IMPACT OF RESEARCH AND DEVELOPMENT EXPENDITURE ON FIRM PERFORMANCE

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Abstract

In today's competitive surroundings, firms' research and development activities and investments in knowledge and innovation have become one of the most important factors that may affect their profitability and sustainability, hence, the aim of this research is to investigate the influence of research and development (R&D) expenditure on the performance of the largest companies that operated in Croatian manufacturing industry in 2018. The analysis is performed with the multiple regression analysis. Corporate performance, as a dependent variable, is measured using two accounting-based performance measures, return on assets (ROA) and net profit margin (NPM), while independent variables, besides R&D, encompass firm-specific variables including size of the firm, firm's age and liquidity. The results of the conducted analysis revealed that depending on the used regressand variable, the R&D expenditure may positively as well as negatively influence firms' performance, however this influence is not found to be statistically significant in neither of the performed regression analyses. The influence of firm's size, age and liquidity is found to be positive and statistically significant.

Key words: R&D expenditure, manufacturing industry, Croatia

JEL Code: D22, L25, L60

Introduction

The large and medium-sized manufacturing companies play important role in any economy as they can be seen as main drivers of prosperity, economic growth and employment creation. According to the Croatian Financial Agency database, the latest available data for Croatian manufacturing sector indicate that the number of large and medium-sized companies in 2018 amounted to 608, what makes only 4% of total number of firms operating within this industry. However, despite their small number, these firms generated €17 billion (74.6%) of industry's sales, €18.1 billion (74.5%) of industry's total revenues and 510 million (80.7%) of industry's profit. Likewise, a more than a half (57.8%) of manufacturing workforce is employed in large

and medium-sized companies. If we further add that these companies are merit for 85.5% of all exports from this industry, the significance and importance of these companies is unquestionable, thus making an ideal base for this research.

Theoretical and empirical literature stress that investments in knowledge and innovation i.e. research and development (R&D), may play a significant part in firm's endeavour to achieve desirable profit and realize long term sustainable growth. In today's world, when firm is surrounded with fierce competition and challenging market condition, being innovative and faster than competition in creating and producing new products, in developing new production process and technologies, in meeting challenging and changing customer demands with lower cost and higher quality, may help firm to create and preserve competitive advantage. Having that in mind, the desire of the authors to examine the extent in which R&D activities influence firm's performance becomes clear.

The rest of the paper organizes as follows. The next section reviews the literature closely related to R&D activities, whereas section two presents research methodology and briefly describes analysed variables. Section three brings the results of the regression analysis, while final section concludes.

1 Literature review

The influence of R&D expenditure has been explored in many studies over the decades covering different industries, geographical areas, economies with different levels of development and employing various methods of analysis Therefore, this literature review will be oriented towards papers dealing with influence of R&D investments in manufacturing industries and their impact on firms' performance.

The paper by Del Monte and Papagni (2003) deals with the effect of R&D on a firm growth rate using a sample of 500 Italian manufacturing firms that operated in the period from 1989 to 1997. The results of the empirical research suggest the positive relation between R&D and growth performance of firms with R&D intensity being expressed as R&D expenditure to sales ratio whereas there is no significant influence of R&D expenditure on other performance measures including rate of profits. Furthermore, the authors form two subsamples, R&D and non-R&D sample confirming, though partly, positive effect of R&D on firm performance.

Raymond and St-Pierre (2004) use the sample of 179 Canadian small and medium-sized manufacturers to investigate the customer dependency and its effects on R&D activities, profitability and productivity. The R&D intensity is expresses using three ratios (product

R&D to sales ratio, process R&D to sales ratio, and share of R&D employees in total firm's work force), productivity is measured as sales per employee, while the profitability is expresses as gross profit over sales. The authors find, among other things, that higher R&D intensity significantly improves gross margins.

Ehie and Olibe (2010) have investigated the influence of R&D on the firm market value of US manufacturing and services industries. The sample consists of 26.500 firm-years that operated in the 1990-2007 period. The firm market value is measured with market capitalization deflated by the total sales while independent variables consist of R&D expressed as R&D expenditure and total net sales ratio, size based on total sales, leverage, industry concentration measured with Herfindahl-Hirschmann index and year dummy to capture the effect of disruptive economic events such as 9/11. After employing ordinary least square regression, the authors find that R&D expenditure positively influences performance in both manufacturing and services industries.

Sher and Yang (2005) explore the impact of innovative capabilities and clustering effects of the Taiwanese semiconductor industry using the sample of publicly traded companies, i.e. companies listed on the Taiwan Stock Exchange as well as on the OTC Securities Exchange that operated in 2000 and 2001. The performance is measured using widely accepted ROA variable whereas independent variables consist of number of patents, R&D intensity measured as the R&D expenditure to number of employees, R&D manpower expressed as the full-time R&D employees and total number of employees ratio, technology cooperation, mergers and acquisitions as well as R&D clustering. Moreover, control variables comprise size of the firm based on sales, capital expenditure and debt ratio. Some of the empirical results of the regression analysis suggest that R&D intensity and R&D manpower positively affect performance, whereas in some models their effect is insignificant.

Chen et al. (2019) have examined the influence of R&D on profitability of Taiwan's semiconductor industry. The authors have applied dynamic panel analysis on the sample of companies that operated in the period 2005 – 2016. Corporate performance is expressed with ROA, while R&D investments variable is defined as total R&D expenditure over the total sales. Control variables include leverage, size and total assets growth. The results of the analysis suggest negative influence of R&D (observed in current year) on ROA. However, results of the other models performed in the research suggest positive influence of lagged (by 1 or 2 period) R&D expenditure on ROA.

2 Methodology and variables

In order to evaluate the influence of research and development expenditure (R&D) on firm performance, a multiple regression analysis is performed. As a dependent variable, a return on assets is employed, while R&D expenditure is used as one of the independent variables i.e. beside R&D, some additional explanatory variables capturing firm-specific characteristics were included as well. These explanatory variables were firm's size, age and liquidity. Aiming to test for the robustness of the obtained results, several additional regression analyses were conducted in which we interchangeably replaced ROA with a net profit margin (NPM) as well as R&D expenditure based on revenue with the one based on assets. A brief description of all analysed variables is provided in what follows.

Accounting based measures of performance are commonly employed in empirical research dealing with determinants of profitability. We have opted for ROA as dependent variable following Goddard et al. (2005) and Yazdanfar (2013) approach. In order to make the results of the analysis more robust another dependent variable, specifically NPM calculated as net profit after tax over sales, has been employed as it is done in papers by e.g. Eriotis et al. (2002) and Waelchli and Zeller (2013).

As regards R&D variable, its intensity is measured using two ratios, R&D expenditure to total revenues as well as R&D expenditure to total assets. Both indicators can be found in e.g. Zhu and Huang (2012). Ehie and Olibe (2010) find technological competitiveness to be crucial for the firm economic soundness. Since R&D expenditure is considered to be one of the key sources of technological innovation it is supposed to increase expected future cash flows and consequently profitability of the firm. Therefore, a positive influence of this variable on both ROA and NPM is expected. Positive impact of this variable is also found in papers by e.g. Del Monte and Papagni (2003), Sher and Yang (2005), Ehie and Olibe (2010).

Size of the firm can be expressed in several ways, i.e. taking into account total assets, sales or number of employees. Size variable has been employed in this analysis as a natural logarithm of total sales following Del Monte and Papagni (2003) and Yazdanfar (2013) approach. A positive influence of size on profitability can be expected since, as stated by Yazdanfar (2013), larger firms may have better access to resources and, as pointed out by Glancey (1998), may benefit by exploiting economies of scale which will consequently result in improved performance.

Liquidity indicator is used in the analysis as current ratio calculated as short-term assets over short-term liabilities showing how successful firm is in meeting its short-term

liabilities. In this context, higher liquidity levels imply greater profitability as found by Goddard et al. (2005). On the other hand, the same authors warn that higher proportion of liquid form assets may prevent companies to benefit from profitable investment opportunities. Furthermore, Majumdar finds liquidity to be insignificant determinant of firm's profitability as well as Serrasqueiro and Nunes (2008). Therefore, the expected sign of this variable is unclear.

Age variable has been employed in this research with the aim of finding out whether more mature or younger firms perform better. It is calculated as the difference between the year of the analysis and foundation year of the firm plus one in order to avoid zero values. Considering the existing literature, the influence of this variable is ambiguous. The reasoning for positive impact can be found in a company's experience, reputation and consequently in easier access to sources of financing as stated by Pervan et al. (2019). On the other hand, Majumdar (1997) emphasizes inactivity of older firms and their rigidity in adapting to changing environment that might deteriorate their profitability.

3 Data analysis and regression results

Since the aim of the research was to analyse the impact of R&D expenditure of the largest Croatian manufacturing companies on their profitability, we first identified all large and medium-sized firms that operated in this industry in 2018. The total number of companies was 608. However, although the authors expected to have a large number of companies actually investing in R&D activities, it was discovered that this number is rather small i.e. less than 10%, as only 55 companies recorded R&D expenditure. It was also noticed that five companies have reported negative book value of equity hence they were omitted from further analysis. At final, the sample consisted of 50 companies.

Descriptive statistics of all variables used in analysis is presented in table 1, from which it can be observed that the largest deviations in variables are related to net profit margin and R&D based on revenue. Although variables representing firms' performance also have wide span of values, a mean value for both profitability measures is positive (yet the mean value of ROA is larger than that of NPM). As regards R&D measure, the average value of R&D based on firm's revenues is much higher (5.78%) then the value of R&D based on firm's assets (2.57%). The span of values of firm's size and liquidity measure is rather low indicating similarity among observed companies from the aspect of this variable. Finally, the average firm is 23 years old.

Tab. 1: Descriptive statistics

Variable	Minimum	Maximum	Mean	Std. Deviation
ROA (%)	-21.28362	36.03479	3.27415	9.86767
NPM (%)	-102.10527	57.54194	0.79616	20.52201
R&D_TR (%)	0.00585	186.94704	5.78388	26.14682
R&D_A (%)	0.00703	33.36765	2.56986	5.92580
SIZE (SALES)	16.18418	20.98443	18.70363	1.11052
LIQ_CURR (%)	0.05790	13.49133	2.26431	2.34084
AGE	10.00000	43.00000	23.07843	5.78910

Source: Authors' calculation

A correlation analysis that was conducted (due to space savings, the results were not presented here) gave us insights on the relationship among investigated variables. Although both measures of profitability showed positive and statistically significant relationship with firm's size, liquidity and age, no significant relationship is recorded between firm's profitability and R&D expenditures. Still, since some variables can behave differently when combined and observed together, we proceeded with the multiple regression analysis. But before turning to the interpretation of the results, several assumptions on which the regression analysis is based must be checked. First of all, the relationship between dependent and independent variables should be linear. Also, the data must show homoscedasticity, meaning that the error variance supposed to be constant. These assumptions are usually examined by plotting the predicted value against residuals. Furthermore, the independence of residuals must be present (this can be easily tested with Durbin–Watson (DW) test). Finally, the data mustn't show the presence of multicollinearity (usually verified with variance inflation factor - VIF, whose value should be lower than 5). It should be also mentioned that dependent variable must be continuous (if it is ordinal, an ordinal regression should be carried out).

After plots confirmed linear relationship among dependent and independent variables and showed no presence of heteroscedasticity, an examination of autocorrelation with the application of a DW test is undertaken. In case when DW value is around 2, then residuals are free of autocorrelation. However, in this research, depending on the model specification, a DW value ranged from 1.77 to 1.87 (table 2 and table 3), so it was necessary to identify upper and lower critical value of the DW statistics, which were found to be dU=1.537 and dL=1.206 (for k=4 and n=50), confirming no presence of autocorrelation, as DW>dU. Finally, according

to the obtained values of variance inflation factor (VIF), which were far below 5, the created models were free of multicollinearity. According to previously stated, obtained results can be treated as valid and reliable.

Tab. 2: Regression models - ROA

	Model 1			Model 2		
Variable	B	Sig.	VIF	B	Sig.	VIF
(Constant)	-63.084	0.006	-	-63.872	0.004	-
R&D_TR	0.014	0.772	1.127	-	-	-
R&D_A	-	-	-	0.172	0.411	1.049
SIZE (sales)	2.543	0.025	1.016	2.546	0.023	1.004
LIQ_CURR	1.236	0.021	1.001	1.226	0.021	1.001
AGE	0.690	0.021	1.116	0.706	0.002	1.048
F-test (sig.)	0.002			0.001		
DW	1.770			1.809		
Adjusted R Square	0.248			0.258		

Source: Authors' calculation

Tab. 3: Regression models - NPM

	Model 1			Model 2		
Variable	B	Sig.	VIF	B	Sig.	VIF
(Constant)	-152.688	0.001	-	-158.209	0.001	-
R&D_TR	-0.070	0.401	1.127	-	-	-
R&D_A	-	-	-	-0.163	0.705	1.049
SIZE (sales)	6.605	0.005	1.016	6.789	0.004	1.004
LIQ_CURR	2.712	0.013	1.001	2.708	0.014	1.001
AGE	1.052	0.024	1.117	1.140	0.013	1.048
F-test (sig.)	0.001			0.001		
DW	1.820			1.871		
Adjusted R Square	0.278			0.270		

Source: Authors' calculation

Robustness of the results was tested with the different model specifications. Regardless of which dependent variable was applied (ROA or NPM) and which base for R&D

expenditure was used (revenue or assets), statistical significance of analysed variables didn't change. All independent variables, except R&D expenditure, remained positive and statistically significant in all models. On the other hand, R&D expenditure was not found to be statistically significant in any model. However, it must be pointed out that although insignificant, the influence of R&D expenditure of firms' performance depended on which profitability measure was used (i.e. when ROA was used, the sign of R&D expenditure was positive, while in case when NPM was applied, the sign of R&D expenditure became negative).

Positive influence of firms' size on profitability might suggest that larger firms exploit all benefits of being large such as economies of scale and scope; enjoy in strong brand recognition; have more skilled managers/employees due to the possibility of offering more attractive salaries and bonuses, etc. Similar results were found by Serrasqueiro and Nunes (2008), Nunes et al. (2009) and Yazdanfar (2013). Positive impact of liquidity on firm's profitability indicate firm's ability to pay its short-term liabilities without borrowing money from the third parties and paying cost of capital for it. The influence of this variable is in line with that of Goddard et al. (2005). Finally, results implied that older firms may have more experience, abilities and skills and consequently can enjoy superior performance, as suggested by Pervan et al. (2019) and Majumdar (1997).

Conclusion

The objective of this research was to examine the significance and intensity of R&D expenditure on firms' profitability. The research was conducted on the sample of all large and medium-sized companies that were recorded R&D activities and that were operated in Croatian manufacturing industry in 2018. It was discovered that only 9% of all large and medium-sized manufacturing companies were engaged in some kind of R&D undertakings. It was also revealed that depending on the used profitability measure, the obtained sign of R&D expenditure (although in this research found to be insignificant) may be positive or negative. Hence, specification of applied dependent variable might be a part of a reason for reporting different results as obtained by various authors. The research also showed that firm's size, age and liquidity have positive and statistically significant influence on firms' profitability.

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