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Effectiveness of Business Innovation in Emerging Economies; Exploitation of Relative Profit Growth Model

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The issues of management and optimization of business innovative effort seem to be of vital importance in the contemporary economics, especially in the period of global economic slowdown. The problem of optimal allocation of limited resources allocated to various categories of innovative effort at the firm level seems to be of paramount importance for emerging and catching up economies in the times of knowledge based economy. The main purpose of the research is to deepen the level of understanding of the factors affecting the effectiveness of business innovation effort in the case of emerging economies. This paper is the continuation of research work aiming to assess, on the basis of estimation of transformation of Cobb-Douglas production function the effectiveness of various types of business innovation expenditures of manufacturing enterprises located in Poland. The survey is based on relatively large data basis obtained from public statistics (The Central Statistical Office). The econometric estimations are based on the total sample of maximum 909 firms active in the field of R&D over the observed 10 year period between 2000 and 2009. The estimations are based on the relative EBITD growth as dependent variable. The estimations were carried out on the basis of five subsamples of firms active in the field of R&D subject to increasing R&D regularity. Previous estimations based on relative sales growth as the dependent variable are used as reference for formulating conclusions. Independent variables including various categories of innovation expenditure plus non innovative capital expenditure relative to sales and relative employment growth were lagged from 0 to 6 years. The study revealed differences in terms of the number of statistically significant independent variables among the examined subsamples. In comparison with previous research, the current survey revealed that relative EBITD growth as the dependent variable is to the smaller extent explained by various categories of innovation expenditure in comparison to the model based on relative sales growth. The study showed positive and constant, regardless of R&D regularity, impact of business R&D effort over relative EBITD growth.

JEL Codes: O31, O32 and Q55

1. Introduction

The effects of innovation at the macroeconomic level are in general unquestionable in today's world. In the process of classical, from the current point of view research, it has been estimated that innovations, and especially the commercial applications of science and technological developments, account for up to 75% of economic growth. According to Denison (1962), social wealth is determined by technical progress in up to 90%. These findings are consistent with more recent studies and the economic theory developed by Sollow (1957) and Romer (1990), who indicate technical change as a major source of long-term productivity growth. According to Sveikauskas (2007), the overall rate of return to R&D is quite impressive; it is estimated at 25% for private returns and at a total of 65% in terms of overall social returns.

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On the other hand the issue of transferring business innovation expenditure into sales growth and product development is by no means straightforward at the microeconomic level. The output of business innovation and R&D are often unclear, indirect, and difficult to measure. This problem is even more important in the case of emerging and transition economies, since research evidence and conclusions based on research work done in developed economies might not be easily transferable due to deferent stages of development of the two types of economies. Innovation is generally considered as a tool for improving the competitiveness of firms and their performance, nevertheless this relationship has not been supported fully by empirical work. The main motivations and reasons behind the study are to improve the pool of knowledge regarding the factors affecting the effectiveness of business R&D in the case of emerging economies. The main specific aim is to study the impact of the regularity of business innovation effort upon the effectiveness of different categories of innovation expenditure. This element, together with the fact that the research reflects the conditions of emerging economies, constitute the major novelty from the cognitive point of view.

This paper is a continuation of previous research work that was based on the relative sales growth model, see Martin (2013), regarding the issue of effectiveness of business innovation and R&D in the case of emerging and transition economies. The general purpose of this research is three fold. In the first place it is to extent the previous research regarding the issue of effectiveness of business innovation activities via implementation of different dependent variable associated with profit growth – exemplified by the relative EBITD growth. Secondly, it is to examine the impact of business R&D (as the most advanced and potentially most rewarding type of business innovation activity) regularity upon the effectiveness of business innovation and R&D effort. Thirdly, to observe the differences between results of previous estimations based on the relative sales growth models and the present ones based on the relative profit growth models.

The paper starts with short “introduction” where the importance of the study and main motivations are shortly presented. The introduction is followed with the “literature review” that contains discussion of main up to date findings available in the literature. Section number three specifies “model and methodology” utilized in the process if econometric estimations. The next section presents the main “findings” and discussion of the results of estimations based on five subsamples derived from the initial sample of data. Section number five embraces “summary and conclusions” where the main points resulting from the research are highlighted, followed by the limitations of the present survey and suggestions for the future research.

2. Literature Review

The impact of innovation on firm performance has been a matter of significant interest for economists and policy makers for decades. One of studies done by Li (2001) and Atuahene-Gima (2001) related to this issue focusing on product innovation strategies and performance of new high-tech firms in China proved that the innovation effectiveness is to large extent determined by environmental factors and institutional support. In another study Hashia (2013) and Stojcicc (2013) found that there is a positive relationship between innovation activities and productivity. In making decisions regarding innovation activities

firms rely on the knowledge accumulated from previously abandoned innovations and cooperation with other firms and institutions and other members of their group. Results of the study reveal several differences in behavior of firms in two groups of countries. Western Europe and advanced transition economies from Central and Eastern Europe.

Triguero (2013) and Corcoles (2013) found that R&D (input) and innovation (output) are highly persistent at the firm level. Among external/environmental factors, market dynamism affects R&D and innovation. Past innovative behavior is clearly more decisive in explaining the current state of R&D and innovation activities than external factors or firm-level heterogeneity. The research done by Pandit (2011), Wasley (2011) and Zach (2011) indicate that firms which have more productive R&D, exhibit higher and less volatile future operating performance. One contribution of this study is that it demonstrates that the relation between R&D expense (input) and future operating performance is better understood by incorporating information about the productivity (output) of a firm's R&D outlays in the form of patent counts and citations. Artz (2010), Norman (2010), Hatfield (2010) and Cardinal (2010) concluded that internal research capabilities, particularly those with strong basic research component, is key to enabling firms to generate creative outputs. Authors also found evidence supporting the hypothesis of increasing returns to scale to R&D spending which is consistent with economic arguments for the advantages of scale in innovation. Another study done in Finland by Leiponen (2000) underlines the fact that profiting from innovation requires strong complementary capabilities between R&D and other business activities within the firm, ie. marketing and manufacturing. Drake (2006), Sakkab (2006) and Jonash (2006) stress the importance of so called "behind innovation". In that respect effectiveness of commercialization strategy is vitally important. The cost of innovation must include creation of novelty, development and commercialization. The overall effect of innovation process depends on proper product positioning and well-tailored pricing policy along product life cycle. Therefore identification of effective paths for maximizing return on business innovation expenditure seems to be relatively important issue. On top of their impact on the firm's market value, innovation and R&D may have an influence on the firm's financial performance in terms of income and sales growth. Other research done by Brenner (1989) and Rushton (1989) indicate the relationships between R&D and firm's financial performance. According to the authors, firms which have higher R&D spending obtain the higher average sales growth than the market average. Study carried out by Pianta (2007) and Vaona (2007) suggests important differences in terms of innovation-related factors determining the productivity growth of European companies in general (represented in the survey by Austrian, French, Dutch, and British firms) and of Italian companies in particular. This may suggest important variation regarding factors determining the effects of innovative activities even among advanced economies representing similar level of economic development. Koku (2010) in the study regarding R & D expenditure and profitability in the US pharmaceutical industry found no statistically significant relation between R&D expenditure and profitability. The primary rational for this is that not 'all innovations that are produced as the result of research and development will necessarily be commercialized, and the spillover effects of innovations in the pharmaceutical industry do not allow innovating firms to capture solely all the benefits resulting from their innovation'. Kim (2011), Lee (2011), Park (2011) and Oh (2011) found that R&D seldom influences firm performance in a direct way. Based on the research, R&D

influence upon business performance was most often determined by technology commercialization capabilities.

According to Mataa (2013) and Woerther (2013) the acquisition of external R&D or cooperation with external partners in R&D projects exerts a positive impact upon the profitability of firms. Internal R&D only not significantly impacts the profitability of firms. External innovation strategies are likely to generate profit gains at the expense of a significantly high risk. Overall estimated magnitude of external research and development effect is greater than the estimated impact of conducting internal R&D activities. Ciftci (2011) and Cready (2011) did a study regarding R&D related earnings performance and earnings variability in relation to the firm size. Authors identified the growing positive relation between the level of future earnings and R&D intensity with increasing firm size. They also found that in general R&D scale is associated with lower market returns.

Gundaya, G (2011), Ulusoya, G (2011), Kilic K (2011) and Alpkan, L (2011) studied effects of the organizational, process, product and marketing innovations on various aspects of firm performance in Turkey. The results reveal the positive effects of all four types of innovation on firm performance in manufacturing industries. Wanga, Ch-H (2013), Lua, Y-H (2013), Huang, Ch-W (2013) and Lee, J-Y (2013) analyzed the production activity, R&D efforts and their linkages between profitability, marketability, efficiency and market value of high technology firms. The research was done on the basis of 65 high-technology firms located in Taiwan. Authors found that production activities and R&D efforts are the two major innovation activities that critically affect the firms' performance.

Veugelers (1997) studied, on a basis of a sample of Flemish R&D active companies, the problem of two way relationships and effectiveness of internal R&D expenditures and external technology sourcing. The external technology sourcing was taken under consideration both in the form of business R&D contracting from external sources and R&D cooperation. The research was based on the basic principle that availability of external technology may limit investment in the in house research and the issue of complementarity. Author found that external technology sourcing have a significant positive effect on internal R&D only in the situation when companies (technology recipients) 'have sufficient absorptive capacity in the form of a full-time staffed R&D department. At the same time, firms are found to be more frequently engaged in R&D cooperation, the more they spend on internal R&D'. In their study related to the issue of decisions between internal and external R&D Audretsch (1996), Menkveld (1996) and Thurik (1996) proved that it is efficient for companies to engage in both types of R&D. According to authors 'internal R&D enables the firm to translate external knowledge into innovation opportunities for the firm. External R&D facilitates spillovers from the outside information network to the firm's specific knowledge stock'. In order for the firm to engage in both types of R&D activities the need for a critical mass exists (in terms of the amount of firms R&D effort or in terms of the quality of the firm's external environment providing sufficient technological opportunities). Authors also found that in high-tech the complementary effect between internal and external R&D takes place whereas in low-tech industries internal and external R&D tend to be substitutes. Among various factors determining effectiveness of business innovation, including return on investment-like measures, innovation management seems to be of paramount importance. Although it has been found by Little (2013) that the overall quality of innovation

management has weakened recently, good innovation management may increase firms' profitability (expressed by EBIT) by up to 13% in comparisons with average performers.

The literature review suggests that the great majority of the up to date studies regarding the issue of effectiveness of business innovative activities were done on the basis of developed economies and the issue of the impact of regularity of the innovative effort upon the effectiveness of various categories of innovation expenditure was addressed at most marginally. There is a fair chance that this specific problem hasn't been yet studied on the basis of data and research evidence obtained from emerging economies.

3. The Methodology and Model

The survey presented in this paper, regarding the effectiveness of business innovative activities in the case of emerging economies, is based on the estimation of the regression function that is based on the transformation of Cobb-Douglas production function. The final version of the linear mathematical regression model was created on the basis of logarithm of both sites of classical Cobb-Douglas equation. The model is based on relative increases (i.e. expenditures), instead of levels of capital. This approach is expected to better capture and reflect small changes of independent variables and is easier to implement. The model, despite the fact that it is easy to implement and estimate, allows for decomposition and examination of the impact of various categories of independent variables (innovation expenditure). The selection of dependent variable allows for examination of unique and potentially practical relationships. For the purpose of the study the dependent variable was defined as the relative growth of earnings before interest, tax and depreciation (EBITD), that is considered as the most suitable measure of profitability of innovative activities at the firm level, since it takes under consideration only short term costs and revenues that reflect the core of business operations at the firm level. Via selection of dependent variable the long term factors like i.e. depreciation and financial costs were omitted in order to grasp the short term changes of output measures reflecting the real business operations. The data utilized in the estimation of the regression functions is obtained from public statistics (The Central Statistical Office) and represents the time series of innovation and R&D expenditures and output measures exemplified by EBIDT and its relative growth. The econometric estimations are based on the total sample of 909 firms active in the field of R&D over the observed 10 year period. The data cover the period between year 2000 and 2009. Estimations include the 0 to 6 years lag of independent variables which results with the maximum of 2866 observations for the sample of firms taken under consideration in estimations presented in the paper. The impact of innovation expenditure on sales or profit growth is not contemporaneous. The actual lag between the expenditure and the observed effect exemplified by EBIDT relative growth may vary significantly depending for instance on a given branch of industry. In various cases the lag may extend to more than 10 years, like in some intensively knowledge based industries i.e. biotechnology. The 6 year maximum lag applied seems to represent a realistic trade-off between the data and model limitations on one hand and maximum expected lag between innovation expenditure and its effects in the case of certain firms included in the sample. It seems to be advisable to further investigate the issues of more lagged effects in the course of the future research. The firms covered by the survey represent medium and large (by EU standards) manufacturing companies located in all parts of Poland. Only medium and large companies, that employ 50+ persons

are taken into consideration in the study, since smaller (employing less than 50 persons) are not covered by the yearly survey of innovative activities (PNT-02 survey) carried out by The Central Statistical Office in Poland.

The initial version of the regression function is specified underneath.

$$\frac{EBITD^{*}_{t} - EBITD^{*}_{t-1}}{EBITD^{*}_{t-1}} = \beta 0 + \beta 1 \frac{EMP_t - EMP_{t-1}}{EMP_{t-1}} + \beta 2 \frac{R\&DInt_t}{y_t} + \beta 3 \frac{R\&DExt_t}{y_t} + \beta 4 \frac{NIE_t}{y_t}$$

$$+ \beta 5 \frac{IETech_t}{y_t} + \beta 6 \frac{IESoft_t}{y_t} + \beta 7 \frac{IEBuild_t}{y_t} + \beta 8 \frac{IEMDom_t}{y_t} + \beta 9 \frac{IEM\ \mathrm{Im}\, p_t}{y_t}$$
$$+ \beta 10 \frac{IETrai_t}{y_t} + \beta 11 \frac{IEMark_t}{y_t} + \beta 12 \frac{IE\ \mathrm{Re}\, m_t}{y_t}$$

Description of variables:

EBITD – Earnings before interest tax and depreciation
EMP – total employment
R&DInt – internal research and development expenditure
R&DExt – external research and development expenditure
NIE – non-innovation capital expenditure
IETech – innovation expenditure on new technologies
IESoft – innovation expenditure on software
IEBuild – innovation expenditure on buildings (associated with innovative activities or investment)
IEMDom – innovation expenditure on domestically made machinery
IEMImp – innovation expenditure on imported machinery
IETrai – innovation expenditure on training (associated with innovative activities or investment)
IEMark – innovation expenditure on marketing
IERem – remaining innovation expenditure

On the basis of available data and common standards, business R&D expenditure is divided into two broad categories:

- Internal business research and development: Activities carried out by a particular business entity regardless of the sources of funds utilized to finance them. Internal R&D expenditure includes both running costs and capital expenditure.
- External business research and development: Includes R&D activities performed outside of a particular business entity by both domestic and foreign contractors.

In the process of model refinement independent variables included in the initial version of the model were proposed to the model in various combinations. The software package

GRETL, that was taken advantage of for econometric calculations and estimations, includes, among others features, the procedure for eliminating collinear variables from the model. After removal of two collinear variables (remaining innovation expenditure and non-innovation capital expenditure), the following model was proposed for final estimations:

$$\frac{EBITD^{*}_{t} - EBITD^{*}_{t-1}}{EBITD^{*}_{t-1}} = \beta 0 + \beta 1 \frac{EMP_t - EMP_{t-1}}{EMP_{t-1}} + \beta 2 \frac{R\&DInt_t}{y_t} + \beta 3 \frac{R\&DExt_t}{y_t}$$

$$+ \beta 5 \frac{IETech_t}{y_t} + \beta 6 \frac{IESoft_t}{y_t} + \beta 7 \frac{IEBuild_t}{y_t} + \beta 8 \frac{IEMDom_t}{y_t} + \beta 9 \frac{IEM\ \mathrm{Im}\ p_t}{y_t}$$
$$+ \beta 10 \frac{IETrai_t}{y_t} + \beta 11 \frac{IEMark_t}{y_t}$$

In order to avoid the issue of outlier, only firms featuring limited variations of dependent variable (+/- 100% variation of dependent variable in the time series) were qualified for the purpose of final model estimation. The dependent variable (relative EBIDT growth) is an indicator in nature. The problem of autocorrelation of dependent variable, potentially unlikely due to the nature of dependent variable, was tested and excluded at the initial stage of the estimation process.

The econometric estimation, based on the final version of the model, were carried out separately on the basis of 5 samples of firms subject to increasing regularity of business R&D effort. This was meant to give the opportunity to test the effect of various levels of business R&D regularity upon the effectiveness (profitability) of business innovation expenditure. The samples include:

1. Sample (A) of firms that at least two times in the 2000-2009 time series reported R&D expenditure – Model A. The estimations of Model A are based on the sample of 672 firms and 2688 observations.
2. Sample (B) of firms that at least four times in the time series reported R&D expenditure – Model B. The estimations of Model B are based on the sample of 472 firms and 1888 observations.
3. Sample (C) of firms that at least six times in the time series reported R&D expenditure – Model C. The estimations of Model C are based on the sample of 373 firms and 1492 observations.
4. Sample (D) of firms that at least eight times in the time series reported R&D expenditure – Model D. The estimations of Model D are based on the sample of 278 firms and 1112 observations.,
5. Sample (E) of firms that 10 times in the time series reported R&D expenditure – Model E. The estimations of Model E are based on the sample of 191 firms and 764 observations.

4. The Findings

After series of estimations of the model using the five samples specified above, five models were specified. All the remaining independent variables included in the initial version of econometric model, that are not listed in the tables underneath, proved to be insignificant, regardless of the lag applied or of the sample used to carry out the estimations. Table 1 includes the results of the estimations of final model on sample A of firms that at least two times in the time series reported R&D expenditure.

Table 1: Sample A - Model A

Variable	Lag applied in years	Value of the coefficient	Standard error	T statistics	P level	
EMP	0	0,24414	0,0691481	3,5307	0,00042	***
IEMDom	0	-0,472909	0,160582	-2,9450	0,00326	***
IETech	2	-3,69067	1,86443	-1,9795	0,04788	**
IEMark	3	-3,66729	1,77172	-2,0699	0,03858	**
IETrai	4	-20,776	7,90809	-2,6272	0,00867	***
IEMark	4	3,64977	1,80411	2,0230	0,04319	**
R&DInt	5	0,508184	0,240796	2,1104	0,03494	**
R&DExt	5	2,70818	1,16725	2,3201	0,02043	**
IEMImp	5	-0,598236	0,268997	-2,2239	0,02625	**

Note: ***, **, and * indicate significance levels of 1, 5 and 10 percent, respectively.
Dependent variable average = 0,013
Determination coefficient R^2 = 0,027

The results of estimation of model A generally show the tendency for the gradual buildup of positive effects as the lag applied increases. One can observe positive effects from 4 year lag upwards with just one exception, that is innovation expenditure on imported machinery lagged five years. The highest positive impact on EBITD was observed in the case of innovative expenditure on marketing lagged four years (coefficient value =3,6) and external business R&D expenditure lagged five years (coefficient value =2,7). Relatively weak but statistically significant positive effect was observed in the case of internal business R&D expenditure lagged five years (coefficient value =0,5). The observed results justify the implementation of extended lag of independent variables. It seems to be worthwhile, from the cognitive point of view, to even further extend the maximum lag in the future research in order to verify the potential existence of more distant effects and their possible regularity. The higher effectiveness of external R&D versus internal, may suggest that externally contracted R&D offers more profitable option for business units. This finding is in coherent with conclusions from other study done by Mataa (2013) and Woerther (2013) and might suggest that this regularity applies both to emerging and developed economies. Lower effectiveness of internal R&D is likely to suggest that firms might be lacking in experience and expertise in the field of in house R&D, due to perhaps low regularity and lack of good

practices, that they could take advantage of. Therefore, it seems to be advisable to consider the development of public policy measures targeted to improve the quality of internal business R&D through i.e.: better R&D management and proliferation of best available internal R&D practices. Nevertheless, in the light of the above research evidence, business R&D seems to potentially constitute a very attractive option for improvement of firms profitability. In the light of the research, positive effects of business R&D come with time (in fact they are the most distant-lagged positive effects of business innovative effort identified in the study). One could also argue that the more direct financial measures supporting business units during this five year period between the actual R&D expenditure and expected effects would be recommended to help companies, not only to survive this difficult period of time, but also to carry on with required R&D activities. One could also hypothesize the appearance of positive effects of innovation expenditure on marketing after four years in conjunction with negative effects after three years, might initially suggest inadequate timing of innovation expenditure on marketing.

Table 2 includes the results of the estimations of final model on sample B of firms that at least four times in the time series reported R&D expenditure.

Table 2: Sample B - Model B

Variable	Lag applied in years	Value of the coefficient	Standard error	T statistics	p level	
EMP	0	0,260817	0,0838976	3,1088	0,00191	***
IEMDom	0	-0,589858	0,230868	-2,5550	0,01072	**
IEMDom	2	0,563717	0,264005	2,1352	0,03290	**
IETrai	3	18,2627	8,4129	2,1708	0,03010	**
IEMark	3	-6,20941	1,91578	-3,2412	0,00122	***
IETrai	4	-25,6154	8,38076	-3,0565	0,00228	***
IEMark	4	4,51771	1,96211	2,3025	0,02144	**
R&DInt	5	0,804678	0, 327224	2,4591	0,01404	**
R&DExt	5	2,83718	1,24979	2,2701	0,02334	**
IEMImp	5	-0,742356	0,294199	-2,5233	0,01173	**

Note: ***, **, and * indicate significance levels of 1, 5 and 10 percent, respectively.
Dependent variable average = 0,009
Determination coefficient R^2 = 0,043

In the case of estimations based on model B one can observe the strongest positive impact in the case of innovative expenditure on training lagged three years (coefficient value =18,2). This positive effect, in the case of innovative expenditure on training, is in excess balanced by negative effect lagged four years (coefficient value =-25,6), which is at this stage of the research hard to interpret. Relatively moderate impact was observed in the case of innovative expenditure on marketing lagged three years (coefficient value =-6,2)

balanced by positive impact of innovative expenditure on marketing lagged four years (coefficient value =4,5) and in the case of external business R&D expenditure (coefficient value =2,8). The relatively weaker level of impact was identified in the case of innovative expenditure on new domestically manufactured machines, non-lagged (coefficient value =-0.59) and two years lagged positive effect (coefficient value =0,53) were identified. Weaker level of influence was also observed in the case of internal business R&D expenditure lagged five years and innovative expenditure on imported machines lagged five years. The above results also to certain extent suggest the gradual build-up of positive results as the lag increases (with one exception in the case of innovation expenditure on training). One can notice that coefficients estimated on the basis of model B for both internal and external business R&D effectiveness show noticeably higher values (although not directly comparable) than relevant estimations based on model A. This might hypothetically suggest that the higher regularity of business R&D effort positively affects its effectiveness.

Table 3 includes the results of the estimations of final model on sample C of firms that at least six times in the time series reported R&D expenditure.

Table 3: Sample C - Model C

Variable	Lag applied in years	Value of the coefficient	Standard error	T statistics	p level	
EMP	0	0,304426	0,0955444	3,1862	0,00148	***
IEMDom	0	-0,556533	0,229395	-2,4261	0,01541	**
IEMark	3	-6,04542	1,97915	-3,0546	0,00230	***
IETrai	4	-23,4686	8,37295	-2,8029	0,00515	***
IEMark	4	4,31869	2,00378	2,1553	0,03134	**
R&DInt	5	0,922249	0,328038	2,8114	0,00501	***
R&DExt	5	3,33408	1,26715	2,6312	0,00862	***
IEMImp	5	-0,948577	0,33706	-2,8143	0,00497	***

Note: ***, **, and * indicate significance levels of 1, 5 and 10 percent, respectively.
Dependent variable average = 0,003
Determination coefficient R^2 = 0,051

The estimations based on the subsample of firms that at least 6 times in the time series reported R&D expenditure (Model C) show that the strongest impact was observed in the case of innovative expenditure on training lagged four years (the value of the coefficient =-23,5). The relatively average impact was observed in the case of innovative expenditure on marketing lagged three years (the value of the coefficient=-6,04) and innovative expenditure on marketing lagged four years that after one year turns into positive territory (the value of the coefficient =4,3). The external R&D shows positive impact after five years from the actual expenditure (the value of the coefficient =3,33). The relatively weaker impact was observed in the case of internal business R&D expenditure lagged five years (the value of the coefficient =0,92), expenditure on imported machines lagged five years (the value of

the coefficient =-0,95) and non-lagged expenditure on domestically manufactured machines (the value of the coefficient =-0,6). The results of estimations based on model and sample C show higher values of coefficients estimated for both internal and external business R&D expenditure than in the case of model/sample A and B. This might further provisionally support the hypothesis that increased regularity of business R&D positively affects its effectiveness.

Table 4 includes the results of the estimations of final model on sample D of firms that at least eight times in the time series reported R&D expenditure.

Table 4: Sample D - Model D

Variable	Lag applied in years	Value of the coefficient	Standard error	T statistics	p level	
EMP	0	0,396967	0,123869	3,2047	0,00140	***
IEMDom	0	-0,787646	0,256675	-3,0687	0,00221	***
IETrai	3	17,5531	8,64481	2,0305	0,04260	**
IEMark	3	-4,48513	1,97337	-2,2728	0,02327	**
IETrai	4	-21,6648	8,60468	-2,5178	0,01198	**
R&DInt	5	1,08689	0,327359	3,3202	0,00094	***

Note: ***, **, and * indicate significance levels of 1, 5 and 10 percent, respectively.
Dependent variable average = 0,003
Determination coefficient R^2 = 0,043

Estimations based on Sample D show no statistically significant impact of external business R&D and highly statistically significant positive impact of internal business R&D. Other statistically significant independent variables show mainly negative or mixed, like in the case of innovation expenditure on training, impact over dependent variable. Model D further provisionally supports, on the basis of estimations of coefficient for internal R&D, hypothesis that grooving regularity of business R&D positively affects its effectiveness. The lack of statistical significance of external business R&D is difficult to interpret on the basis of presented material. One can initially hypothesize that high regularity and possibly intensity of internal business R&D might incur or be associated with lower intensity and regularity of external business R&D. It might also be, that in the case of highly persistent business R&D performers external business R&D in fact supports internal business R&D effort, that itself constitutes the leading element of the business R&D effort. The problem described above is itself an interesting area of interest and may constitute and suggest the directions for future research.

Table 5 includes the results of the estimations of final model on sample E of firms that at 10 times in the time series (each year in the time series) reported R&D expenditure.

Table 5: Sample E - Model E

Variable	Lag applied in years	Value of the coefficient	Standard error	T statistics	p level	
EMP	0	0,364195	0,156161	2,3322	0,02001	**
IEMark	3	-4,84478	2,27575	-2,1289	0,03366	**
IETrai	4	-22,1081	8,92752	-2,4764	0,01354	**
R&DInt	5	1,01929	0,335367	3,0393	0,00247	***
IEMImp	5	-1,14772	0,503252	-2,2806	0,02291	**

Note: ***, **, and * indicate significance levels of 1, 5 and 10 percent, respectively.
Dependent variable average = -0,003
Determination coefficient R^2 = 0,044

In the case of model E one can observed the positive impact of only internal R&D expenditure lagged five years (the value of coefficient = 1,02). The increasing regularity of business R&D expenditure doesn't seem to improve expected number of statistically significant variables. In fact the result seem to be quite opposite and in the case of Model E any statistically significant impact was identified in the case of only four types of innovative expenditure and the positive impact was identified only in the case of one variable - internal R&D expenditure lagged five years. This may suggest in a sense unique, highly statistically significant and positive impact of internal R&D activities in respect to EBIDT relative growth in the case of firms undertaking permanent R&D effort. In the light of the research evidence, internal business R&D seems to represent the only profitable option out of other forms of business innovation. All the other categories of business innovation effort are either insignificant or seem to have negative effect over relative EBIDT growth. From the point of view of recommendations for economic policy, initially it seem reasonable to foster targeted measures to encourage internal R&D effort in the case of subcategory of companies representing the very high regularity of business R&D effort.

5. Summary and Conclusions

The study revealed strong variation of the impact of various innovative expenditures on relative sales growth. In the light of the presented estimations part of independent variables incorporated in the model proved to be of no significant impact over the relative EBITD growth regardless the regularity of the R&D effort of the firms in question and lag applied. The study showed that regardless of the R&D regularity, the following independent variables have no statistically significant impact: innovation expenditure on software, innovation expenditure on buildings, non-innovation capital expenditure, remaining innovation expenditure. The strongest statistically significant influence over relative EBIDT growth regardless of the R&D regularity was observed in the case: of innovation expenditure on training and marketing. The study revealed, highly statistically significant and consistent regardless of the R&D regularity, positive impact of business R&D lagged five years over relative EBITD growth. This consistency was especially observed in the case of internal business R&D. The above finding is in line with the results of the work done by Wanga, Ch-H (2013), Lua, Y-H (2013), Huang, Ch-W (2013) and Lee, J-Y (2013) in respect to the

consistently positive effects of business R&D effort over firms' performance. As the business R&D regularity increases the coefficients estimated for internal business R&D tend to show slightly greater values. The same tendency was observed in the case of external business R&D on the basis of estimations of sample A, B and C. The noticeably greater effect of external business R&D, than internal was found on the basis of model/sample A, B and C. This finding is consistent with the results of research work done by Mataa (2013) and Woerther (2013) on the basis of a sample of Swiss firms. In the case of the sample D and E no statistically significant impact of external business R&D was observed, this may initially suggest that firms showing the highest R&D regularity relay mainly on internal business R&D. It might be also the case, that for some hard to understand at this stage of the research reasons, that external R&D effort becomes ineffective, in respect to EBIDT, in the case of firm showing the highest R&D regularity. Author is planning to investigate further the issue and reasons behind the lack of statistical significance of external business R&D in the case of firm showing very strong regularity of business R&D. The study reviled significant, delayed positive effects of certain innovation expenditures over relative EBITD growth. The effects of business R&D expenditure are consistently positive and are lagged five years. The positive effects of other than R&D innovation expenditures tend to appear as the lag increases, this was especially observed in the case of innovation expenditure on marketing on the basis of sample A, B and C (negative three years lagged effect and positive four years lagged effect). In the case of sample D and E only three years lagged negative effect was observed in that respect. This might suggest that in the case of highly dedicated in terms of business R&D regularity companies the returns to investment on marketing are more questionable. The innovative expenditure on buildings, although included in PNT-02 survey and formally classified as innovation expenditure, but in the reality are often regarded as infrastructure expenditure, proved to be insignificant in every sample/model examined. The comparison of the results of the current survey based on relative EBITD growth and the previous estimations, see Martin (2013), based on relative sales growth as the dependent variable indicate that various categories of innovation expenditure at the business level have far greater impact on sales growth (exemplified by relative sales growth) than on profit growth (exemplified by relative EBITD growth). The difference in terms of impact over dependent variables between the two above mentioned approaches/variables is close to an order of magnitude or greater. This may suggest that the EBIDT relative growth is to far smaller extent determined by business innovation expenditure, than relative sales growth. In this case other factors that are not specified in the model have a greater impact over dependent variable. One could assume and hypothesize, that business innovation effort is targeted to smaller extent at profit growth than it is targeted at sales growth. The above observation may also suggest, that the firms in the research sample are on average in terms of their innovation effort more sales growth, than profit growth oriented. One could suggest that the traditional neoclassical profit maximization theory of the firm, in fact to the very limited extent explain the economic and business aims and motives behind innovation effort of the firm in the research sample. The alternative, sales growth maximization oriented theories of the firm, might be more appropriate.

Another explanation might be, that in the case of highly innovative – R&D oriented companies, profits are being reinvested, what in turn limits the growth of profitability. In fact the research indicates that as the regularity of the business R&D increases the dependent

variable average decreases. The previous research, see Martin (2013) reviled the noticeable differences between the relative sales growth of firms in the total sample and firms in the subsample of firms active in the field of business R&D. Firms active in field of business R&D have noticeable higher values of relative sales growth. In the case of the current research the dependent variable average seems to decrease as the R&D regularity increases. This might initially suggest, that as the R&D regularity increases, firms show lower profit growth due to heavy R&D investment and/or in a sense might become less profit oriented.

As far as the limitations and scope for future research are concerned, it seems to be advisable to continue the research and estimations on the basis of more refined and advanced method and models. It might be achieved for instance via: (1) the utilization of panel models combined with search for fixed and variable effects, (2) implementation of different dependent variables. Theory, in certain cases, suggests the more than 6 year lagged effects of business innovation activities. It seems to be advisable to also further extend the maximum lag applied in the estimations in order to fully examine the possible existence and regularity of more lagged effects of business innovation and R&D effort in certain categories of business units.

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