2019 and in 2011 is only 0.102 – which, again, defends the existence of an industry or systematic effect in profitability variation for CEE automotive firms.

Traditional ANOVA applied to our sample of firms shows that, regardless of the level of NACE aggregation, between-group EBITmg variation is significantly higher than within-group EBITmg variation for more years and more prominent when a higher level of industry disaggregation is used. The size of the ratio between EBITmg variation between-group and within group ranges from 2.15 to 4.90 for 3-digit codes, from 1.98 to 6.23 for 4-digit codes, and from 0.05 to 9.62 for 2-digit codes. This indicates that industry effects play an important role in explaining profitability variation. Still, ANOVA finds statistically significant EBITmg between mean EBITmg of automotive companies for all years only when the 4-digit disaggregation is used; in eight out of nine years such statistically significant differences exist in the 3-digit disaggregation, and in 4 out of nine years in the 2-digit disaggregation. This may imply that industry effects matter more for 4-digit industries than for more aggregated industries and it remains to be confirmed by the next steps in our analysis. When the country is used as discriminating variable, ANOVA shows that between-group EBITmg variation is 1.16 to 8.51 times higher than within-group variation, which indicates the presence of a country effect for profitability variance in the CEE automotive industry. Moreover, in five out of eight years, the difference between mean EBITmg when the country of headquarters is considered

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Table 3: Correlations between variables for full sample

						EBIT margin									CUMEBIT margin			
	Variable	Means	SD	2019	2018	2017	2016	2015	2014	2013	2012	2011	2011-2013	2011-2014	2011-2015	2011-2016	2011-2017	2011-2018
EBIT margin	2019	3.040	7.043	1.000														
	2018	3.557	5.048	0.563	1.000													
	2017	3.709	6.037	0.561	0.652	1.000												
	2016	4.185	5.433	0.036	0.483	0.326	1.000											
	2015	4.221	6.422	0.492	0.605	0.472	0.332	1.000										
	2014	4.022	7.362	0.495	0.500	0.477	0.139	0.721	1.000									
	2013	3.713	7.055	0.353	0.484	0.391	0.168	0.684	0.766	1.000								
	2012	3.775	5.809	0.373	0.476	0.473	0.223	0.581	0.659	0.717	1.000							
	2011	3.544	8.116	0.102	0.250	0.076	0.287	0.304	0.124	0.339	0.371	1.000						
CUM EBIT margin	2011-2013	12.147	20.359	0.277	0.466	0.358	0.282	0.646	0.588	0.785	0.732	0.724	1.000					
	2011-2014	17.575	33.622	0.287	0.491	0.351	0.283	0.726	0.716	0.790	0.683	0.583	0.951	1.000				
	2011-2015	24.145	57.682	0.252	0.480	0.313	0.279	0.759	0.694	0.726	0.599	0.479	0.868	0.972	1.000			
	2011-2016	30.229	70.252	0.254	0.502	0.334	0.323	0.761	0.689	0.712	0.589	0.468	0.854	0.963	0.997	1.000		
	2011-2017	36.447	84.870	0.269	0.536	0.378	0.345	0.762	0.687	0.702	0.585	0.453	0.839	0.952	0.991	0.997	1.000	
	2011-2018	43.641	114.805	0.265	0.561	0.368	0.344	0.759	0.680	0.685	0.565	0.425	0.789	0.918	0.973	0.981	0.988	1.000

Source: Authors' calculations

is statistically significant at 5%. On the other hand, the ratio of EBITmg between-group variation and within-group variation diminishes over time when 3 and 4-digit NACE disaggregation and country are used (more in the case of country) but increases in the case of 2-digit disaggregation. This might reveal that the closer industry to firm activity has become over time less important for profitability variance, as well as countries of incorporation. In the latter case, this may be explained by the wider scope of automotive firms' operations at EU and global level and by the horizontal and vertical integration of local companies in CEE in the supply chain of the big players in the automotive sector.

We show in Tables 4 to 6 the results of variance components estimation for CEE automotive firms' EBITmg between 2015-2019 and for three levels of NACE disaggregation; thus, we study the firm-industry-country effects in a dynamic setting by investigating the relevance of the NACE disaggregation level for EBITmg variance. Moreover, we address the relative importance of these effects when firms' size is included in the analysis. The most important result is, in our opinion, the statistical significance of firm effects in all models, regardless of year, NACE disaggregation level and business size, albeit all estimations indicate the presence of importance errors which need to be further addresses in future research endeavours. The error size varies between 12.99% in the 4-digit division lor large firms in 2019 and 85.90% in the 2-digit division for small firms in 2016. Overall, we observe higher errors in the variance decomposition for smaller firms and smallest for large or medium-size firms, which suggest a higher importance of various other factors for explaining profitability variance in formers' case that are not captured by our investigated effects, such as firm's age, employees' experience, region where the firm operates, etc. Besides this difference in error importance depending on firm size, no trend in error size is observable, regardless of the NACE disaggregation level and/or firm size.

Concerning firm effects, as importance in total EBITmg variance, their size varies between 4.08% in 2016 (4-digits NACE) and 45.82% in 2015 (2-digits NACE) for the full sample, but we found overall a reduced importance of firm effects for smaller companies, which is an expected result – this finding is valid for all NACE levels of disaggregation. Another interesting finding is that firm effects increase for all classes of firms based on size when a higher level of industry aggregation is used, indicating that firms in the automotive sector in CEE countries were able to build competitive advantages that are the result of operating in a specific sector, which may have added to the specific attributes at firm level. Thus, for large firms the size of firm effects varies between 8.52% to 29.98% in the 4-digit disaggregation, from 8.52% and 32.81% in the 3-digit disaggregation, and between 10.18% and 35.02% in the 2-digit industry definition. For medium firms, the firm effect dimension ranges between 10.49% and 25.54% in the 4-digit disaggregation, from 12.71% and 30.37% in the 3-digit disaggregation, and between 16.67% and 39.22% when the 2-digit disaggregation is used. In the case of small firms, this effect is positioned at 6.67% to 14.03% in the 4-digit disaggregation, at 2.69% to 49.96% in the 3-digit disaggregation, and at 2.71% to 52.49% in the 2-digit disaggregation. Still, the importance of firm effect for explaining EBITmg variance is rather fluctuating over time, no matter the NACE disaggregation level or firm size.

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TABLE 4: Results of variance components estimation – 2-digit NACE codes

	EBITmg 2019		EBITmg 2018		EBITmg 2017		EBITmg 2016		EBITmg 2015	
	Estimate	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**
Full sample										
Firm	*1209.6*	5.19%	*3133.4*	26.16%	*1531.6*	8.94%	*895.0*	6.45%	*8882.0*	45.82%
Industry	46.7	0.20%	16.9	0.14%	21.2	0.12%	60.4	0.44%	7.6	0.04%
Country	*2035.6*	8.73%	145.6	1.22%	355.4	2.07%	*577.0*	4.16%	*496.8*	2.56%
Industry x Country	*1775.2*	7.61%	234.9	1.96%	*495.2*	2.89%	338.7	2.44%	*432.9*	2.23%
Error	18957.2	81.30%	8170.2	68.21%	14337.1	83.70%	11843.6	85.37%	8581.1	44.27%
Total	23316.8	100.00%	11978.3	100.00%	17129.4	100.00%	13873.0	100.00%	19383.8	100.00%
Large firms										
Firm	*1387.2*	25.51%	*868.5*	35.02%	*929.7*	30.59%	*789.6*	31.71%	*304.4*	10.18%
Industry	55.2	1.02%	26.2	1.06%	1.7	0.06%	6.7	0.27%	12.2	0.41%
Country	*494.7*	9.10%	49.5	2.00%	121.2	3.99%	*181.3*	7.28%	*295.7*	9.89%
Industry x Country	*597.9*	11.00%	*139.4*	5.62%	*185.1*	6.09%	*166.4*	6.68%	87.7	2.93%
Error	3070.3	56.47%	1237.8	49.91%	1749.5	57.57%	1269.6	50.99%	2126.1	71.10%
Total	5436.7	100.00%	2480.2	100.00%	3039.0	100.00%	2489.9	100.00%	2990.1	100.00%
Medium firms										
Firm	*1165.0*	23.43%	*949.3*	39.22%	*793.0*	29.52%	*460.7*	16.67%	*1016.2*	36.24%
Industry	15.9	0.32%	0.9	0.04%	7.4	0.28%	35.3	1.28%	12.8	0.46%
Country	75.5	1.52%	82.9	3.43%	*170.4*	6.34%	*236.0*	8.54%	*156.3*	5.57%
Industry x Country	12.4	0.25%	28.1	1.16%	*180.9*	6.73%	*139.6*	5.05%	63.8	2.28%
Error	3690.7	74.23%	1190.3	49.18%	1465.5	54.55%	1843.8	66.72%	1455.7	51.91%
Total	4972.2	100.00%	2420.5	100.00%	2686.7	100.00%	2763.6	100.00%	2804.4	100.00%
Small firms										
Firm	*348.1*	2.71%	*1739.4*	24.98%	*515.9*	4.64%	*278.8*	3.42%	*6954.3*	52.49%
Industry	*511.8*	3.99%	*125.0*	1.80%	*513.0*	4.61%	67.1	0.82%	14.6	0.11%
Country	*1982.6*	15.45%	277.7	3.99%	358.3	3.22%	363.5	4.45%	*556.8*	4.20%
Industry x Country	*1577.3*	12.30%	*303.4*	4.36%	*537.9*	4.83%	360.1	4.41%	*483.1*	3.65%
Error	9131.4	71.18%	4394.2	63.11%	8941.8	80.37%	7011.8	85.90%	4094.0	30.90%
Total	12828.9	100.00%	6963.0	100.00%	11125.2	100.00%	8162.4	100.00%	13248.7	100.00%

Note: Figures in italics indicate statistical significance of effects at 5% level. Source: Authors' calculations

A rather surprising result is the small statistical significance for industry effects (28.33% for all estimations), but the higher extent of statistical significance for country effects (43.33%), as well as for industry-country interaction effects (60%). In the case of industry effects, we found statistical significance for the full sample only in 2018 – for 3-digit and 4-digit NACE disaggregation -, for large firms in 2019 and 2018 in the 3-digit disaggregation, and in 2019, 2018 and 2015 in the 4-digit disaggregation, and for small firms in 2019, 2018 and 2014 in the 2-digit and 3-digit disaggregation, and for all years in the 4-digit disaggregation. Hence, smaller firms (perhaps niche traders or producers) seem to have benefited more from industry-related advantages reflected in their profitability compared to larger firms – to note that industry effects have not been found statistically significant for medium firms. In terms of size, industry effects also tend to be higher for smaller firms, even up to 6 times for example for 2017 and the 4-digit disaggregation. The size of industry effects varies also with the NACE disaggregation level, for all types of firms, and is higher for a higher level of NACE disaggregation. Thus, the importance of industry effects ranges for large firms between 0.12% and 0.41% in the 2-digit disaggregation, between 1.47% and 4.17% in the 3-digit disaggregation, and between 2.20% and 10.82% in the 4-digit disaggregation. For medium firms, industry effects have an importance in EBITmg variation between 0.04% and 1.28% when the 2-digit industry definition is used, between 0.85% and 3.14% in the 3-digit industry definition, and between 1.19% and 4.92% in the 4-digit industry definition. In the case of small firms, industry effects vary between 0.11% and 4.61%, between 3.64% and 11.42%, and between 4.89% and 19.99% as we move from the 2-digit to 4-digit industry definitions. However, as in the case of firm effects, no significant upward or downward trend is detectable for industry effects, regardless of firm size or level of NACE disaggregation level.

While EBITmg variation in the CEE automotive sector is lesser explained by industry effects, country effects presented a higher statistical significance in our tests, although not necessarily higher size than industry effects. Thus, country effects were found to be statistically significant in three years out of five in the 2-digit and 3-digit disaggregation (2019, 2016, 2015, and 2019, 2018, and 2015, respectively), and in two out of five years in the 4-digit disaggregation for the full sample, in 3 out of five years in the 2-digit and 4-digit disaggregation for large firms (2019, 2016 and 2015), in three out of five years for medium firms only in the 2-digit disaggregation (2017, 2016 and 2015), and in 2 years out of five for small firms in the 2-digit disaggregation, and in three out of five years in the 3-digit and 4-digit disaggregation (2019, 2018 and 2015). Based on these results, we cannot uphold that firm size is significantly linked to the presence of country effects, which may indicate that firms' location in particular CEE countries could have acted as entrants' advantage for the automotive sector. This finding may be connected to the results revealed in Table 2, which revealed that mean EBITmg has varied in a ratio of even 1:3 across CEE countries. Moving forward to the size of country effects, this varies between 1.22% and 9.83% for the entire sample, but firm size acts as differentiator for country effects size, in a rather similar manner to firm and industry effects. Thus, country effects vary between 2.00% and 9.89% (2-digit disaggregation), 1.07% and 19.24% (3-digit disaggregation), and 1.63% and 16.05% (4-digit disaggregation) for large firms, between 1.52% and 8.54% (2-digit disaggregation), 1.10% and 3.55%

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TABLE 5: Results of variance components estimation – 3-digit NACE codes

	EBITmg 2019		EBITmg 2018		EBITmg 2017		EBITmg 2016		EBITmg 2015	
	Estimate	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**
Full sample										
Firm	*1089.2*	4.67%	*2869.9*	23.96%	*1459.1*	8.52%	*758.1*	5.46%	*8421.7*	43.45%
Industry	423.1	1.81%	*265.1*	2.21%	251.0	1.47%	270.1	1.95%	131.4	0.68%
Country	*2291.5*	9.83%	*264.5*	2.21%	338.1	1.97%	200.3	1.44%	*796.5*	4.11%
Industry x Country	*3263.5*	14.00%	*875.2*	7.31%	*1519.1*	8.87%	*1352.1*	9.75%	*1230.8*	6.35%
Error	17222.4	73.86%	7269.7	60.69%	13117.0	76.58%	10522.2	75.85%	7658.5	39.51%
Total	23316.8	100.00%	11978.3	100.00%	17129.4	100.00%	13873.0	100.00%	19383.8	100.00%
Large firms										
Firm	*871.1*	16.02%	*776.1*	31.29%	*997.0*	32.81%	*702.9*	28.23%	*254.8*	8.52%
Industry	*205.6*	3.78%	*134.9*	5.44%	60.8	2.00%	58.9	2.36%	124.6	4.17%
Country	*1046.3*	19.24%	67.8	2.73%	32.7	1.07%	110.8	4.45%	*416.9*	13.94%
Industry x Country	*2259.3*	41.56%	*385.4*	15.54%	375.6	12.36%	297.0	11.93%	*784.7*	26.24%
Error	1322.0	24.32%	940.2	37.91%	1433.7	47.18%	1059.3	42.54%	1385.2	46.33%
Total	5436.7	100.00%	2480.2	100.00%	3039.0	100.00%	2489.9	100.00%	2990.1	100.00%
Medium firms										
Firm	*937.2*	18.85%	*735.1*	30.37%	*630.6*	23.47%	*351.1*	12.71%	*824.0*	29.38%
Industry	62.7	1.26%	50.6	2.09%	84.3	3.14%	54.1	1.96%	24.0	0.85%
Country	54.6	1.10%	79.0	3.26%	89.0	3.31%	98.1	3.55%	64.2	2.29%
Industry x Country	109.5	2.20%	165.4	6.83%	*281.0*	10.46%	292.1	10.57%	172.4	6.15%
Error	3575.3	71.91%	1023.9	42.30%	1283.1	47.76%	1639.3	59.32%	1327.2	47.33%
Total	4972.2	100.00%	2420.5	100.00%	2686.7	100.00%	2763.6	100.00%	2804.4	100.00%
Small firms										
Firm	*378.8*	2.95%	*1558.8*	22.39%	*549.1*	4.94%	*219.4*	2.69%	*6221.8*	46.96%
Industry	*955.9*	7.45%	*549.8*	7.90%	*957.9*	8.61%	931.9	11.42%	482.1	3.64%
Country	*2562.7*	19.98%	*307.8*	4.42%	460.7	4.14%	287.9	3.53%	*684.9*	5.17%
Industry x Country	*3354.2*	26.15%	*762.2*	10.95%	*1351.4*	12.15%	1049.6	12.86%	*1039.7*	7.85%
Error	7082.8	55.21%	3557.6	51.09%	7862.4	70.67%	5619.0	68.84%	3204.6	24.19%
Total	12828.9	100.00%	6963.0	100.00%	11125.2	100.00%	8162.4	100.00%	13248.7	100.00%

Note: Figures in italics indicate statistical significance of effects at 5% level. Source: Authors' calculations

(3-digit disaggregation), and 0.65% and 2.92% (4-digit disaggregation) for medium firms, and between 3.22% and 15.45% (2-digit disaggregation), 3.53% and 19.98% (3-digit disaggregation), and 3.76% and 15.73% (4-digit disaggregation) for small firms. Nevertheless, while firm size seems to be inversely correlated with the country effect dimension, the NACE industry disaggregation level does not play a distinguishable role for country effects size across CEE automotive companies.

The interaction of industry-country was also found statistically significant in a quite an important number of years, NACE digits and firm size combinations. Hence, these interaction effects are statistically significant in 3 out of five years (2019, 2017, 2015) in the 2-digit industry definition and in all years in the 3- and 4-digit definitions for the full sample, in four years out of five (2016 to 2019) in the 2-digit disaggregation and in three out of five years (2019, 2018, 2015) in the 3- and 4-digit disaggregation for large firms, in two years out of five (2017, 2016) and in one year out of five (2017) in the 3-digit disaggregation for medium firms, and in four years our of five (2019, 2018, 2017, 2015) in the 2-digit and 3-digit disaggregation, and in all years in the 4-digit disaggregation. At full sample level, the importance of the industry-country effect varies between 1.96% and 20.12% and is higher for smaller firms than for large and medium firms. For large firms, the size of the industry-country interaction effect ranges between 2.93% and 11.00% (2-digit NACE), 11.93% and 41.56% (3-digit NACE) and 14.99% and 51.28% (4-digit NACE), while for medium firms it ranges between 0.25% and 6.73% (2-digit NACE), 2.20% and 10.57% (3-digit NACE), and 5.49% and 12.76% (4-digit NACE). In the case of small firms, the effect varies between 3.65% and 12.30% (2-digit NACE), 7.85% and 26.15% (3-digit NACE) and 9.57% and 42.92% (4-digit NACE). Therefore, the inverse correlation between size and this effect identified for firm and industry effect is also present for the industry-country interaction effect.

Table 7 shows the relative importance of firm versus industry versus country effects for our sample of companies, for the three industry definitions and various firm sizes. Firm effects dominate industry effects in all NACE levels of disaggregation in the full sample and for all categories of firm size; the only exceptions are small firms, in whose case industry effects were more important than firm effects in years between 2016 and 2019. Nevertheless, the ratio of firm to industry effects takes impressive values in some years, particularly in the higher industry aggregation (2-digit NACE) – 1170.22 for full sample in 2015, or 1069.05 for medium firms in 2018). At the other end, the smallest value of the ratio was 1.55 for the full sample, 1.26 for large firms, 4.21 for medium firms and 0 for small firms. Regardless of firm size, though, the relative importance of firm over industry effects decreases when a higher level of NACE disaggregation is used, which may indicate a stronger impact on automotive firms' profitability of industry-related factors in industries that define closest firms' operations. Firm effects tend to be more important than country effects as well, although the size of the ratio between the two is generally smaller compared to the firm-to-industry effect ratio. As such, this ratio varies between 0.48 and 32.98 for the full sample, between 0.64 and 30.53 for large firms, between 1.95 and 21.94 for medium firms, and between 0.15 and 12.49 for small firms. When industry effects are contrasted against country effects, the overall higher relative importance of country effects is evidenced for smaller firms, while the inverse is

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TABLE 6: Results of variance components estimation – 4-digit NACE codes

	EBITmg 2019		EBITmg 2018		EBITmg 2017		EBITmg 2016		EBITmg 2015	
	Estimate	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**	**Estimate**	**Percent**
Full sample										
Firm	*1130.8*	4.85%	*2391.4*	19.96%	*1379.9*	8.06%	*565.3*	4.08%	*6832.0*	35.25%
Industry	428.0	1.84%	*263.3*	2.20%	306.4	1.79%	365.0	2.63%	242.9	1.25%
Country	*1124.3*	4.82%	72.5	0.61%	128.0	0.75%	133.6	0.96%	*400.1*	2.06%
Industry x Country	*4690.3*	20.12%	*1295.8*	10.82%	*1918.8*	11.20%	*1716.5*	12.37%	*1524.1*	7.86%
Error	15759.4	67.59%	6758.2	56.42%	12643.6	73.81%	10049.7	72.44%	7230.9	37.30%
Total	23316.8	100.00%	11978.3	100.00%	17129.4	100.00%	13873.0	100.00%	19383.8	100.00%
Large firms										
Firm	*616.9*	11.35%	*625.0*	25.20%	*911.2*	29.98%	*691.2*	27.76%	*254.7*	8.52%
Industry	*490.8*	9.03%	*168.5*	6.79%	70.5	2.32%	106.3	4.27%	*323.6*	10.82%
Country	*872.7*	16.05%	40.4	1.63%	64.0	2.10%	*147.2*	5.91%	*397.9*	13.31%
Industry x Country	*2787.8*	51.28%	*517.1*	20.85%	456.9	15.04%	373.2	14.99%	*1232.9*	41.23%
Error	706.5	12.99%	797.1	32.14%	1341.4	44.14%	963.9	38.71%	820.4	27.44%
Total	5436.7	100.00%	2480.2	100.00%	3039.0	100.00%	2489.9	100.00%	2990.1	100.00%
Medium firms										
Firm	*707.8*	14.24%	*565.2*	23.35%	*556.3*	20.70%	*290.0*	10.49%	*716.4*	25.54%
Industry	95.1	1.91%	88.2	3.64%	132.1	4.92%	63.4	2.29%	33.3	1.19%
Country	32.3	0.65%	70.6	2.92%	62.0	2.31%	48.2	1.74%	49.1	1.75%
Industry x Country	273.1	5.49%	201.2	8.31%	309.1	11.51%	352.6	12.76%	218.7	7.80%
Error	3281.4	65.99%	902.6	37.29%	1234.7	45.95%	1573.0	56.92%	1224.1	43.65%
Total	4972.2	100.00%	2420.5	100.00%	2686.7	100.00%	2763.6	100.00%	2804.4	100.00%
Small firms										
Firm	*939.7*	7.33%	*977.0*	14.03%	*742.2*	6.67%	742.2	9.09%	*915.7*	6.91%
Industry	*2124.2*	16.56%	*1050.3*	15.08%	*1632.1*	14.67%	*1632.1*	19.99%	*648.4*	4.89%
Country	*2018.4*	15.73%	398.2	5.72%	471.6	4.24%	471.6	5.78%	*497.7*	3.76%
Industry x Country	*5506.4*	42.92%	*1258.0*	18.07%	*2134.0*	19.18%	*2134.0*	26.14%	*1267.7*	9.57%
Error	4426.5	34.50%	2984.8	42.87%	6773.8	60.89%	6773.8	82.99%	2874.3	21.69%
Total	12828.9	100.00%	6963.0	100.00%	11125.2	100.00%	11125.2	136.30%	13248.7	100.00%

Note: Figures in italics indicate statistical significance of effects at 5% level. Source: Authors' calculations

true for large and medium firms. At full sample level, the ratio between the two effects varies between 0.02 and 3.63, for large firms between 0.01 and 1.86, for medium firms between 0.01 and 2.95, and for small firms between 0.03 and 3.46. These results point towards a heightened importance of country-related advantages for profitability in the automotive industry in the form of population size, income, purchasing power, urban to rural living, etc., particularly in the case of smaller firms. However, for larger-sized firms the appurtenance to the automotive sector seems to play a more important role for profitability, due to industry-related benefits such as concentration, supply chain framework etc.

5. Conclusions

Our investigation of the automotive sector in CEE countries revealed the statistical significance of firm effects on profitability, as measured by the EBIT margin. The effects are however different in intensity based on the size of the company. Namely, we noticed higher firm effects for larger companies in size, and lower importance of firm effects for smaller companies. This can only be an indication that firm size matters significantly as a driver of operational profitability, as it is converted into sustained competitive advantages. It should also be noted that many of the firms included in our sample are affiliates of the big global players in the automotive industry, therefore they benefit from the ownership advantages of the group to strengthen their performance. Another objective of our research resided in answering whether industry classification has any bearing on firm profitability. We found quite insignificant evidence about this (except maybe for 2019), which is surprising, given the variety of the sector, in both manufacturing and trade. It would be interesting to see if the 2019 trend is continuing in 2020 and beyond. This may be the subject of future research for the sector.

However, the most surprising finding of our study is the country effect on profitability of firms. Moreover, the smaller the company, the larger the country effect. The importance of the country effect may be an indication of “historical” factors which led to large OEMs setting up manufacturing facilities or even trading entities in some of the countries. Going deeper, this may be the result of economic policies of state aid, which in those times was specifically addressed to the automotive sector. We thus conclude that there are specific country-related advantages that ultimately influence profitability in the automotive sector. Certainly, population size and purchasing power affect all firms. In the case of larger size companies, business models may also play an important role in the profitability – typically larger size companies use profit stripping business models such as toll manufacturing (production with no inventory risk and market risk) and limited risk distributors (entities with limited market risk). How profitability indicators evolve based on different business models may be the subject of subsequent research.

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Table 7: Ratios of firm-industry-country effects

	EBITmg 2019				EBITmg 2018				EBITmg 2017				EBITmg 2016				EBITmg 2015			
	FS	LF	MF	SF	FS	LF	MF	SF	FS	LF	MF	SF	FS	LF	MF	SF	FS	LF	MF	SF
2-digit NACE codes																				
Firm - Industry	25.91	25.12	73.39	0.68	185.08	33.18	1069.05	13.91	72.18	543.38	106.80	1.01	14.81	118.72	13.04	4.15	1170.2	24.89	79.51	475.02
Firm - Country	0.59	2.80	15.44	0.18	21.52	17.54	11.45	6.26	4.31	7.67	4.65	1.44	1.55	4.35	1.95	0.77	17.88	1.03	6.50	12.49
Industry - Country	0.02	0.11	0.21	0.26	0.12	0.53	0.01	0.45	0.06	0.01	0.04	1.43	0.10	0.04	0.15	0.18	0.02	0.04	0.08	0.03
3-digit NACE codes																				
Firm - Industry	2.57	4.24	14.94	0.40	10.82	5.75	14.53	2.84	5.81	16.40	7.48	0.57	2.81	11.94	6.49	0.24	64.10	2.05	34.39	12.91
Firm - Country	0.48	0.83	17.15	0.15	10.85	11.44	9.30	5.06	4.32	30.53	7.08	1.19	3.79	6.34	3.58	0.76	10.57	0.61	12.84	9.08
Industry - Country	0.18	0.20	1.15	0.37	1.00	1.99	0.64	1.79	0.74	1.86	0.95	2.08	1.35	0.53	0.55	3.24	0.16	0.30	0.37	0.70
4-digit NACE codes																				
Firm - Industry	2.64	1.26	7.44	0.44	9.08	3.71	6.41	0.93	4.50	12.93	4.21	0.45	1.55	6.50	4.57	0.00	28.13	0.79	21.48	1.41
Firm - Country	1.01	0.71	21.94	0.47	32.98	15.48	8.00	2.45	10.78	14.25	8.97	1.57	4.23	4.70	6.01	0.01	17.08	0.64	14.58	1.84
Industry - Country	0.38	0.56	2.95	1.05	3.63	4.17	1.25	2.64	2.39	1.10	2.13	3.46	2.73	0.72	1.31	2.59	0.61	0.81	0.68	1.30

Note: FS – Full sample, LF – Large firms, MF – Medium firms, SF – Small firms. Source: Authors' calculations

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