
The Patents and Financial Performance of Firms - Evidence from Polish Manufacturing Companies¹

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Abstract

This article is a contribution to the discussion on innovation activity and its influence on financial performance of companies. The authors employ a simple measure of innovativeness, which was also used in other studies, and the division of companies into two groups (innovative and non-innovative) was based on the fact whether they obtained a patent (patents) or not. In this paper, we compare the rates of return and revenue growth achieved by innovative versus non-innovative companies operating in the manufacturing industry in Poland, in the years 2006 to 2012. Financial and qualitative data for testing the hypotheses were taken from the Amadeus database provided by Bureau van Dijk. The sample consisted of 4004 enterprises, of which 681 were owners of at least one patent. T-Student test, ANOVA and OSL models were used to verify the working assumptions. The study tests the following three research hypotheses. H1: "Innovative companies achieve higher rates of return than the non-innovative ones." That hypothesis was confirmed in relation to the EBITDA margin and ROS (return on sale), but not to ROA (return on assets) and ROE (return on equity). The fact of belonging to a group of innovative companies had an impact on an average EBITDA margin increase by 0.83 p.p. in 2007, 0.78 p.p. in 2009 and 0.73 p.p. in 2012, ceteris paribus. The difference between ROE was found statistically insignificant in most analysed periods (except 2007 and 2009), however, non-innovative companies have achieved a higher return on equity than innovative companies. It can be associated with higher operational risk in innovative companies which restrict access to external capital, leading such companies to expand their businesses through their own equity. The second tested hypothesis is: "An innovative activity has higher impact on financial performance in medium-sized companies than in large and very large ones." During the research, it was found out that having obtained a patent is important determinant of EBITDA margin for medium-sized companies, increasing it

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by 0.76 p.p., *ceteris paribus*. In large companies, it contributed to an increase of 0.71 p.p., and for very large ones – by only 0.19 p.p., with the slope for the latter group at a number other than zero found to be statistically insignificant. In relation to third tested hypothesis: “Innovative companies are more sensitive in terms of revenue dynamics to economic slowdown than the non-innovative ones.” it was found out that in the period of time from 2006 to 2012 the dynamics of revenue growth in innovative companies was generally higher than in the non-innovative ones, except in the year 2009, when all companies showed a significant decline in revenues, but for innovative companies, the decline amounted to 6.39%, and for the remaining ones it was found at 4.98%. Based on those findings it was confirmed that innovative companies are characterized by a greater sensitivity to economic slowdown.

Keywords: innovation, financial performance, economic slowdown, patents.

INTRODUCTION

In the contemporary world, innovations are perceived as a crucial factor of economic growth, warranting the success and the survival of companies, particularly small and medium ones. Understanding the benefits offered by investing in innovation, research, development and other innovative activities is a key element in convincing managers and politicians to undertake and support this type of activities.

The authors compare rates of return achieved by innovative companies with those of companies qualified for the non-innovative group of entities, out of a sample of companies operating in the manufacturing industry in Poland. Previous studies have been conducted mainly with respect to companies operating in the UK, USA, Italy, Germany, and Austria. This analysis covers the period of 2006 to 2012, i.e. a time of good economic prosperity, followed by the economic slowdown started in 2008, and the period of slow economic growth in Poland, contrasted with the detrimental effects of the financial crisis in the rest of the world.

In the research, a simple measure of innovativeness was adopted, namely the number of patents granted to the firm. However, the authors are aware of the fact that patents are only one of the determinants of innovativeness, and, although that measure is significantly different from the ideal measurement of innovativeness, deciding to conduct research in this form, taking under consideration a limited access to data on other determinants of innovativeness for Polish enterprises, such as, for example, expenses on the activity in the field of R&D, obtained grants for launching innovative products on the market, or the number of innovative solutions recently launched in the market.

LITERATURE REVIEW

The debate on the benefits of innovations is not new, and over the recent decades researchers have related the research and development expenditures to the measures of total factor productivity and labour, suggesting a positive relationship between the share of R&D expenditure in revenues and the number of patents granted with the rate of revenue growth, profitability, and company survival (Audretsch, 1995; Ciftci and Cready, 2011; Del Monte and Papagni, 2003; Geroski, Machin and Reenen, 1993; Koellinger, 2008; Neuhäusler, Frietsch, Schubert, and Blind, 2011; Nunes, Serrasqueiro and Leitão, 2012; Paunov, 2012; Scellato, 2007; Teece, 1986).

According to Schumpeter (1934, 1950), an innovative new product which has been launched tends to face little competition at the moment of introduction, and therefore earns relatively high profits, which can attract imitators, so finally, an increased competition leads to profit reduction for the firm which has introduced the new product on the market. Geroski (1995) examined the effects of the production of major innovations and patents on the various measures of corporate performance on panel data for 440 UK firms over the period: 1972-1982. He observed that the direct effects of innovations on performance are relatively small, and the benefits from innovation are more likely to be indirect, namely for user industries. According to Geroski (1995), innovative companies are less sensitive to cyclical pressures than non-innovative firms. Companies in a competitive environment are more prone to engage in innovative activities than other firms. Audretsch (1995) found out that the effect of company growth and profitability on subsequent innovation depends on the technological opportunity environment. Profitability is found to promote a subsequent innovative activity for firms in high-technological opportunity industries, but not in the low-technological opportunity ones. By contrast, high growth generates more innovative activity for firms in low-technological-opportunity industries, but not in high-technological-opportunity environments. Cefis (2003) on the basis of research suggested that companies which are persistent innovators and earn profits above the average are highly likely to keep innovating and earn above the average profits. The likelihood of earning profits in the long term is higher if a company starts to act as a systematic innovator. Neuhäusler, Frietsch, Schubert and Blind (2011) analysed how the results of R&D and its protection can influence companies' market value and profits. On the basis of theoretical arguments, they hypothesized that the large and highly-valuable patent portfolios of firms can have substantial effects on their competitiveness in the long term. Furthermore, in an analysis of a sample of German manufacturing firms, Czarnitzki and Kraft (2010) found out that the patent stock of a company has a significant effect on profitability. For example, the average profit margin in

the sample of Western German firms amounts to 3.98%. A Western German firm whose innovation activity is at an average level (i.e. means of the patent stock among innovating firms) will *ceteris paribus* achieve a profit margin that is 0.67% points higher compared to patent stock equal to zero.

A separate motif in the research concerning the innovativeness of firms was devoted to analysing the significance of the size of the firm for that issue. One of the basic assumptions of the Schumpeterian hypothesis is that large companies are more efficient in transforming R&D investments into an innovative activity than small firms. The main reason for this situation is a high risk connected with R&D investment. Usually, small companies invest a large part of their resources in a single R&D project, which makes them sensitive to any failure connected with project implementation. On the contrary, larger entities can reduce the risk connected with innovation through diversification into parallel research projects. In addition, due to the economies of scale, larger firms realize a greater profit potential from innovation. Diaz-Mayans and Sanchez-Perez (2013), using the panel data set of Spanish manufacturing firms over the period: 2004–2009, demonstrated that innovative firms are more efficient than the non-innovative ones, and that small and medium-sized companies tend to be more efficient than the large entities. The authors also expected that the larger the economic entity under study, the less significant the impact of innovation activities on its financial results would be, which may be due, *inter alia*, to the significant diversity of production and the scale of economic activity characteristic of big entities. Also Ciftci and Cready (2011) find that the positive association between the level of future earnings and R&D intensity increases with firm size, and that the positive association between the volatility of future earnings and R&D intensity decreases with firm size, consistent with R&D productivity increasing with scale. They also showed that R&D scale is associated with lower market returns, consistent with the idea that R&D investment risk declines with scale.

Discussion on innovativeness focuses, *inter alia*, on finding the adequate measure of innovativeness. Battagion and Tajoli (2000), Lin, Lee, and Hung (2006) used granted patents as criteria for innovation. In other studies, Scellato (2007) decided to include in the sub-sample of innovative entities not only those companies which filed at least one patent per year, but also the companies belonging to the top 5% of innovators in their industry, according to the absolute number of patents granted between 1995 and 2000. An alternative measure of companies' innovation is the yearly R&D expenditure or the share of this type of expense in the operating revenue (Del Monte and Papagni, 2003; Nunes et al., 2012; Shefer and Frenkel, 2005; Ughetto, 2008; Wakelin, 2001).

Another problem in research connected with innovations is the number of lags between R&D expenditures, time of granting a patent and the effect on profits. The empirical results of Ravenscraft and Scherer (1982) point to a mean lag of four to six years, but the first returns are realized in the next year after starting the project and the effect for the second and third year.

In the research, it is as well a connection between the innovativeness of companies and business cycle that is analyzed. There is some empirical research at the national level, e.g. Paunov (2011) provides quantitative evidence on these questions based on original firm-level datasets for eight Latin American countries in 2008–2009; he found out the crisis led many firms to stop ongoing innovation projects. Probit regression results show that firms with access to public funding were less likely to abandon those investments.

HYPOTHESES AND RESEARCH METHODS

In the research presented in this paper, it was presumed that the ownership of only one patent is enough to qualify a company as an innovative one. Companies without any patents were considered non-innovative for the purpose of this study. Due to the fact that patent protection may last in Poland for maximum 20 years, it was presumed that benefits resulting from a patent granted for an invention may be observed in a firm for a long period of time. Moreover, the experiences of the authors in the course of assessing several hundred of innovative projects in Poland and the EU give rise to the conclusion that firms which protect their inventions usually constantly conduct a pro-innovative activity directed at launching new products and services on the market. As it can be concluded from the analysis of the database which is used in the research into enterprises which received patents, such enterprises quite frequently take advantage of other methods of protecting intellectual property, such as, for example, the right to protect trademark, which proves their high awareness of the necessity of protecting intellectual property, and may be a result of the conviction that such an investment will bring benefits to the firm.

Similar criteria for innovation (patents granted) were used for example by Battagion and Tajoli (2000), Lin, Lee, and Hung (2006). An alternative measure of companies' innovation is the annual R&D expenditure or the share of this type of expense in the operating, however, in the light of Polish accounting regulations, companies are not obliged to include this type of information in their financial statements. Moreover, many companies (particularly the smaller ones) do not spend much money on R&D but can patent a new solution or acquire the right to use the patented solution under a license agreement. Taking into account all the previously mentioned circumstances,

as well as observations that Polish companies are not prone to patent their inventions, and that smaller companies show a preference for alternative protection measures (e.g. industrial secrecy), a single patent held seems enough to classify the company as an innovative one.

Based on a literature review, the authors expected the companies classified as innovative to reach higher rates of return, inter alia, on the grounds that they better protect their own solutions against imitations by competitors, which allows them to achieve above-average returns, compared to non-innovative firms (Geroski et al., 1993; Schumpeter, 1934).

This led them to formulate the first hypothesis: H1: *Innovative companies achieve higher rates of return than the non-innovative ones.*

The following ratios were considered in studies:

- EBITDA margin (EBITDA to revenue sale),
- ROSb – return on sale (profit/loss before taxation to revenue sale),
- ROAb – return on assets (profit/loss before taxation to company booking assets value),
- ROEb – return on equity (profit/loss before taxation to equity).

The return on sales (ROS) indicator is a synthetic depiction of the sale profitability, and evaluates company efficiency on sales activity. The higher the indicator, the better cost management in a company. The EBITDA margin is a measurement of a company's operating profitability, and it is equal to earnings before interest, tax, depreciation and amortization (EBITDA) divided by total revenue. EBITDA excludes depreciation and amortization so the EBITDA margin gives a clearer view of a company's core profitability and ability to generate operational cash flow.

ROAb gives information about how efficient management is at using its assets to generate earnings. The ROSb, ROAb and EBITDA margins vary a lot across different sectors, so in the study, the authors used companies from only one sector (manufacturing) to test the H1.

Return on equity is a ratio that provides investors with insight into how efficiently a company is managing the equity that shareholders have contributed to the company.

Thus, finally, for H1 four specific hypotheses can be formulated:

H1a: Innovative companies achieve a higher EBITDA margin than the non-innovative ones.

H1b: Innovative companies achieve a higher ROSb than the non-innovative ones.

H1c: Innovative companies achieve a higher ROAb than the non-innovative ones.

H1d: Innovative companies achieve a higher ROEb than the non-innovative ones.

The verification of the H1a,b,c,d was made by establishing whether any statistically significant differences occur in profit margins calculated for innovative and non-innovative companies using the t-Student test. In the next step, we used the OLS regression model in which EBITDA margin was a dependent variable and with independent variables of: company age, company size, patents in possession, company independence.

The inclusion of company age in the model was based, among others, on the concept of company life cycle. The inclusion of company size was related to the empirical research trend that focuses on company size as a determinant of its financial result (Diaz and Sanchez, 2008; Serrasqueiro and Nunes, 2008). Large companies benefit from the effect of scale, improved bargaining position in relation to customers and suppliers, and facilitated access to capital compared to smaller entities. Smaller companies are markedly less affected by the agency problem and show more flexibility in their reaction to the changing market conditions. In this context, it may also be useful to note a number of studies examining the correlations between company size and its innovation level (Diaz-Mayans and Sanchez-Perez, 2013). In this context, it seems that company size is a factor to be considered in the model. Professional literature provides no definitive approach to company size categorization. This aspect is typically measured by asset value, revenue or the employment figures. For the purpose of this study, the authors adopted both the logarithm of revenue and that of assets for each year, in order to reduce the distance between the analyzed entities, since the research sample contained both very large and very small companies.

Since the sample included both independent companies and those operating within larger structures of capital groups, the factor of ownership structure was also considered as a potentially significant determinant of the return rates.

Taking into account the fact that previous studies on innovation and profitability of companies focused on their size (Ács and Audretsch, 1990; Hall and Bagchi-Sen, 2007; Lefebvre, Lefebvre and Bourgault, 1998; Schumpeter, 1934), the authors decided to include this factor in the study. This led to the formulation of H2: *An innovative activity has higher impact on financial performance in medium-sized companies than in the large and very large ones.*

The verification of H2 was initially carried out by analyzing the statistical significance of the difference in the average rates of return between innovative and non-innovative companies for very large, large and medium-sized enterprises, as well as on the basis of three multiple regression models constructed for each of the groups which were classified on the basis of size criteria where independent variables were the same as for EBITDA margin model.

Since the selected test period of 2006-2012 was a time of changing economic conditions, the authors analyzed the impact of the economic slowdown on the results of innovative and non-innovative companies in Poland. Taking into consideration the fact that innovative activity is associated with higher operational risk, the authors formulated a third hypothesis: *H3: Innovative companies are more sensitive in terms of revenue dynamics to economic slowdown than the non-innovative firms.*

The authors worked on an assumption that in 2009 the economic slowdown resulted in revenue fall. For 2011, business recovery was assumed to be well under way, followed by an operating revenue growth (Table 1). Using the t-Student test and comparing the average revenue dynamics of innovative vs. non-innovative companies, the authors expected to verify whether, in the time of the economic slowdown, innovative companies would be more exposed to drops in revenue. An opposite effect was anticipated during the periods of economic revival, in the case of which it was expected that the revenues dynamic of innovative companies is higher than those of the non-innovative ones.

Table 1. GDP growth rates in Poland against the EU-27 results

Year	2012	2011	2010	2009	2008	2007	2006
GDP Poland [%]	2	4.5	3.9	1.6	5.1	6.8	6.2
Average GDP EU-27 [%]	-0.4	1.6	2.0	-4.5	0.4	3.2	3.4

Source: Eurostat database.

DATA

The sample framework employed for this study was obtained from the Amadeus database provided by Bureau van Dijk, covering financial statements of private and public companies from European countries, together with the number of patents owned by companies. The empirical analysis was based on the balance sheets and profit-and-loss accounts of manufacturing companies. The selection process was based on the NACE rev.2 code. C. Manufacturing. As of the day of acquiring data (August, 2014), the Amadeus database included data on 142,047 active enterprises on the territory of Poland, 8,490 of which

belonged to section C. Manufacturing. The main financial indicators, such as profit margins and revenue growth, were calculated for each year from 2006 to 2012; therefore, the additional criterion in data selection was that the financial data had to be complete for the selected companies for this particular period of time, which narrowed the sample down to almost about 50%. Finally, the panel sample consists of 4004 companies: 275 very large, 1489 large, and 2240 medium-sized ones.

The classification of companies into three size subsamples (medium, large, very large) was based on the number of employees, the operating revenue and the total assets value. In an early concept of this research, the number of employees was considered as a proxy for company size criteria. However, due to the unavailability of employment figures for many companies, the authors were forced to use database classification as the criterion for company size. Taking into account only the workforce, the sample size would be significantly smaller. The typology of companies used in the database (very large, large and medium) is contrasted with the approach adopted by the European Union in Table 2. The classification of firms on the basis of the criteria adopted in the database as medium enterprises includes both part of firms which are small in accordance with the EU definition (employing between 15 and 49 people), and also part of the medium ones (employing between 50 and 150 people). In turn, the category of large firms in accordance with the database criteria of classification (based on the EU definition) includes both part of medium enterprises employing between 151 and 249 people, as well as large firms with the number of employees between 250 and 1,000. Therefore, the conclusions which are formulated in the course of the research and concerning the group of medium firms are, de facto, relevant both to firms which are small by the EU definition, but employing more than 15 people, and part of medium firms with the staff of up to 150. In the research we omit, therefore, micro-firms (in accordance with the EU definition), employing fewer than 10 people, and part of small firms employing between 10 and 15 people.

Table 2. Comparison between typology for company's size – database vs. European Union

Size of company	Number of employee - database	Number of employee - EU	Operating revenue (in mln EUR) database	Operating revenue (in mln EUR) - EU	Total assets (in mln EUR) - database	Total assets (in mln EUR) - EU	Additional criterion in database
Very large	1000+	no	>=100	no	>=200	no	must be listed on the stock exchange
Large	151-999	250+	<10-100)	>=50	<20 -200)	>=43	
Medium-sized	16-150	50-249	<1-10)	<10-50)	<2-20)	<10-43)	
Small	<=15	10-49	<1	<2-10)	<2	<2-10)	
Micro	No	<10	no	<2	no	<2	

Source: Amadeus database and UE Commission Recommendation 2003/361/EC of 6 May 2003.

On the basis of the database of the Central Statistical Office, it was established that in the year 2012 in Poland, in the C. Manufacturing section 175,692 companies were registered (CSO database), therefore, the researched sample constitutes 2% of the population of entities active in section C, whereas 29,333 enterprises employing more than 9 people in the industrial processing section were registered in 2012 (Statistical Yearbook of Industry – 2013, Warsaw), therefore, taking under consideration the fact that the research omits firms employing fewer than 15 people, finally, it covers more than 14% of population. It is difficult to compare the structure of the sample of researched firms in terms of their size with the structure of production firms in Poland due to the different criteria of dividing firms on the basis of the number of employees adopted in the database from which the data was obtained, and those in force in the Central Statistical Office (they are partly identical in terms of the number of employees in accordance with the EU definition). However, it might be claimed, having adopted approximated criteria in the scope of employees' number, that the structure of firms is partly similar to the structure of firms in economy.

The authors collated the number of patents owned by each company, whereas it was not possible to obtain information about which patents were obtained as a result of own notification for the purpose of invention protection, and which patents were acquired from other individuals. The database includes both information about domestic and international patents. Patent counts have been collected for all years available in the database.

The Amadeus database uses patent data only to supplement other corporate information so there is a risk that some errors may occur in the

database. The authors randomly verified patent data on the basis of specialized patent databases such as e.g. the database of the Polish Patent Office and the results were positive. Taking into account that the authors assumed one patent as the basis for qualifying a company as innovative, some mistakes that may occur in the number of patents assigned to a company in fact do not affect the results of the study. The outcome of the research may, however, be slightly distorted by assigning the patent to a company which in fact does not hold any patent or vice versa, a company qualified as non-innovative in reality has a patent and should be qualified as an innovative company. Therefore, in order to get 100% certainty that the data in the Amadeus database correspond to patent reality of companies, the whole sample (4004 firms) should be “manually” verified, and not only in the database of the Polish Patent Office, but also in other international patent databases. In this situation the optimal solution is the adoption of the data verified by Bureau van Dijk, being aware, however, that these data may contain slight errors.

It was expected that the bigger the company, the higher its rating with respect to the number of patents held would be; this assumption has been confirmed. The share of companies with patents in the ‘very large companies’ subset is 32%, in that of large companies 21%, and in case of the medium-sized ones it amounts to 13% (Table 3).

Table 3. The structure of companies, taking into account the number of patents held

Firm size	Number of companies	Companies with patents (number)	Companies with patents (%)
Very large	275	88	32%
Large	1489	309	21%
Medium-sized	2240	284	13%
Total	4004	681	17%

Table 4 presents the structure of companies in each company size group, taking into account the number of patents owned (both concerning inventions being the subject of own notification, and patents acquired from other entities). Most of the very large and large companies owned between 2 to 5 patents. Nearly half of the medium-sized companies which were found to hold any patents, were found to hold not more than one patent.

Table 4. The structure of companies, taking into account the number of patents held

Number of patents	1	2 to 5	6 to 10	11 to 20	21 to 98	103 to 128	600*	Total
Very large	29.5%	30.7%	14.8%	13.6%	8.0%	2.3%	1.1%	100%
Large	36.6%	36.9%	14.9%	6.1%	5.2%	0.3%	0.0%	100%
Medium-sized	45.8%	37.7%	9.2%	3.9%	3.5%	0.0%	0.0%	100%
Total	39.5%	36.4%	12.5%	6.2%	4.8%	0.4%	0.1%	100%

*Note: This number of patents was assigned to PKN ORLEN in the Amadeus database. In case of many patents assigned to PKN ORLEN in the Amadeus database the inventors are connected to The Institute of Heavy Organic Synthesis „Blachownia”, which is R&D centre working within the field of organic chemistry.

The research involved companies operating within corporate groups as well as independent entities. A company was qualified as independent when 25% of direct ownership or more was in the hands of a single shareholder. The research sample consisted of 1704 independent companies and 2300 companies operating within the structures of corporate groups. The structure of companies, taking into account the company size, innovation and ownership status, is shown in Table 5.

Table 5. The structure of companies, taking into account the company size, innovation and ownership status

Description	Independent	In a corporate group	Total	Independent (%)	In a corporate group (%)	Total
Very Large	30	245	275	11%	89%	100%
NON-INNOV	23	164	187	8%	60%	68%
INNOV	7	81	88	3%	29%	32%
Large	482	1007	1489	32%	68%	100%
NON-INNOV	373	807	1180	25%	54%	79%
INNOV	109	200	309	7%	13%	21%
Medium sized	1192	1048	2240	53%	47%	100%
NON-INNOV	1047	909	1956	47%	41%	87%
INNOV	145	139	284	6%	6%	13%
Total	1704	2300	4004			

For each indicator (profit margin and change of revenue), 10% of abnormal results were removed from the sample (5% of the highest and 5% of the lowest figures). The selected descriptive statistics are presented in Table 6.

Table 6. Descriptive statistics

Variable	Mean	Med.	Min.	Max
ROE_2012 (%)	12.55	10.3540	-27.4990	56.0460
EBITDA_2012 (%)	7.76759	6.94250	-5.21500	23.1620
ROA_2012 (%)	6.21292	4.92200	-13.0280	27.1130
ROS_2012 (%)	3.16717	2.55155	-10.4649	15.9833
Rev. change_2012/2011 (%)	3.128	2.278	-30.3792	45.507
Rev. change_2009/2008 (%)	-5.222	-4.898	-46.5826	39.862

Patents and rates of return

To verify the H1a hypothesis, the authors calculated the EBITDA margin for both groups – the innovative and the non-innovative companies – and tested the statistical significance of the difference between the groups using the t-Student method (Table 7). Very low results of the *p-value* in the period under study (from 2006 to 2012) suggest the high statistical significance of patent ownership in EBITDA margin results. The difference of margin values for companies classified as innovative and non-innovative is always in excess of 1 p.p., with the highest value observed for the year 2006 (1.6 p.p.), and the lowest – for the year 2011 (1.04 p.p.).

Table 7. The EBITDA arithmetic mean margin (%) in innovative and non-innovative companies, 2012

Year	INNOV	NON-INNOV	Statistically significant difference?	p-value
2012	9.00679	7.56568	YES***	<0.001
2011	9.36167	8.31792	YES***	0.0009
2010	9.63665	8.29739	YES***	<0.001
2009	10.5661	9.20665	YES***	0.0002
2008	10.3127	8.74672	YES***	<0.001
2007	10.6654	9.43489	YES***	0.0002
2006	11.0044	9.39818	YES***	<0.001

Note: * p-value < 0.05; ** p-value <0.01; *** p-value <0.001.

Verification of H1a was carried out also on the basis of a multiple regression model (Table 8), using EBITDA margin as a dependent variable, and the explanatory variables of: the time of company operation on the market (AGE), the company size measured by the logarithm of revenues (Log_REV) and assets (Log_ASSETS), the number of patents granted (INNOV) and membership in a capital group (CAP_GR). Estimations were carried

out for the years: 2007 (significant economic growth), 2009 (economic slowdown) and 2012 (slow economic growth). All explanatory variables proved to be statistically significant, and the model explains the formation of the explanatory variable in 12% (2009), 10.9% (2007) and 13.4% (2012). A low value of R^2 results, among others, from the fact that selected variables are not the only ones having a connection at the level of the EBITDA margin. Apart from them, there also exist a number of other variables, e.g. connected with sales market (number of competitors, market capacitance), general market outlook, the level of the abilities of the executives.

Table 8. The econometric model – EBITDA Margin in years: 2007, 2009, 2012

Description	Model 1 OLS, Dependent variable: EBITDA Margin 2007	Model 2 OLS, Dependent variable: EBITDA Margin 2009	Model 3 OLS Dependent variable: EBITDA Margin 2012
Const	12.2768*** (0.898824)	4.75674*** (0.975718)	4.33166*** (0.82699)
AGE	-0.0277605*** (0.0051362)	-0.0448521*** (0.006066)	-0.0217614*** (0.00487673)
log_REV	-8.88083*** (0.513213)	-6.45645*** (0.535454)	-6.7642*** (0.444274)
log_ASSETS	9.04693 *** (0.478413)	8.28011*** (0.511357)	8.12536*** (0.431376)
CAP_GR (1 for CG, 0 for independent company)	-0.896909*** (0.231164)	-1.46475*** (0.262282)	-0.804881*** (0.222396)
INNOV (1 for innovative companies, 0 for non-innovative)	0.82926** (0.314667)	0.779329* (0.355158)	0.733387* (0.307323)
Sample size	4004	4004	4004
Number of complete observations	2521	2532	2548
Mean dependent var	9.611091	9.404771	7.767592
Sum squared resid	74296.71	96416.30	70419.09
R-squared	0.133630	0.119591	0.136406
F(5, 2526)	77.58332	68.62401	80.30263
S.D. dependent var	5.833548	6.577894	5.658170
S.E. of regression	5.435203	6.178152	5.263292
Adjusted R-squared	0.131908	0.117848	0.134707
P-value(F)	7.60e-76	1.93e-67	1.94e-78

Note: *p-value < 0.05; ** p-value <0.0 1; *** p-value <0.001.

Stand. error in brackets.

All three models suggest a negative relation between company age and its profitability. On average, the longer the history of company operation on the market, the lower the EBITDA margins are, which is in line with the theory

of company life cycle. The value of trade margin is also lower with increased sales revenue, which may be related to the fact that larger companies tend to increase their rate of return on assets by increasing the asset rotation with simultaneous decrease of trade margins. On the other hand, the relation between asset value and profitability was positive, as expected, since the higher the asset value, the more profits can be expected due to the effect of scale, which is reflected in the reduction of per-product costs. Affiliation with a capital group, in turn, has a negative effect on the EBITDA margin, which is probably associated with such activities as tax optimization at the level of the whole capital group.

The most important, from the viewpoint of the formulated hypotheses, was the relation between company innovativeness and profitability. The fact of belonging to a group of innovative companies had an impact on an average EBITDA margin increase by 0.83 p.p. in 2007, 0.779329 p.p. in 2009 and 0.733387 p.p. in 2012, *ceteris paribus*. Therefore, the H1a was confirmed as valid.

Verification of H1b was conducted based on the ROS ratio. In this respect, the observations were similar to the ones obtained for the EBITDA margin. The ratio gradually drops in value for the respondent sample, but the status of an innovative company generally allows the entity to reach a higher ROSb ratio (Table 9).

Table 9. The ROS arithmetic mean in innovative and non-innovative companies, 2006-2012

Year	INNOV	NON-INNOV	Statistically significant difference?	p-value
2012	0.0355542	0.0308799	YES*	0.0234
2011	0.0465977	0.0418938	YES*	0.0460
2010	0.0477664	0.0406275	YES**	0.0032
2009	0.0494733	0.0417225	YES**	0.0045
2008	0.0501716	0.0418563	YES**	0.0022
2007	0.0675721	0.0593717	YES***	0.0005
2006	0.0355542	0.0308799	YES*	0.0234

Note: *p-value < 0.05; ** p-value <0.01; *** p-value <0.001.

The ROSb ratio is a proportion of gross profit to the revenues from sale, and, therefore, it is presented as the final profitability. Its value is influenced, among other things, by company asset structure, as reflected in the depreciation cost, and by financial decisions (revenues and financial

costs), therefore the observed differences are less pronounced (as reflected in higher p-values) than in case of the EBITDA margin.

In the next stage, we tested the arithmetic means of ROEb (H1d). Research conducted in this area has not yielded the expected results. The average rates of return on equity drastically decreased from approximately 21% in 2006 (Table 10) to the level of 0.9-0.8% in 2009 (almost twenty-fold) and then, during the following years, the rates slowly increased to an average value of 12%. The most crucial aspect of the research, however, is the fact that non-innovative companies have, on average, achieved a higher return on equity than innovative companies, which is a tendency contradictory to the previously analyzed trade margins. The differences between ROEb for innovative companies and the other ones were statistically significant for 2007 and 2009. The ROEb indicator is determined by capital structure, which can be significantly different across the analyzed companies. Furthermore, operating in the innovation field may, due to the associated higher operational risk, restrict access to external capital, leading to such companies being forced to expand their businesses through their own equity.

Table 10. The ROEb arithmetic mean in innovative and non-innovative companies, 2006-2012

Year	INNOV	NON-INNOV	Statistically significant difference?	p-value
2012	12.2524	12.6239	NO	0.5778
2011	13.3953	13.8555	NO	0.4934
2010	12.9323	13.7027	NO	0.2526
2009	0.809117	0.9076	YES**	0.0035
2008	15.0053	14.9798	NO	0.9765
2007	21.247	23.1604	YES*	0.0180
2006	21.6756	21.5781	NO	0.9027

Note: *p-value < 0.05; ** p-value <0.01; *** p-value <0.001.

In the case of return on assets (H1c), which is determined by an enterprise's structure of assets used for operating and other activities, innovative companies have achieved a higher return on assets, but only in one of the researched years, 2006, the difference was statistically significant (Table 11).

Table 11. The ROAb arithmetic mean in innovative and non-innovative companies, 2006-2012

Year	INNOV	NON-INNOV	Statistically significant difference?	p-value
2012	6.47945	6.15735	NO	0.3616
2011	7.01283	6.86798	NO	0.6850
2010	6.63391	6.73758	NO	0.7701
2009	7.15839	7.1416	NO	0.9665
2008	7.9174	7.53479	NO	0.3888
2007	10.9007	11.015	NO	0.7829
2006	10.9477	10.061	YES*	0.0292

Note: *p-value < 0.05; ** p-value <0.01; *** p-value <0.001.

The above study proves that being a patent holder improves trade margins of companies operating in the manufacturing industry in Poland. Particularly significant effects were observed to EBITDA margin. In terms of other indicators as ROSb and ROAb the authors obtained evidence that the innovative status of a company helps to keep these indicators on average level higher than in other companies. Quite different observations were made for ROEb indicator. It was found that return on equity is lower in innovative companies. As the authors mentioned above, the reason of the lower ROEb might be higher operational risks associated with innovative activities and the need to involve a relatively substantial amount of equity, due to possible difficulties in obtaining outside capital.

Patents, company's size and the rates of return

With reference to the second hypothesis, the authors wanted to verify whether the observed rates of return differences between innovative and non-innovative companies in the context of changing economic conditions would also be found statistically significant if the companies were distributed according to the size criterion. Special attention was paid to the analyses for the years 2012, 2011, 2009 and 2007. The years 2012 and 2011 were most recent at the time the research was conducted. The year 2009 was of interest since it marked the initial effects of the global financial crisis for companies operating in Poland, as attested (among other things) by the marked decrease of GDP in Poland (1.6%) and in EURO-27 countries (-4.5%), as well as by a decrease of sales revenues (Table 6). The year 2007 was deemed of interest, since it directly preceded the onset of the financial crisis, with a marked increase of Poland's GDP (6.8%) and company revenues

in the respondent sample (Table 6). The analysis of the selected years, particularly the periods of prosperity and economic slowdown, was intended to help address the question of whether being an innovative company brings better financial results regardless of the economic conditions or if it has the opposite effect, by making the pro-innovative companies more susceptible to economic downturns. As shown in Table 7, within the whole respondent sample, the differences between innovative and non-innovative companies were significant, both in the periods of economic slowdown and in the periods of prosperity. Table 12 presents a comparison of mean EBITDA margins in the selected years, by company size. The observations may suggest that being a patent holder is relatively insignificant for very large companies, while it plays an important role in the case of medium-sized companies. The latter holds true for every year under study. For large companies, the difference between the innovative and non-innovative ones was found statistically significant in the years 2012 and 2007.

Table 12. The EBITDA arithmetic mean margin (%) in innovative and non-innovative companies, 2012, 2011, 2009, 2007

Company size	INNOV	NON-INNOV	Statistically significant difference?	INNOV	NON-INNOV	Statistically significant difference?	INNOV	NON-INNOV	Statistically significant difference?	INNOV	NON-INNOV	Statistically significant difference?
Year	2012	2012	2012	2011	2011	2011	2009	2009	2009	2007	2007	2007
Very large	8.92	8.46	NO (0.702)	10.44	8.97	NO (0.227)	11.92	9.84235	NO (0.159)	10.0027	9.29578	NO (0.571)
Large	9.37	7.96	YES** (0.003)	9.39	8.67	NO (0.123)	10.74	9.89695	NO (0.129)	10.9271	9.58252	YES** (0.006)
Medium-sized	8.65	7.25	YES** (0.004)	9.17	8.05	YES* (0.014)	10.18	8.73303	YES** (0.006)	10.5032	9.3614	YES* (0.018)

Note: *p-value < 0.05; ** p-value <0.01; *** p-value <0.001; p-value in brackets.

The analyses were supplemented by three multiple regression models construed for the three company size categories (Table 13).

Table 13. The econometric model - EBITDA margin for medium, large and very large firms, 2012

Dependent variable: EBITDA Margin 2012	Model 4 OLS VERY LARGE	Model 5 OLS, LARGE	Model 6 OLS, MEDIUM
const	4.40313 (5.72932)	4.40925* (2.54819)	-0.551241 (2.03157)
AGE	-0.00869636 (0.0172302)	-0.0158309** (0.00656018)	-0.0313782*** (0.00772174)
log_REV	-9.07913*** (1.88656)	-8.67289*** (0.789794)	-4.42895*** (0.712517)
log_ASSETS	10.2978*** (2.03514)	10.0438*** (0.705572)	6.99506*** (0.571613)
CAP_GR (1 for CG, 0 for independent company)	-0.568789 (1.66063)	-0.444259 (0.353421)	-1.03303*** (0.290567)
INNOV (1 for innovative companies, 0 for non-innovative)	0.197721 (1.18973)	0.715778* (0.427348)	0.763356* (0.463314)
Sample size	275	1489	1450
Number of complete observations	131	967	790
Mean dependent var	8.554931	8.208729	7.402267
Sum squared resid	3379.197	23631.84	42597.31
R-squared	0.177233	0.185921	0.111500
F(5, 2526)	5.385283	43.89491	36.24229
S.D. dependent var	5.620782	5.481846	5.752124
S.E. of regression	5.199382	4.958920	5.431346
Adjusted R-squared	0.144323	0.181685	0.108424
P-value(F)	0.000161	7.69e-41	4.72e-35

Note: *p-value < 0.1; ** p-value < 0.05; *** p-value < 0.001; stand. error in brackets.

All three models in the previous section suggested negative relation between company age, size (measured by revenue), affiliation with a capital group and profitability. Positive relation was found between asset value, innovations and profitability. Innovation was found to be the most important determinant of EBITDA margin for medium-sized companies, increasing it by 0.76 p.p., ceteris paribus. In large companies, it contributed to an increase of 0.71 p.p., and for very large ones – by only 0.19, with the slope for the latter group at a number other than zero found to be statistically insignificant.

Patents and revenue dynamics

The third hypothesis was verified by checking the difference in the rate of revenue growth from 2006 to 2012 with the previous year used as a base year. In four of the seven periods of time analyzed, the difference between growth rates in innovative companies vs. non-innovative ones was found to be statistically significant.

In the periods of average revenue increase (2012, 2010 and 2006), revenue growth was higher for innovative companies, compared to the non-innovative ones (Table 14). It must be noted that the year 2006 should be regarded as a period of prosperity, as attested by the mean revenue increase of 16% for innovative companies, and 14% for the non-innovative ones, while the years 2012 and 2010, despite the continued effects of the financial crisis, marked a period of economic prosperity in Poland, with economic growth at 2% in 2012, 3.9% in 2010, and continued development and increase of sales revenues in companies under study. In 2010, the dynamics of revenue growth was higher by 2 p.p. for innovative companies and amounted to 10.03%, while in 2012, it dropped to 4.15% for the innovative companies and to 2.91% for the remaining ones. However, the year 2009 deserves special attention, with companies showing, in general, a significant decline in revenues. For innovative companies, the decline amounted to 6.39%, and for the remaining ones to 4.98%. The difference between the growth rate of revenues in 2009 was found statistically significant for both groups under study.

Findings are similar to those presented in “The 2014 EU Industrial R&D Investment Scoreboard European Commission”. For 478 out of the top innovative EU 633 companies in 2009 the revenue drop almost 10%. (European Commission, 2014, p.32).

Table 14. The revenue growth in innovative an non-innovative companies

Years	INNOV	NON-INNOV	Statistically significant difference?	p-value
2012/2011	4.15%	2.91%	YES**	0.0061
2011/2010	14.35%	14.41%	NO	0.9356
2010/2009	10.03%	7.95%	YES***	0.0002
2009/2008	-6.39%	-4.98%	YES*	0.0829
2008/2007	3.99%	3.35%	NO	0.3600
2007/2006	16.54%	16.31%	NO	0.7721
2006/2005	15.95%	14.29%	YES*	0.0585

Note: *p-value < 0.05; ** p-value <0.01; *** p-value <0.001.

Using ANOVA test we also found statistically important difference between revenue growth for companies in years of economic slowdown and years of prosperity (p-value for ANOVA test for each group of companies was smaller than 0.001).

In addition, analyses were performed with respect to the dynamics of revenue growth in the year 2009, taking into account the company size (Table 15). For very large companies, the difference in revenue growth dynamics between innovative and non-innovative companies was found to be significant. Of particular note was the fact that for very large innovative companies there was a decrease of revenues by 4.94%, compared to the marked increase by 1.97% for non-innovative ones. For large companies, the difference was statistically insignificant, while medium-sized companies registered a decrease in revenues in both groups. It must be noted, however, that in the latter group the decrease was markedly more pronounced among the patent holding companies (9.47%) compared to 6.98% for the non-holding ones. The results seem to suggest that patent holding companies are more susceptible to changes in the economic environment.

Table 15. The revenue change 2009/2008

Company size	INNOV	NON-INNOV	Statistically significant difference?	p-value
Very large	-4.94%	1.97%	YES**	0.0023
Large	-4.13%	-2.85%	NO	0.2945
Medium-sized	-9.47%	-6.98%	YES*	0.0449
Total	-6.39%	-4.98%	YES*	0.0142

Note: *p-value < 0.05; ** p-value <0.01; *** p-value <0.001.

DISCUSSION

The results presented herein suggest that pro-innovative orientation of production companies in Poland, connected with the number of patents granted to a company, has the significant effect on the trade margins. The effect was particularly evident in the case of EBITDA margin, which does not reflect the remaining operational and financial activities, and disregards the company asset structure. Even after the inclusion of activities other than the operational activity, the relation between gross profit and sales revenue (ROSb) is still higher for companies holding patent rights. Also for ROAb, which is shaped by fixed and current asset policies, we find that it is higher in innovative companies, but only for one year the difference was statistically important.

The research does not confirm the above observations with respect to return on equity.

The ROEB is significantly influenced by company capital structure policies. Consequently, despite significantly more pronounced difference of EBITDA margins, the difference between rates of return on equity was found statistically insignificant in most analysed periods, however, non-innovative companies have, on average, achieved a higher return on equity than innovative companies. Indirectly, it may also be concluded that innovative companies, due to higher operational risk of their activities, may face greater problems in leveraging their operational cost and are forced to rely more on their equity. Apart from the difficulties in acquiring outside funds, we suppose the reason for the higher ROEB in non-innovative companies may be attributed to the higher cost of borrowed capital acquisition, with its reducing effect on the level of net and gross profit. This particular lead will be addressed in our future research.

Pro-innovative orientation was found statistically significant in relation to EBITDA margin for large and medium-sized companies. In very large companies, the effect of patents on EBITDA profitability was insignificant, which may be due to their greater operational diversification. Moreover, obtaining a single patent in a smaller company has a more dramatic effect in terms of revenue increase compared to very large corporation with a sizeable product portfolio, where the amount of operational margin influences a much wider spectrum of factors compared to smaller entities. In this context, and in line with the discussed concept of Schumpeterian rent, it may be concluded that innovation activities help improve the competitive advantage, particularly in smaller companies, and offers much higher rates of return on trade, with the indirect effect of improving company market value.

The above results seem to confirm a more pronounced susceptibility to economic changes on the part of innovative companies. On average, innovative companies were characterized by greater dynamics of revenues compared with the non-innovative ones in the majority of periods under examination. For 2009, when the revenue growth dynamics was negative for all entities under study, it was found to be more pronounced in innovative companies. It is particularly evident for very large companies, with the revenues for non-innovative companies increasing by 2%, compared to the decrease of nearly 5% for the innovative ones. This effect may be attributed to the greater operational risk involved in this type of activities.

Interestingly, despite the revenue decrease by more than 6% for innovative companies in the year 2009, the mean EBITDA margin in this group was still higher compared to the non-innovative ones. This may attest to their greater operational cost flexibility, particularly with respect to fixed costs, as

well as their ability to anticipate market signals, which helps adjust the fixed cost level to the decreased demand. Moreover, the innovative companies may also enjoy lower operational leverage compared to the non-innovative ones.

CONCLUSION

The relation between company innovativeness and profitability is complex, because it is shaped mainly by the responses from competing entities. The fundamental problem of any inventor is to protect the product (or process) novelty against imitation. The principal safeguard in this context comes in the form of patent rights. The sooner the innovation is copied by the competition, the less time the authoring company has in store to reap the outstanding revenues off the product.

For the purpose of this research, the authors adopted the criterion of innovative vs. non-innovative companies based on ownership of at least one patent. This criterion should definitely be more restrictive, for example by means of relating the number of patents held to the level of revenues, as well as by examining the time-gap between the results and the introduction of new products based on the registered patent. This approach may be extremely difficult in practice, due to the limited availability of this type of data. In the case of smaller companies, it would also be useful to obtain detailed information on process vs. product innovations. Nonetheless, the results of this study seem to confirm the earlier observations on the higher level of trade returns for innovative companies (compared to the non-innovative ones), thus the criterion of innovation adopted for the purpose of this study seems valid. The research also showed greater susceptibility of innovative companies to the changing economic conditions, compared to the non-innovative ones. Sudden slowdown, such as the one observed in Polish companies in 2009, seems to affect the innovative companies to a much larger extent, at least in the sphere of operational revenue. Additional in-depth analyses should also be performed with respect to the effects of innovation as a function of company size. The classification of companies by size, as used in this study, departs slightly from the criteria adopted by the European Commission. Stronger effect of innovation activities in group of medium-size entities than in other groups suggests that the smaller the entity, the greater the effects of pro-innovative activities on the EBITDA margin and ROSb ratio. But, as mentioned before, the research would require a change in the classification of companies into innovative vs. non-innovative, for example based on declarative statements of product or organizational innovations introduced on the market. Such an approach, however, would be based on

declarations, rather than factual data such as the information on the number of patents held.

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Abstract (in Polish)

Artykuł jest kolejnym przyczynkiem w dyskusji na temat wpływu działalności innowacyjnej przedsiębiorstw na ich wyniki finansowe. Autorzy przyjęli w badaniach prostą miarę innowacyjności, stosowaną również w innych badaniach, przyjmując, iż posiadane przez firmę patenty są kryterium zakwalifikowania jej do grupy przedsiębiorstw innowacyjnych. W artykule porównujemy stopy zwrotu osiągnięte

przez firmy innowacyjne i pozostałe, działające w branży produkcyjnej w Polsce, w latach 2006-2012. Dane finansowe oraz ilościowe wykorzystane w weryfikacji hipotez zostały pozyskane z bazy Amadeus prowadzonej przez Bureau van Dijk. Próba badawcza stanowi 4004 przedsiębiorstw, z czego 681 dysponowało przynajmniej jednym patentem. W badaniach wykorzystaliśmy metodę t-Studenta oraz modele regresji wielorakiej. Na podstawie danych empirycznych testowaliśmy trzy hipotezy badawcze. Pierwsza hipoteza „Firmy innowacyjne osiągają wyższe stopy zwrotu niż nieinnowacyjne” została potwierdzona w odniesieniu do marży EBITDA oraz ROS (stopa zwrotu ze sprzedaży), natomiast nie udało się jej potwierdzić w odniesieniu do ROA (stopa zwrotu z aktywów) oraz ROE (stopa zwrotu z kapitału własnego). Firmy, które znalazły się w grupie przedsiębiorstw innowacyjnych osiągnęły przeciętnie wyższą marżę EBITDA o 0,83 p.p. w 2007, 0,78 p.p. w 2009 oraz 0,79 p.p. w 2012 roku, ceteris paribus, w stosunku do firm nieinnowacyjnych. Z kolei różnica pomiędzy grupami w zakresie ROE była statystycznie nieistotna dla większości lat objętych badaniem (z wyjątkiem roku 2007 i 2009), aczkolwiek firmy nieinnowacyjne osiągają wyższe ROE niż innowacyjne, co może być spowodowane większym ryzykiem operacyjnym towarzyszącym działalności innowacyjnej, które prowadzić może do ograniczenia w dostępie do zewnętrznych źródeł finansowania dla tej grupy, a to z kolei wymusza na firmach innowacyjnych konieczność rozwijania działalności w oparciu o kapitał własny. Drugą testowaną hipotezą było stwierdzenie, że: „Działalność innowacyjna ma większy wpływ na wyniki finansowe średnich przedsiębiorstw niż dużych i bardzo dużych”. Podczas badań potwierdziło się, iż w grupie średnich przedsiębiorstw, zakwalifikowanych jako innowacyjne, marża EBITDA był wyższa o 0,76 p.p. od nieinnowacyjnych, dla dużych firm o 0,71 p.p., a dla bardzo dużych różnica wynosiła tylko 0,19 p.p. W odniesieniu do trzeciej hipotezy: „Firmy innowacyjne są bardziej wrażliwe w zakresie dynamiki przychodów ze sprzedaży na spowolnienie gospodarcze niż przedsiębiorstw nieinnowacyjne” stwierdzono, że w okresie od 2006 do 2012 roku dynamika przychodów w firmach innowacyjnych była wyższa niż nieinnowacyjnych, z wyjątkiem roku 2009, kiedy to wszystkie firmy odnotowały spadek przychodów. Obniżenie przychodów było jednak wyższe w firmach innowacyjnych (-6,39 p.p) niż nieinnowacyjnych (-4,98 p.p). Na podstawie tego badania potwierdziło się zatem, że firmy innowacyjne charakteryzują się większą wrażliwością na spowolnienie gospodarcze niż pozostałe jednostki.

Słowa kluczowe: innowacje, wyniki finansowe, patenty, spowolnienie gospodarcze.

Biographical notes

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