

# DETERMINANTS OF INNOVATION ACTIVITIES AND SME ABSORPTION – CASE STUDY OF GERMANY

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***Abstract:** SME's are integral pillars in ladder of innovation. Due to their proximity to end users and their flexibility, they are credited with the creation of ground level product and process innovations in their local and world markets. SMEs absorption of innovations is significantly assisted by the entrepreneurial environment, globalization tendencies, rapidly changing technological issues of the environment as well as other determinants. However, depending on the industry, determinants of innovation affects each firm differently depending on the type of innovation considered. The goal of this research is therefore, to analyse what determinants influence the innovation activities of small and medium enterprises across three different German industries, namely, in the Electrical, Chemical and Pharmaceutical and the Metal Industry. Results from the SMEs were compared against themselves as well as SMEs from the three considered industries. This paper used data from the Community Innovation Survey (2010-2012) which employed stratified sampling technique with surveys. Logistic regression tool was used to analyse the impact of certain activities and expenditures, information and competitive strategies on product on process innovation. The research eventually discovered that the determinants influencing product and process innovations in selected enterprises varied according to the size of enterprise analysed. It was proposed that small enterprises should primarily focus on In-house R&D and acquisition of capital assets whilst medium size enterprises would be best served in concentrating on training for innovative activities.*

***Keywords:** Innovation Activities, Determinant, Innovation Capacity, Germany*

***JEL Classification:** O38, O47, H50, C33.*

## Introduction

Many studies present that the innovation capacity of businesses determines economic growth, both in the company itself and in the entire industry and hence in the economic growth of the country (Jorgenson, Gollop & Fraumeni, 2016; Leigh & Blakely, 2016). It has been shown that innovation is created by the involvement of various internal and external sources (production factors), but also knowledge and interaction between economic subjects (West & Bogers, 2014; Doloreux, 2015). The favorable business environment and the openness of the economy are two important components (Belás, Demjan, Habánik, Hudáková & Sipko, 2015). The open innovation concept highlights importance of the business and innovation environment. Open innovation is currently an interesting interconnected concept (Chesbrough et al., 2014). This concept primarily emphasises the role of external technological sources, which helps to create a competitive advantage (mainly by reducing the time needed to create innovation and market it; Feniser, Lungu & Bilbao, 2017). Another advantage is the orientation of the open innovation concept to small and medium- sized enterprises (SME). SME use cost sharing, experience sharing, and often the risk sharing associated with the production of an innovative products or services (West, Salter, Vanhaverbeke & Chesbrough, 2014). SME does not have sufficient resources to cover

increased technology or innovation costs. Some scholars add that SME occupy small positions in the space of knowledge (Feniser, Lungu & Bilbao, 2017), which is due to several factors: the first is the unavailability of investment funds. The second is the lower number of workers, especially those in research and development (again linked to the inability of SMEs to pay really high experts). The third relates to the business innovation strategy, particularly in the CEE region (Malerba et al., 2015). It is still evident that the only SME strategy is to compete with price and possibly with small innovation changes. The innovation production is not a major business strategy for SMEs in many European countries.

SMEs are a very specific group of enterprises, notwithstanding their location in advanced or developing countries, they have very similar characteristics and, above all, behavioural patterns (Ates, Garengo, Cocca & Bititci, 2013). Due to the situation in national and even more in international markets, they are forced to use their production capabilities and in-house knowledge very efficiently. The market situation forces them to be more flexible and dynamic, which often requires a change in business strategy or an increase in specialization on those products that the SME firms are able to produce and sell within the market at the moment with the available resources (Arend, 2014).

Therefore, the collaboration in cooperation-based or knowledge-based networks is much more frequent (McCann & Ortega-Argilés, 2015; Hájek & Stejskal, 2018). SMEs are part of cooperative chains and regional innovation systems in many developed European countries. It helps to increase the innovative absorption of SMEs, use spill-over effects (not only knowledge spill-over effects) and realize the technology transfer (Hajek, Henriques & Hajkova, 2014). All of these abilities strengthen their competitive advantage.

The remainder of this paper is structured as follows. In the next section, the theoretical background on the determinants of innovation activities and the goal of this paper is presented. Section 2 will provide the characteristics of the dataset and the research methodology. Section 3 will list the experimental results and in Section 4, the discussion, conclusion, limitations and future research areas are presented.

## **1 Theoretical background**

High-quality R&D activities are an essential prerequisite for creating innovative outputs. They also significantly influence innovation activities and innovative absorption. As mentioned by Rammer, Czarnitzki & Spielkamp (2009), there are several features of R&D that are likely to result in systematic differences between small and large firms with respect to conducting in-house R&D. They include, for example: (a) R&D in SMEs is determined by a number of projects whose scope can be financed and bring at least reasonable returns on the scale. Research costs are very often fixed, thus reducing the profitability of the business; (b) similarly, R&D in SMEs is associated with high initial investment whose return-on-investment need not be positive in the early years; (c) research activities increase the business risk of the business and therefore it is possible often to encounter so-called ad hoc research, which is of a temporary nature and is usually associated with the realization of a research project. These and other characteristics of the SMEs lead to their less

willingness to systematically support their innovation activities and increase innovative absorption (Prokop, Stejskal & Kuvíková, 2017).

Innovative absorption is also often associated (and unfortunately sometimes severely demotivated) by determinants that affect the total competitiveness of individual outputs and the whole of the enterprise. These determinants to competitive advantage protecting are patents, utility patents, design trademarks, copyrights etc. By them, it is possible to ensure (in a globalized world for a relatively short time) the uniqueness of the product on the market. There are a number of studies that agree on the importance of patents and their impact on maintaining a competitive advantage. Bottazzi & Peri (2003) add that patents and protection features can generate the effect of research externalities across space, in generating innovation. They found that innovation is dependent on spill-over effects (and they are given by tacit knowledge in regions). Acs, Anselin & Varga (2002) have similar results. The role of geographically mediated knowledge externalities in regional innovation systems they perceived as a major issue in the research policy.

SMEs are forced to search for additional resources that can overcome the shortcomings given by the nature of SMEs. One option is to accept the public support or other R&D support activities most often from public sector organizations, in Europe, especially from the EU Structural Funds (Klímová, Žitek & Králová, 2019). This has been particularly massive in recent years and is directed, in particular, towards the acquisition of high-quality staff, the creation of innovative capacities, and often the encouragement of innovation cooperation or technology transfer. Some scholars disagree with the effectiveness of such public support, because of a high level of bureaucracy and production inefficiency. Likewise, SMEs are threatened by the effects of the so-called "low-emission fruit", i.e. the dependence on public funds. This is confirmed by a number of studies. For example: Almus & Czarnitzki (2003) analysed the effects of public R&D policy schemes on innovation activities of firms located in Eastern Germany. They also addressed the issue of whether public support stimulates R&D activities in their businesses. They found that enterprises (that did not benefit from public support) expanded innovation activities more than those who used the public support. Kang & Park (2012) examined the effects of inter-firm collaborations as well as the direct and indirect effects of government R&D support on innovation outputs of SMEs in Korea. They concluded that government support through project funding directly and indirectly affects firms' innovation by stimulating internal R&D and domestic upstream and downstream collaborations. Clausen (2009) analysed whether "research" and "development" subsidies influence private R&D activity. The results show that "research" subsidies stimulate private R&D activity, mainly by increasing research spending, while "development" subsidies substitute private R&D activity, mainly by decreasing development expenditure. Given the results of various studies, it is necessary to state that the effectiveness of public support for innovation activities also depends on the quality of the business environment and public policies.

Many SMEs, which do not realize permanent in-house R&D but want to innovate, use external resources and available technologies from elsewhere. Engaging a SME enterprise into certain cooperative relationships and using network sharing is a way how to get the necessary information sources or knowledge, or access to external

resources needed to create innovation. The most common is to use of resources and incentives from customers, suppliers or collaborating organizations, including competitors and the public. Many studies show that these information sources are very effective and provide the necessary impetus for innovation. In addition, thanks to the willingness to share information, experience and knowledge, it is possible to get a synergistically larger amount of information for your own needs back. Some studies show that it is necessary to have certain capabilities and often internal research to use external knowledge (Nilakanta & Scamell, 1990). Balancing between internal R&D efforts and external knowledge acquisition is therefore another major concern of innovation management (Rammer, Czarnitzki & Spielkamp, 2009). Amara & Landry (2005) analysed the information sources as determinants of innovation in manufacturing firms in Canada. Innovation-based enterprises (absolute novelty for the domestic or international market) use a wider range of sources of information and use a wider range of sources of research resources to develop or improve their outputs. Varis & Littunen (2010) examined the information sourcing practices of SMEs related to the development of different types of innovation (product / process / market / organizational). They (unlike other studies) find that the introduction of innovation is associated with the use of rather free (without any consideration) accessible information resources. Analysed enterprises have introduced innovation as their business objective and therefore none of the above innovations have significantly increased the profits of the firm in first years.

It is clear that the results of many published studies differ thanks to the different business environments and the unpredictable behaviour of businesses in different industries. Therefore, it is still necessary to realize the research to help determine which determinants have a significant impact on the innovation capacity of SMEs in the industrial branches. The ideal option is to use a benchmarking approach that can be applied in economies that are linked to each other. Therefore, the goal of this paper is to analyse what determinants influence the innovation activities of small and medium enterprises across three different German industries in comparison with the results obtained for the whole industries. Industrial branches (electrical, chemical and pharmaceutical, and metal) are representing most of the manufacturing industry in Germany. Therefore, the results can be considered significant for other industries in Germany.

## **2 Data and methodology**

To perform the empirical analysis, Eurostat collected and pre-processed the data from the Community Innovation Survey 2010-2012 (CIS). CIS uses harmonized questionnaire created for all EU Member States by Eurostat and combines stratified random sampling with exhaustive surveys. In agreement with previous related studies (e.g. see Archer & Lemeshow, 2006; Coad & Rao, 2008; Schneider & Spieth, 2013), a logistic regression model was fitted. According to previous parts and CIS dataset, we selected following three groups of independent variables (all independent variables are listed in Tab. 1.):

- a) activities and expenditures for product and process innovations which include, in particular, research and development. R&D usually helps firms to create new

knowledge, solve scientific or technical problems and fuels firms' innovation, knowledge stock, technology and productivity (Prokop, Odei & Stejskal, 2018);

- b) sources of information and co-operation for product and process innovation. Accessing a greater number of knowledge, information and cooperation sources improve firms probability of obtaining knowledge that will lead to a valuable innovation outcomes (Leiponen & Helfat, 2010);
- c) methods for maintaining or increasing the competitiveness of product and process innovations. These methods usually help firms to protect their products, processes, and brand (Brem, Maier & Wimschneider, 2016) as well as their internal knowhow and innovations.

We analyse how these variables influence firms' product and process innovations (dependent variables) within selected German industries. The effects within small and medium enterprises as well as within the whole industries (including small, medium and large enterprises together) are compared and the comparison is presented. In total, the study analysed 474 Electrical (NACE 26-27), 473 Chemical and Pharmaceutical (NACE 19-22) and 465 Metal (NACE 24-25) firms within these industries.

To analyse whether CIS data are not correlated, Spearman's test was used. The hypothesis that the data are correlated with a level of significance at  $p < 0.05$  were rejected. Subsequently, the collinearity among the independent variables by Variance Inflation Factor (VIF) for each regression model was tested. Multicollinearity was rejected in the models ( $VIF < 5$ ). All calculations were made using the statistical software SPSS.

**Tab. 1: Independent variables**

| <b>Activities and expenditures for product and process innovations</b>            |   |
|---|---|
| RRDIN   | In-house R&D  |
| RRDEX   | External R&D  |
| RMAC  | Acquisition of machinery, equipment, software & buildings                 |
| ROEK  | Acquisition of existing knowledge from other enterprises or organisations |
| RTR   | Training for innovative activities  |
| RMAR  | Market introduction of innovations  |
| RDSG  | Design  |
| RPRE  | Other <sup>1</sup>  |
| <b>Sources of information and co-operation for product and process innovation</b> |   |
| SCON  | Conferences, trade fairs, exhibitions                                     |
| SJOU  | Scientific journals and trade/technical publications                      |
| SPRO  | Professional and industry associations                                    |
| SENTG   | Within enterprise or enterprise group                                     |
| SSUP  | Suppliers of equipment, materials, components, or software                |

<sup>1</sup> Other in-house or contracted out activities to implement new or significantly improved products and processes such as feasibility studies, testing, tooling up, industrial engineering, etc.

|   |  |
|---|--|
| SCLPR   | Clients or customers from the private sector         |
| SCLPU   | Clients or customers from the public sector          |
| SCOM  | Competitors or other enterprises in industry         |
| SINS  | Consultants and commercial labs                      |
| SUNI  | Universities or other higher education institutions  |
| SGMT  | Government, public or private research institutes    |
| SCON  | Conferences, trade fairs, exhibitions                |
| SJOU  | Scientific journals and trade/technical publications |
| SPRO  | Professional and industry associations               |
| <b>Methods for maintaining or increasing the competitiveness of product and process innovations</b> |  |
| CMPAT   | Patents  |
| CMUPAT  | Utility patents                                      |
| CMRCD   | Design registration                                  |
| CMCO  | Copyright  |
| CMCTM   | Trademarks   |
| CMLTAD  | Lead time advantages                                 |
| CMCPX   | Complexity of goods or services                      |
| CMSEC   | Secrecy (include non-disclosure agreements)          |

*Source: (CIS 2012, Eurostat)*

In the following part, results of binary logistic models that analysed the influence of several independent variables – determinants of innovation activities (grouped into three groups, see above) on the product and process innovations in small and medium enterprises as well as on the product and process innovations within whole industries were presented. Generally, most of significant results were obtained during analyses of the entire industries. However, numbers of important results were also obtained from analyses within SME's.

### **3 Results**

Tab. 2 presents results for the firms in German Electrical industry. Factors that influenced firms' innovation activities differ according to the size of enterprise. Research and development activities undertaken by enterprises (RRDIN) to create new knowledge or to solve scientific or technical problems significantly influenced product innovations in small enterprises and within the whole industry. Internal sources of information and co-operation for innovations (SENTG) played an important role within the whole German Electrical industry. Other in-house or contracted out activities to implement new or significantly improved products and processes such as feasibility studies, testing, tooling up, industrial engineering (RPRE), Training for innovative activities (RTR) and Lead time advantages (CMLTAD) most significantly influenced innovation activities within medium enterprises.

**Tab. 2: German Electrical industry**

|        | Small<br>(under 50 employees) |                        | Medium<br>(50-249 employees) |                        | Industry               |                        |
|--------|-------------------------------|------------------------|------------------------------|------------------------|------------------------|------------------------|
|        | Product<br>Sig. (Beta)        | Process<br>Sig. (Beta) | Product<br>Sig. (Beta)       | Process<br>Sig. (Beta) | Product<br>Sig. (Beta) | Process<br>Sig. (Beta) |
| RRDIN  | .000(2.172)***                | .811(-.132)            | .380(.772)                   | .091(1.259)*           | .000(1.851)***         | .541(.252)             |
| RRDEX  | .630(.246)                    | .818(.088)             | .076(1.330)*                 | .778(.133)             | .181(.507)             | .507(.179)             |
| RMAC   | .431(.398)                    | .022(.949)**           | .504(.510)                   | .067(1.035)*           | .425(.322)             | .000(1.266)***         |
| ROEK   | .544(-.396)                   | .272(.501)             | .693(-.363)                  | .759(-.173)            | .680(-.207)            | .362(.287)             |
| RTR    | .781(.139)                    | .076(.683)*            | .813(.158)                   | .040(1.005)**          | .703(.147)             | .001(.917)***          |
| RMAR   | .007(1.439)***                | .109(-.667)            | .764(-.234)                  | .191(-.765)            | .017(.926)**           | .034(-.643)**          |
| RDSG   | .139(.846)                    | .559(.236)             | .037(1.696)**                | .776(.162)             | .001(1.485)***         | .092(.482)*            |
| RPRE   | .102(.910)                    | .049(1.097)**          | .007(2.149)***               | .353(.590)             | .006(1.133)***         | .089(.642)*            |
|        |                               |                        |                              |                        |                        |                        |
| SENTG  | .000(1.791)***                | .011(1.209)**          | .071(1.130)*                 | .217(.717)             | .000(1.598)***         | .002(1.049)***         |
| SSUP   | .988(-.009)                   | .001(1.314)***         | .063(1.061)*                 | .107(.721)             | .151(.539)             | .000(.971)***          |
| SCLPR  | .001(1.474)***                | .453(.281)             | .228(.660)                   | .889(-.068)            | .000(1.399)***         | .082(.464)*            |
| SCLPU  | .013(1.529)**                 | .839(.085)             | .281(.804)                   | .265(-.611)            | .001(1.451)***         | .964(.013)             |
| SCOM   | .851(-.091)                   | .048(-.765)**          | .430(.447)                   | .771(.138)             | .614(.173)             | .024(-.606)**          |
| SINS   | .992(-.007)                   | .816(-.151)            | .872(-.151)                  | .854(.126)             | .846(.100)             | .184(.504)             |
| SUNI   | .134(.773)                    | .322(.391)             | .973(-.019)                  | .449(.345)             | .257(.384)             | .147(.370)             |
| SCON   | .103(.897)                    | .864(.073)             | .124(.947)                   | .011(1.305)**          | .033(.775)**           | .022(.641)**           |
| SJOU   | .627(.264)                    | .663(.182)             | .672(-.275)                  | .774(-.152)            | .887(.054)             | .910(.032)             |
| SPRO   | .020(-1.601)**                | .448(.421)             | .949(.047)                   | .758(.179)             | .055(-.853)*           | .237(.385)             |
|        |                               |                        |                              |                        |                        |                        |
| CMPAT  | .096(.851)*                   | .405(-.338)            | .698(.319)                   | .264(-.728)            | .006(1.066)***         | .781(-.083)            |
| CMUPAT | .874(.120)                    | .563(.293)             | .567(.489)                   | .392(.546)             | .311(-.483)            | .494(.228)             |
| CMRCD  | .035(-1.710)**                | .650(.250)             | .831(.286)                   | .945(.048)             | .218(-.638)            | .364(.326)             |
| CMCO   | .241(.762)                    | .857(.079)             | .845(-.168)                  | .681(.222)             | .742(.140)             | .453(.219)             |
| CMCTM  | .295(.552)                    | .797(-.107)            | .020(1.939)**                | .606(.287)             | .002(1.206)***         | .267(.312)             |
| CMLTAD | .081(.860)*                   | .127(.780)             | .008(1.755)***               | .489(.400)             | .000(1.285)***         | .054(.651)*            |
| CMCPX  | .007(1.354)***                | .780(.123)             | .381(-.669)                  | .018(1.331)**          | .065(.665)*            | .312(.295)             |
| CMSEC  | .816(.108)                    | .055(.808)*            | .091(1.237)*                 | .538(.338)             | .482(.244)             | .011(.719)*            |

Source: own

Tab. 3 shows that in-house and external R&D activities and expenditures for product and process innovations most significantly influenced small firms' innovation activities in German Chemical and Pharmaceutical industries. Results also show that R&D activities play an important role in small and medium enterprises as well as in the whole industry. Similarly, to the results in Tab. 3, internal sources of information and co-operation for innovations had positive impact on the firms' product and process innovations. Patents, trademarks and lead-time advantages most significantly supported firms' competitiveness of product and process innovations.

**Tab. 3: German Chemical and Pharmaceutical industries**

|       | Small<br>(under 50 employees) |                        | Medium<br>(50-249 employees) |                        | Industry               |                        |
|-------|-------------------------------|------------------------|------------------------------|------------------------|------------------------|------------------------|
|       | Product<br>Sig. (Beta)        | Process<br>Sig. (Beta) | Product<br>Sig. (Beta)       | Process<br>Sig. (Beta) | Product<br>Sig. (Beta) | Process<br>Sig. (Beta) |
| RRDIN | .000(2.341)***                | .004(1.858)***         | .166(.870)                   | 1.000(.000)            | .001(1.277)***         | .203(.454)             |
| RRDEX | .012(-1.979)**                | .033(-1.287)**         | .614(.305)                   | .195(.654)             | .452(-.289)            | .769(.091)             |
| RMAC  | .012(1.376)**                 | .000(2.635)***         | .857(-.120)                  | .012(1.372)**          | .038(.724)**           | .000(1.822)***         |
| ROEK  | .045(1.602)**                 | .634(.291)             | .772(-.172)                  | .975(-.016)            | .698(.149)             | .138(.458)             |
| RTR   | .527(-.401)                   | .112(.818)             | .004(1.690)***               | .007(1.307)***         | .134(.523)             | .000(1.172)***         |

|        |                |                |                |                |                |                |
|--------|----------------|----------------|----------------|----------------|----------------|----------------|
| RMAR   | .034(1.496)**  | .091(-.952)*   | .000(2.388)*** | .909(-.054)    | .000(2.233)*** | .330(-.305)    |
| RDSG   | .653(.314)     | .601(-.302)    | .381(.562)     | .192(.688)     | .128(.626)     | .438(-.240)    |
| RPRE   | .056(1.194)*   | .730(.206)     | .466(.416)     | .092(.840)*    | .037(.730)**   | .073(.581)*    |
|        |                |                |                |                |                |                |
| SENTG  | .002(1.507)*** | .006(1.544)*** | .014(1.267)**  | .001(1.754)*** | .000(1.374)*** | .000(1.587)*** |
| SSUP   | .610(-.265)    | .193(.618)     | .344(.445)     | .637(.215)     | .407(.250)     | .111(.413)     |
| SCLPR  | .093(.794)*    | .958(-.025)    | .014(1.225)**  | .177(.684)     | .000(1.175)*** | .329(.283)     |
| SCLPU  | .229(.812)     | .718(-.203)    | .335(.723)     | .652(.286)     | .215(.504)     | .965(-.014)    |
| SCOM   | .985(.010)     | .530(-.310)    | .717(-.179)    | .818(.109)     | .658(-.140)    | .864(-.047)    |
| SINS   | .959(-.039)    | .490(.476)     | .994(.004)     | .243(.709)     | .575(.226)     | .140(.515)     |
| SUNI   | .104(.910)     | .855(.089)     | .403(-.462)    | .495(-.344)    | .079(.574)*    | .221(.334)     |
| SCON   | .277(.609)     | .011(1.371)**  | .778(-.158)    | .465(.404)     | .966(.014)     | .123(.473)     |
| SJOU   | .547(.329)     | .783(-.142)    | .239(.658)     | .403(-.455)    | .342(.327)     | .345(-.286)    |
| SPRO   | .501(.521)     | .066(-1.197)*  | .497(.405)     | .226(-.634)    | .141(.645)     | .325(-.327)    |
|        |                |                |                |                |                |                |
| CMPAT  | .035(1.298)**  | .007(1.466)*** | .016(1.534)**  | .095(.846)*    | .008(1.022)*** | .006(.880)***  |
| CMUPAT | .399(-.621)    | .074(-1.133)*  | .150(-1.086)   | .212(-.737)    | .165(-.624)    | .145(-.519)    |
| CMRCD  | .747(.292)     | .276(-.759)    | .014(-1.976)** | .898(.090)     | .255(-.531)    | .325(-.371)    |
| CMCO   | .024(-1.858)** | .024(-1.366)** | .683(.292)     | .332(-.541)    | .079(-.745)*   | .084(-.563)*   |
| CMCTM  | .087(1.281)*   | .924(.052)     | .146(.954)     | .359(.474)     | .003(1.202)*** | .218(.390)     |
| CMLTAD | .067(1.209)*   | .323(.587)     | .015(1.497)**  | .050(1.098)*   | .000(1.488)*** | .002(1.066)*** |
| CMCPX  | .386(.560)     | .015(1.435)**  | .014(1.477)**  | .078(.873)*    | .028(.740)**   | .058(.550)*    |
| CMSEC  | .001(1.760)*** | .253(.559)     | .775(-.152)    | .949(.029)     | .071(.572)*    | .105(.459)     |

Source: own

In Metal industry (see Tab. 4), internal R&D activities, acquisition of machinery, equipment, software & buildings influenced small enterprises' innovation activities. Internal and some external (e.g. clients and suppliers) sources of information and co-operation also led to the support of small firms innovation activities. Medium firms' innovation activities were most significantly influenced by other in-house or contracted out activities to implement new or significantly improved products and processes such as feasibility studies, testing, tooling up, industrial engineering (RPRE), design activities (RDSG) and selected methods for maintaining or increasing the competitiveness (e.g. complexity of goods or services, trademarks, lead time advantages). Within the whole industry, number of activities and expenditures for product and process innovations and sources of information and co-operation for product and process innovation played important role. These, for example, are in-house R&D, acquisition of machinery, equipment, software & buildings, training for innovative activities, internal sources of information and co-operation for innovations, universities or other higher education institutions.

**Tab. 4: German Metal industry**

|       | Small<br>(under 50 employees) |                        | Medium<br>(50-249 employees) |                        | Industry               |                        |
|-------|-------------------------------|------------------------|------------------------------|------------------------|------------------------|------------------------|
|       | Product<br>Sig. (Beta)        | Process<br>Sig. (Beta) | Product<br>Sig. (Beta)       | Process<br>Sig. (Beta) | Product<br>Sig. (Beta) | Process<br>Sig. (Beta) |
| RRDIN | .000(2.172)***                | .811(-.132)            | .380(.772)                   | .091(1.259)*           | .009(1.018)***         | .001(1.233)***         |
| RRDEX | .630(.246)                    | .818(.088)             | .076(1.330)*                 | .778(.133)             | .826(-.101)            | .916(-.042)            |
| RMAC  | .431(.398)                    | .022(.949)***          | .504(.510)                   | .067(1.035)*           | .003(1.113)***         | .000(1.391)***         |
| ROEK  | .544(-.396)                   | .272(.501)             | .693(-.363)                  | .759(-.173)            | .182(-.652)            | .620(-.200)            |
| RTR   | .781(.139)                    | .076(.683)*            | .813(.158)                   | .040(1.005)**          | .948(.025)             | .002(.986)***          |
| RMAR  | .007(1.439)***                | .109(-.667)            | .764(-.234)                  | .191(-.765)            | .000(2.109)***         | .814(-.089)            |
| RDSG  | .139(.846)                    | .559(.236)             | .037(1.696)**                | .776(.162)             | .125(.714)             | .410(-.323)            |



|        |                |                |                |               |                |                 |
|--------|----------------|----------------|----------------|---------------|----------------|-----------------|
| RPRE   | .102(.910)     | .049(1.097)**  | .007(2.149)*** | .353(.590)    | .001(1.156)*** | .036(.709)**    |
| SENTG  | .000(1.791)*** | .011(1.209)**  | .071(1.130)*   | .217(.717)    | .002(1.171)*** | .001(1.196)***  |
| SSUP   | .988(-.009)    | .001(1.314)*** | .063(1.061)*   | .107(.721)    | .346(.300)     | .000(1.156)***  |
| SCLPR  | .001(1.474)*** | .453(.281)     | .228(.660)     | .889(-.068)   | .001(1.211)*** | .293(.375)      |
| SCLPU  | .013(1.529)**  | .839(.085)     | .281(.804)     | .265(-.611)   | .030(1.064)**  | .415(-.359)     |
| SCOM   | .851(-.091)    | .048(-.765)**  | .430(.447)     | .771(.138)    | .367(.297)     | .475(-.237)     |
| SINS   | .992(-.007)    | .816(-.151)    | .872(-.151)    | .854(.126)    | .436(-.339)    | .619(.219)      |
| SUNI   | .134(.773)     | .322(.391)     | .973(-.019)    | .449(.345)    | .006(.901)***  | .000(1.220)***  |
| SCON   | .103(.897)     | .864(.073)     | .124(.947)     | .011(1.305)** | .447(.264)     | .320(.338)      |
| SJOU   | .627(.264)     | .663(.182)     | .672(-.275)    | .774(-.152)   | .307(.358)     | .109(.552)      |
| SPRO   | .020(-1.601)** | .448(.421)     | .949(.047)     | .758(.179)    | .716(-.155)    | .522(.259)      |
| CMPAT  | .096(.851)*    | .405(-.338)    | .698(.319)     | .264(-.728)   | .133(-.659)    | .184(.523)      |
| CMUPAT | .874(.120)     | .563(.293)     | .567(.489)     | .392(.546)    | .003(1.394)*** | .060(.817)*     |
| CMRCD  | .035(-1.710)** | .650(.250)     | .831(.286)     | .945(.048)    | .719(-.189)    | .485(-.344)     |
| CMCO   | .241(.762)     | .857(.079)     | .845(-.168)    | .681(.222)    | .030(-1.010)** | .007(-1.139)*** |
| CMCTM  | .295(.552)     | .797(-.107)    | .020(1.939)**  | .606(.287)    | .001(1.355)*** | .300(.383)      |
| CMLTAD | .081(.860)*    | .127(.780)     | .008(1.755)*** | .489(.400)    | .002(1.307)*** | .008(1.062)***  |
| CMCPX  | .007(1.354)*** | .780(.123)     | .381(-.669)    | .018(1.331)** | .065(.769)*    | .264(.441)      |
| CMSEC  | .816(.108)     | .055(.808)*    | .091(1.237)*   | .538(.338)    | .152(.521)     | .031(.734)**    |

*Source: own*

## 4 Discussion

Results of the analyses showed that determinants influencing enterprises product and process innovations differ according to the size of enterprises. Therefore, there is a need for subsequent analyses because relationship between innovations and firms size represents an important factor (see e.g. Hwang et al., 2015). On the other hand, some factors are the same across industries and across small and medium enterprises as well as across whole industries. These factors are, mainly, research and development activities undertaken by enterprises to create new knowledge or to solve scientific or technical problems (include software development in-house that meets this requirement) – in-house R&D. These results are in agreement with previous analyses that stated the importance of in-house R&D expenditures in the process of creating innovation outputs (Catozzella & Vivarelli, 2014), also within SMEs (Newman et al., 2015). In addition, selected information and co-operation sources, specifically internal (within enterprise or enterprise group) and selected external (e.g. clients, customers, and suppliers) influenced enterprises' innovation activities. Clients and customers and their important role are pointed, e.g., by the Lead-user theory (Franke et al., 2006). Patents, lead-time advantages, complexity of goods or services and trademarks represent most significant methods for maintaining or increasing the competitiveness of product and process innovations in this study.

The authors proposed some practical implications both for enterprises within different industries and for policy makers on general level. In Electrical industry, it is possible to recommend support of firms' R&D activities, specifically internal activities and expenditures undertaken by enterprises to create new knowledge or to solve scientific or technical problems. Firms should properly choose their sources of information and co-operation for product and process innovation (e.g. suppliers, clients or customers) and use trademarks, complexity of goods or services and lead-

time activities. Similarly, the diversification of public aid and public finance schemes by enterprise size should be recommended. It is obvious that in this industry the problems vary according to the size of the enterprise. Especially in the case of medium-sized enterprises, there were unspecific problems in financing the scientific and research activities of their product and process innovations. Similarly, these businesses are unable to use their capabilities in new knowledge and information. Public incentives to co-operate with the knowledge industry, or incentives for new knowledge-based projects, can help.

In Chemical and Pharmaceutical industries, R&D activities and expenditures play an important role in the process of influencing product and process innovations – mainly, market introduction of innovations and acquisition of machinery, equipment, software & buildings. Enterprises' internal sources (within enterprise or enterprise group) should be supported. Patent activities, copyrights and lead-time activities represent important factors supporting innovation activities. The results have shown that in the industrial sector (unlike the electrical industry), businesses (irrespective of size) can use their research and development capacities. This area appears to be fully saturated and does not require modification. On the contrary, it was found that all sizes of the enterprises were unable to use the sources of information. Again, it is probably the specificity of this industry. Authors encourage more public policy makers to work with the academic sector.

In Metal industry, similarly to other industries, enterprises should primarily focus on the activities and expenditures for product and process innovations and on proper finding of sources of information and co-operation. In this industry, the biggest differences between small and medium-sized enterprises are again seen. There is a diversification of input variables into production chains. This is due in particular to the specificities of this industry, which must also be reflected in future public policies that will aim to restructure the entire sector due to its small competitive advantage in a globalized world. Public sector attention must be focused primarily on workers and their qualifications for potential industrial change.

## **Conclusion**

The practices of the European countries, as well as the practice of the whole EU, confirm the importance of SMEs for the local, European as well as the global markets. SMEs are an important employer, a creator of added value and GDP. Innovation makers as they are, SMEs absorption of innovation are significantly assisted by the entrepreneurial environment, globalization tendencies, rapidly changing technological issues of the environment as well as other determinants. That is why Governments offer to SMEs some subsidies or benefits to enable them to gain the basic attributes that are necessary for innovation activities. Two fundamental questions remain: (a) whether public policies are focused on the right segment of SMEs and their innovation activities and whether policies are able to help to create innovation, (b) whether firms consider public support to be beneficial and they are interested in despite the connected bureaucracy.

Generally, authors proposed implications for SMEs across industries and point out the factors that are same and influence enterprises' innovation activities. Small

enterprises should primarily focus on the activities and expenditures for product and process innovations, specifically: a) in-house R&D; b) acquisition of machinery, equipment, software & buildings. Within medium size enterprises, training for innovative activities represent most important determinant of product and process innovation activities. Authors showed that different determinants have different influences on both product and process innovations. Analysed determinants have a much stronger effect on product innovations. An interesting result is that the determinants of small businesses seem to be consistent with the major determinants of the entire industry. Medium enterprises are clearly influenced by other determinants (these must be the subject of further research). This result has to be taken into account in practical implications, or taken into account in the country's industrial policy focus. The results of our study should be seen in the context of the German economy. On the other hand, benchmarking can be used as a basis for international comparison.

Finally, it should be remembered the limitations of this study. We work with obsolete data that does not allow defining implications, conclusions, and recommendations for the current present. On the other hand, analogy can be used as a scientific method that builds on the knowledge of the past in order to define more effective measures in the future. Defined conclusions, in the author's opinion, are generally valid and occur to a similar extent in other EU countries even today.

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