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SIZE EFFECTS IN DRIVERS OF PROFITABILITY FOR CZECH AND GERMAN MANUFACTURING FIRMS

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Abstract: Small and medium-sized enterprises (SMEs) represent the majority of firms within the manufacturing sector in Czechia and Germany; they play a very important role in the economic development and success of both countries. This paper presents a comparative analysis of size-specific profitability values among SMEs and large firms within the Czech and German manufacturing sectors. The data used were extracted from the BACH database of the European Union and cover the latest ten-year cycle (from 2008 to 2017). As with previous research in this field, an analytical model of common financial and accounting ratios is used to derive characteristic effects on profitability of empirically observed driver variables, including taxes, debt financing, asset structures and other aspects of operating profits. Structural differences in these underlying factors are tested for significance and are quantified to measure their impact on profitability. This approach provides valuable insights into the comparative advantages and disadvantages of the different size groups for the two countries. It presents effective starting points for specific benchmarking and the improvement of profitability.

Keywords: Comparative analysis, firm size, profitability, variance analysis

JEL Classification: G32, L6, M4

INTRODUCTION

Measures for profitability, such as return on equity (RoE), return on net assets (RoNA) or return on sales (RoS), are well established and accepted in economic theory and practice. They are widely applied tools in the context of decision-making and performance measurement (e.g. Bhimani, Horngren, Datar, & Rajan, 2012, p. 632 f.; Brealey, Myers, & Allen, 2014, p. 728 f.; Coenenberg, Haller & Schultze, 2018, p. 1195 f.; Penman, 2012, p. 369 f.). Comparisons made on the basis of these performance indicators are basically intended to give evidence of the attractiveness of a business. With this general perspective, these ratios are frequently used in comparative analyses among countries and sectors, and for firm- or division-related benchmarking purposes. An important aim of such comparisons is to identify the driving forces behind observed differences in corporate performance in order to enable rational decisions and targeted actions of the management. These questions are also relevant in a cross-national or firm size-related context to enable a determined economic policy or to support investment decisions. Therefore, such comparisons of firm profitability are also common among the countries of the European Union (EU), often based on the BACH database (BACH Working Group, 2015). This database provides aggregated and harmonized accounting information for several European countries, economic sectors and firm sizes. Differences in profitability between these elements have been the subject of various researches in the past. Some of these studies are of a primarily descriptive nature (e.g. BACH Working group, 2015, 2018b). Other research has proved significant country and size effects on profitability, or analysed whether certain influencing factors have an impact on profitability (e.g. Alcalde-Fradejas & Ramírez-Alesón, 2015; Cinca, Molinero, & Larraz, 2005; Koralun-Bereznicka, 2013, 2014).

The study presented here goes a step further by using a different approach based on a functional model of profitability. Due to the determined analytical relationship, the statistical effects of the included variables do not need to be proved; instead, the analysis focuses on the question of whether there are significant differences between different firm sizes of Czech and German firms in terms of these underlying drivers of profitability. These specific size effects were not the subject of the own previous research in this field

using a comparable approach (Beyer & Hinke, 2018). To ensure meaningful results, this approach must distinguish different business sectors, because economic conditions and performance vary greatly between them. Hence, the focus of this study is on the manufacturing sector, according to the NACE classification (Eurostat, 2008). This selection is made for two reasons: firstly, the major importance of this sector for the economies of both countries, Czechia and Germany; and secondly, the high coverage of these firms in the database used. Accordingly, this focus is also to be found in several other studies (e.g. Alcalde-Fradejas & Ramírez-Alesón, 2015; BACH Working Group, 2015, p. 28 f.).
The article is structured as follows. In the next section, the problem is defined in detail and the research approach explained. Subsequently, section 3 shows the results of the comparative analysis for Czech and German manufacturing firms of different sizes, referring to their driving factors of profitability. After this, some research limitations are discussed in section 4 before a final conclusion is drawn in section 5.

1. PROBLEM FORMULATION

The fundamental aim of this study is to identify size-specific factors influencing the profitability of Czech and German manufacturing firms and to quantify their impact. To do this, the first step is to define the calculation of profitability used. Typical measures in this field are applied according to the following examples (Bhimani et al., 2012, p. 632 f.; Brealey et al., 2014, p. 728 f.; Coenenberg et al., 2018, p. 1195 f.; Penman, 2012, 369 f.):

$$\begin{aligned} Return\ on\ sales\ (RoS) &= \frac{Erarnings\ \ before\ interest\ and\ taxes}{Turnover} \\ Return\ on\ net\ assets\ (RoNA) &= \frac{Erarnings\ \ before\ interest\ and\ taxes}{Fixed\ \ assts + working\ capital} \\ Return\ on\ equity &= \frac{Net\ \ income}{Equity} \end{aligned} \tag{1}$$

All three of these ratios and their calculative elements can be integrated into one comprehensive model, as shown in equation (2), which aggregates common financial and accounting terms to a mathematical function of these arguments. Return on sales (RoS) and return on net assets (RoNA) this way become partial terms of the resulting return on equity (RoE). This formulation of the model enables to carry out a stepwise analysis of all the incorporated elements.

$$RoE = \left\{ \left[\underbrace{\underbrace{VAR \cdot (1 - SCR)}_{RoS} \cdot \frac{1}{WCI + FAI}}_{RoNA} \right] \cdot (1 + FL) - i \cdot FL \right\} \cdot (1 - t) \tag{2}$$

where:

VAR *Value added ratio (Value added / Turnover)*
SCR *Staff cost ratio (Staff costs / Value added)*
WCI *Working capital intensity (Working Capital / Turnover)*
FAI *Fixed assets intensity (Fixed and other noncurrent assets / Turnover)*
i *Average interest rate on debt (Interest / Debt)*
FL *Financial leverage (Debt / Equity)*
t *Corporate tax rate (Taxes / EBT)*
RoS *Return in sales (EBIT/Turnover)*
RoNA *Return on net assets (EBIT/(Fixed Assets + Working Capital)*
RoE *Return on equity (Profit/Equity)*

All the involved terms with reference to their definition including the approach to extract them from the BACH database are shown in a compressed way in Table 1.

Tab. 1: Definition of model variables and their extraction from the BACH database

Fields of management decisions		Model variables			BACH variables used for calculation[1]	Affected measure of profitability		
		Variables		Definitions				
Operations	Value adding operations	*VAR*	Value added ratio	= Earnings before interest, taxes and staff costs / Turnover	*= (I1 + I2 + I3 + I4 – I5 – I6 – I8 – I9) / 100*	**Return on sales (RoS)**	**Return on net assets (RoNA)**	**Return on equity (RoE)**
	Staff policy	*SCR*	Staff cost ratio	= Staff costs / Value added	*= I7 / (I1 + I2 + I3 + I4 – I5 – I6 – I8 – I9)*			
	Working Capital Management	*WCI*	Working Capital Intensity	= Networking Capital / Turnover	*= (A2 + A3 + A4 – A42 +A5 – A52 + A6 + A7 – LP + LP1 – L321 – L4 – L5 – L6 + L62) × Turnover / Total assets / 100*			
Investment in fixed and other noncurrent assets		*FAI*	Intensity of fixed and other non-current assets	=Fixed and other non current asses / Turnover	*= (A1 + A42 + A 52) × Total Assets / Turnover / 100*			
Financing	Relative volume of debt financing	*FL*	Financial leverage	= Financial debt / Equity	*= (LP1 + L1 + L2 + L3 – L321 + L62) / E*			
	Interest rates	*i*	Interest rate	= Interest and similar charges / Debt	*= I10 × Turnover / (LP1 + L1 + L2 + L3 - L321 + L62) / Total asset*			
Taxes		*t*	Empirical tax rate	= Income taxes / earnings before debt	*= I11 / = (I1 + I2 + I3 + I4 – I5 – I6 – I7 – I8 – I9 – I10)*			

Source: Own research

All variables used in the model will be extracted for the ten-year cycle from 2008 to 2017 and condensed to their ten-year average values (download 19/09/2019). These average values are assumed to be representative of the recent past. The period covers prospering years as well as the years of the automotive crisis, 2008/09. To go beyond the year 2008 increases the risk of incorporating conditions which are out of date.

The application of this model will focus exclusively on manufacturing firms, as mentioned above. One reason for this concentration on the manufacturing sector, besides its importance for the economies of both countries, is the huge numbers of firms which are covered in each size group. Table 2 shows the average annual size of the three observed size groups. Due to the huge numbers of firms covered, it can be assumed that the extracted parameters form a representative picture. In both economies, small and medium-sized enterprises (SMEs) play a dominant role within the manufacturing sector. The classification of the group size by turnover was taken from the BACH database.

[1] For further explanation of the variables, see the BACH user guide (BACH Working Group, 2018a).

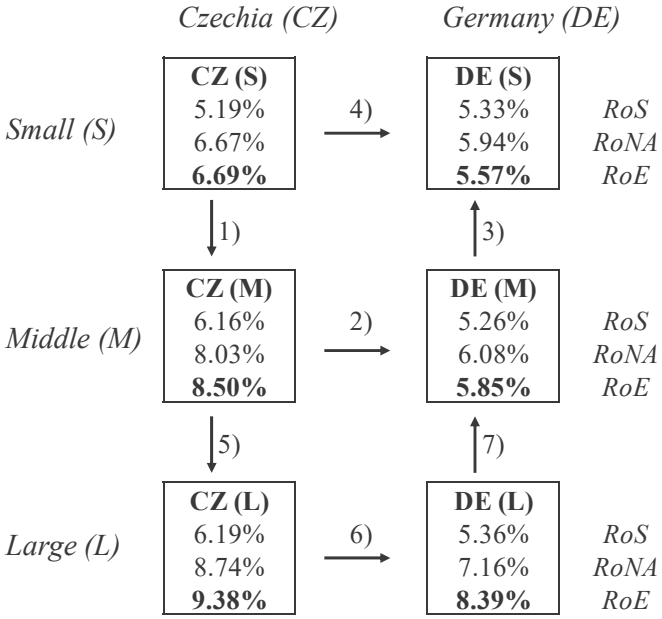
Tab. 2: Annual average of sample size per group and country during the cycle 2008 to 2017

Number of firms	Czechia (CZ)	Germany (DE)[2]
Small (S): turnover <10M€	4,939	5,703
Medium (M): turnover 10M€–50M€	973	3,960
Large (L): turnover >50M€	327	2,287

Source: Based on BACH data

Based on equation (2), using the observed model parameters of each group of firms, which are presented in detail in Table 3, the following values of profitability can be calculated and are the subject of a partial comparative analysis. This partial comparison will focus on differences between the size groups of each country and further incorporate a Czech-German cross-border reflection on each size group. In total, seven partial comparisons have to be made, as illustrated in Figure 1.

Fig. 1: Overview of the partial comparative analyses within the study



Source: Based on BACH data

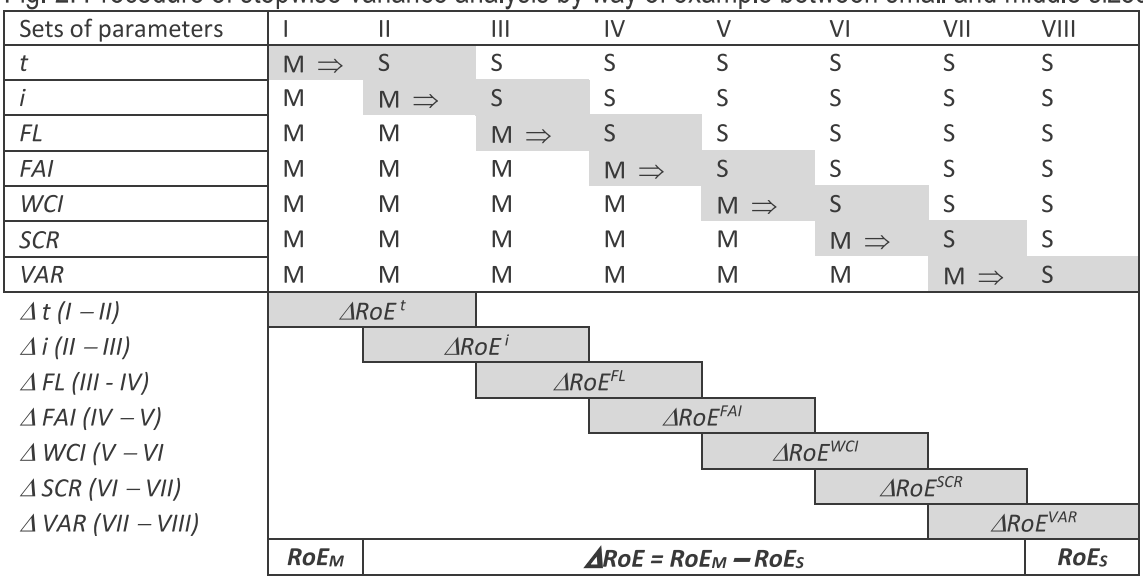
The first step in these partial analyses is to prove the differences in the underlying drivers of profitability for statistical significance. This was realized by applying an unpaired two-tailed t-test for each partial comparison (Pace, 2012, p. 111 f.). The confidence levels resulting from the p-values of the t-tests are presented and interpreted in Table 4.

The second step of the analysis concerns the quantification of the impact on profitability, which arises from differences in the driving factors. Here, a cumulative variance analysis is used. This method is a common technique in the field of managerial accounting, where the variances between the planned and actual costs or revenues have to be quantified and allocated to certain influencing factors (e.g. Bhimani et al., 2012, p. 563 f.; Peles, 1986). If some of these influencing parameters interact in a multiplicative way, separating their effects is difficult. A pragmatic way to solve this problem is to fix a particular sequence for the analysed influences. Incorporating the differences in the driving factors in a gradual manner according to this order will allocate the compounded effects to those influencing factors involved, which are considered first. For this study, it starts with aspects which are less designable by the firms themselves, like taxation, and progresses via financing aspects towards the parameters of firms' core business operation. The whole procedure is illustrated in Figure 2. A stepwise change

[2] Abbreviations used as within the BACH database

of the incorporated variables for two compared elements, here small (S) and medium-sized (M) firms, leads to partial differences in profitability, represented by the RoE.

Fig. 2: Procedure of stepwise variance analysis by way of example between small and middle sized firms



Source: Own research

2. RESULTS

An analysis of the ten-year average values for the previously defined drivers of profitability gives the values presented in Table 3. Smaller companies show a higher value added in relation to turnover, which indicates a higher degree of vertical integration (Haller & Stolowy, 1998). Staff costs, here relative to value added, are also higher than for smaller companies. These size effects are observable between small and medium-sized companies as well as between medium-sized and large companies for both Czechia and Germany. Whereas the pattern of working capital management seems to be similar for Czech firms of all sizes, there are huge differences among German firms. SMEs especially tend to hold higher volumes of working capital. Since working capital is a net value, this could be driven by higher short-term assets or lower short-term liabilities, and could be worth further research in this field.

Tab. 3: Ten-years average values of drivers of profitability per group

	Value added ratio (VAR)	Staff cost ratio (SCR)	Working capital intensity (WCI)	Fixed asset intensity (FAI)	Financial leverage (FL)	Interest rate (i)	Empirical tax rate (t)
CZ (S)	0.3014	0.8278	0.3894	0.3882	0.5581	0.0284	0.2411
CZ (M)	0.2230	0.7239	0.4032	0.3639	0.4644	0.0310	0.1759
CZ (L)	0.1422	0.5648	0.4021	0.3060	0.4472	0.0279	0.1771
DE (S)	0.3587	0.8514	0.6872	0.2099	1.1090	0.0423	0.2895
DE (M)	0.2989	0.8240	0.6397	0.2258	0.9295	0.0393	0.2758
DE (L)	0.1991	0.7306	0.2896	0.4589	1.3935	0.0356	0.3111

Source: Based on BACH data

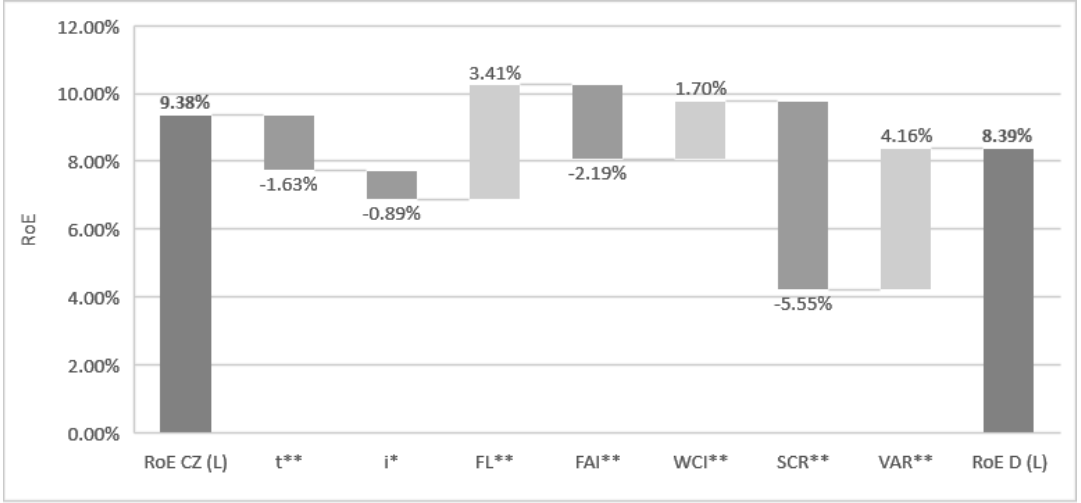
For Czech firms, the fixed asset intensity declines with increasing size; for German firms, the opposite seems to be true. This could indicate structural differences within the production facilities or their

utilization. Furthermore, there are differences concerning the level and costs of debt financing. German firms depend much more than Czech firms on debt financing, where there is declining volume with increasing size. Interest rates are more affected by size effects in Germany than in Czechia. The nominal tax rate set by legislation was 21 per cent for Czechia in 2008 and declined to 19 per cent within the observed cycle. During this time, the nominal average tax rate for Germany has been about 30 per cent, considering corporate taxes and a locally varying trade tax (Bundesfinanzministerium, 2009, 2018). Whereas the empirical tax burden seems higher for small Czech companies, this effect is not found for Germany. In general, however, the empirically observed tax burden is not far from its nominal rate, so for both countries, no significant opportunities for tax avoidance seem to exist, not even for large firms.

Based on these group- and country-specific average values for the drivers of profitability, the model presented in equation (2) can be used to calculate specific values of profitability considering RoS, RoNA and RoE. The resulting values are shown in Figure 1. The primary goal of this study, however, is not to show that there are country- and size-specific differences in profitability; instead, the main focus is on the driving factors. The two questions to answer are, firstly, are there significant differences among the defined drivers of profitability in the two countries and the observed size groups? And, secondly, what are the quantified effects on profitability? A possible method to find an answer to the second question is to carry out a cumulative variance analysis. The results for partial comparisons concerning differences in the RoE between the groups are shown in Table 4. The marks with * or ** are related to question one. The results reflect a t-test confidence level higher than 95 per cent (*) or 99 per cent (**), and so significant differences do exist in the underlying drivers. Besides the RoE, an analogue analysis is possible for RoNA and RoS, but since RoE incorporates the most underlying drivers, only the variance analysis of RoE is performed by way of example here.

In order to ease the interpretation of Table 4, a comparison between large Czech and German manufacturing firms (partial analysis 6) is shown as a graph in Figure 3. Even if the total difference in the RoE provides an advantage of only 0.99 per cent in favour of Czech firms, there are many stronger partial effects which can be used for targeted improvements. The advantage of lower staff cost (SCR) would have an isolated effect on the RoE of even 5.55 per cent. However, this is to a great extent offset by a lower value added (VAR), with a 4.16 per cent effect on RoE. More efficient working capital management provides an advantage for German firms, while lower capital tie-up in fixed assets increases the Czech RoE. Looking at the financing aspects, the higher financial leverage (FL) of German firms increases their RoE by 3.41 per cent. With all the other influencing factors in combination, the high nominal difference in the corporate tax rate (19% vs. 30%) leads to an advantage in RoE for Czech firms of only 1.63 per cent.

Fig. 3: Variance of Return on equity (RoE) between large Czech and German manufacturing firms



Source: Based on BACH data

Similar calculations and interpretations can be made for all the other partial comparisons, too, with reference to RoE or the other measures of profitability shown above.

Tab. 4: Partial variance analysis of RoE for size and cross-border effects on profitability of manufacturing firms

RoE CZ (S)	**6.69%**		**4) ➡**								**RoE D (S)**	**5.57%**	
			ΔRoE^{t}	ΔRoE^{i}	ΔRoE^{FL}	ΔRoE^{FAI}	ΔRoE^{WCI}	ΔRoE^{SCR}	ΔRoE^{VAR}				
			-0.43%**	-0.55%**	0.96%**	2.97%**	-4.31%**	-1.18%	1.42%**				
1) ⬇	ΔRoE^{t}	0.67% *								**3) ⬆**	ΔRoE^{t}	-0.11%	
	ΔRoE^{i}	-0.09%									ΔRoE^{i}	-0.24%	
	ΔRoE^{FL}	-0.37%									ΔRoE^{FL}	0.26%	*
	ΔRoE^{FAI}	0.29%									ΔRoE^{FAI}	0.14%	**
	ΔRoE^{WCI}	-0.16%									ΔRoE^{WCI}	-0.45%	**
	ΔRoE^{SCR}	3.52% **									ΔRoE^{SCR}	-1.59%	**
	ΔRoE^{VAR}	-2.05% **									ΔRoE^{VAR}	1.70%	**
RoE CZ (M)	**8.50%**		**2) ➡**								**RoE D (M)**	**5.85%**	
			ΔRoE^{t}	ΔRoE^{i}	ΔRoE^{FL}	ΔRoE^{FAI}	ΔRoE^{WCI}	ΔRoE^{SCR}	ΔRoE^{VAR}				
			-0.81%**	-0.63%*	1.14%**	1.01%**	-1.95%**	-4.70%**	3.29%**				
5) ⬇	ΔRoE^{t}	-0.01%								**7) ⬆**	ΔRoE^{t}	0.29%	
	ΔRoE^{i}	0.11%									ΔRoE^{i}	-0.23%	
	ΔRoE^{FL}	-0.08%									ΔRoE^{FL}	-0.80%	**
	ΔRoE^{FAI}	0.80% **									ΔRoE^{FAI}	2.13%	**
	ΔRoE^{WCI}	0.01%									ΔRoE^{WCI}	-3.69%	**
	ΔRoE^{SCR}	3.56% **									ΔRoE^{SCR}	-6.14%	**
	ΔRoE^{VAR}	-3.51% **									ΔRoE^{VAR}	5.92%	**
RoE CZ (L)	**9.38%**		**6) ➡**								**RoE D (L)**	**8.39%**	
			ΔRoE^{t}	ΔRoE^{i}	ΔRoE^{FL}	ΔRoE^{FAI}	ΔRoE^{WCI}	ΔRoE^{SCR}	ΔRoE^{VAR}				
			-1.63%**	-0.89%*	3.41%**	-2.19%**	1.70%**	-5.55%**	4.16%**				

** p-value of the t-test < 0.05; ** p-value of the t-test < 0.01*

Source: Own

3. RESEARCH LIMITATIONS

Even if the results seem to be plausible and are to a great extent statistically significant, there are still weaknesses within the study presented here. Some of the major aspects shall be discussed. The first are related to the data used. The BACH database is seen as one of the largest and most reliable sources for aggregated accounting data in Europe. Despite the huge number of firms covered, however, there may still not be complete representativeness. There could be specific differences with among the compared groups which cannot be controlled here. The accounting data provided by that database

claim to be harmonized. Nevertheless, there can be still differences in the accounting pattern, driven by varying national accounting principles or cultural differences. Furthermore, the selected ten-year cycle might not be a perfect choice. There is a clear trade-off between current aspects and long-term effects. The chosen ten-year cycle was intended to be a compromise between capturing a representative but contemporary business cycle and not relying on outdated, obsolete values. In consequence, the limited number of years may weaken the power of the statistical tests. However, t-test statistics are seen to be very robust. Therefore, the results should still be reliable.
Another research limitation concerns the method of cumulative variance analysis. In rather complex models, especially if the parameters are interacting in a multiplicative way, it is not possible to extract pure impacts of singular driver variables. The method used here is a practical and widely accepted way to deal with this issue. However, there are compounded effects included which cannot be isolated. The impacts from operational factors presented are less affected by that issue than the taxation or financing aspects, due to the chosen order of this analysis. Therefore, in general, the results seem to be plausible and reliable.

CONCLUSION

Summarizing the detailed results in Figure 1, two principal effects are concluded: large firms seem to be more profitable than smaller ones, and Czech manufacturing firms seem to be more profitable than German ones of the same size. These differences in profitability, however, depend on various driving parameters, as Table 4 shows in detail. It could turn into other situations, if single drivers change or differences among them disappear. For Czech firms, significant size effects only occur from operational aspects, such as value added, staff costs and working capital management. Taxation, financing and investment patterns have low impact and are not significant. For German manufacturing firms, the size effects are much broader. Only taxation and interest rates show no significant impact. A size-specific cross-border comparison for each size group, however, shows significant differences for nearly all parameters. Only taxation, which is usually discussed as an important national (dis)advantage, has no significant impact on differences in the RoE. All the other parameters cause specific differences in profitability and provide useful benchmarks for targeted improvements, which could lead to a process of convergence of economic performance among European countries and firms of different sizes.

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