Sources of ideas for new products, product complexity and innovation results

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Abstract

Sources of innovation are temporarily unexplored, since the majority of research was conducted prior to the year 2010, mostly in developed countries. Developed countries in these research show significant innovation sources in own R&D, customers and suppliers. On the other hand, developing countries largely depend on OEM for production process improvement and incremental innovation. This work contributes to the literature by analysing two transition countries Slovenia and Croatia. We argue that globalisation of manufacturing has actually changed the sources of innovation since last studies. We contribute to this literature gap by exploring recent data from European Manufacturing Survey 2012.

Keywords: Innovation sources, new product development, European manufacturing survey

Introduction

Today's companies are experiencing significant pressures from increased levels of competition, rapidly changing market requirements, higher rates of technical obsolescence, shorter product life cycles and the growing importance of meeting the needs of increasingly sophisticated customers (Shepard and Ahmed, 2000). This is even more challenging for transition countries like Slovenia and Croatia recently joining the EU community. They have to compete globally because their home markets are too small. They have to differentiate themselves from cheaper China products that are now of far better quality than a decade ago. One way to differentiate is a good price for quality ratio and innovation.

Chandra and Neelankavil (2008) name sources of ideas for innovation: customers and own R&D in developed countries, while in developing countries there is a far more need for incremental innovation. Pejić Bach et al. (2015) on CIS 2008 data show that innovation sources differ in countries. They compared sources of innovation in France, Netherlands and Croatia. For example, it was shown in their research that conference and trade shows are nonsignificant for Netherlands and Croatia. Liu (2014) researching China shows still high dependence of Chines manufacturing on OEMs. Van Hemert et al. (2013) show a significant positive innovation effect as a result of cooperation of Dutch

manufacturing companies with universities and private research establishments. Their research is conducted on data for the period 2006-2009. In Cotič Svetina and Prodan (2008) research of 303 European companies the authors found out that internal sources of ideas for innovation dominated. In their work it is not mentioned when was the research conducted, but it is surely before year 2008.

According to Mikelsone and Liela (2015) literature research, internal idea management was especially pronounced from 1982 to 2006. Since 2006, external focus of generating ideas and information started to emerge with its peak in 2009. Especially in 2009 open innovation became popular as source of innovation and much was written on external sources of innovation. However, since 2009 number of research investigating the sources of innovation has fallen, together with the idea that open innovation can solve all problems. Our question is, do comapnies in transition countries as Slovenia and Croatia find their ideas internally as in developed countries or, from customers as in developing countries (Chandra and Neelankavil, 2008).

Florén and Frishammar (2012) state the difference in idea generation for incremental or radical innovation. While ideas for incremental innovations might come from customers, radical innovation depend more on creativity of individuals. Success of a product depends on the idea, but also on collaborative process in turning ideas into concrete products. Tödtling; et al. (2009) and Freel and de Jong (2009) were among the first to differentiate type of innovation and source of information. We research how these sources of innovation ideas differ for incremental and new to the market (radical) innovation.

Finally, there is the question how to measure innovation. Most research (as in example of CIS data) only measure if a company introduced a new product. In EMS survey, which is more detailed, there is also an objective measure of innovation in terms of revenues generated by new products. Therefore, in our investigation we add value to the analysis considering also revenues as a proxy of innovation success.

Theoretical background

Sources of ideas

OSLO manual (OECD 2005, 78-80) defines sources of information for innovation activities as internal sources of information (R&D, marketing, and production departments etc.) or external sources (customer/user, supplier, research units, conferences, scientific papers etc.). Every innovation starts with an idea (Chandra and Neelankavil, 2008). An "idea" is an opportunity to create value through further investment (Terwiesch and Ulrich 2009) or a recognized opportunity (Florén and Frishammar, 2012). An idea may be recognizing a new need; a new modified product providing a solution to an existing need; an existing solution that could meet needs from new markets; and ideas evolve over the course of the innovation process (Kornish and Ulrich, 2014). An idea/ideas emerge through iterative process after identifying a problem (Harvey, 2014), or opportunity identification (Koen et al., 2014). Moreover, these sources of information will differ depending on the type of innovation (Florén and Frishammar, 2012).

New products

According to Oslo manual (OECD 2005, 32) product innovations are divided into new improved products and products new to the market or radically new products:

- An improved product "is an existing product whose performance has been significantly enhanced or upgraded. A simple product may be improved (in terms

of better performance or lower cost) through use of higher-performance components or materials, or a complex product which consists of a number of integrated technical sub-systems may be improved by partial changes to one of the sub-systems".

- A new product "is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. Such innovations can involve radically new technologies, can be based on combining existing technologies in new uses, or can be derived from the use of new knowledge".

From the above definitions, it can be seen that that indeed different sources of ideas are necessary for those two different types of innovation. In EMS research, the consortium accepted terms new product – defined as improved product by Oslo manual, and product new to the market – defined by new product in Oslo manual. This unfortunately brings a problem that a product new to the market in Croatia is not necessarily a new to the global market.

Size of the company

There is a difference in innovation output in small and large firms (Krawczyk, 2013; Varis and Littunen, 2010; Laursen and Salter, 2006). Bigger companies have larger and better R&D background, more staff, suppliers, customers that are all sources of innovative ideas. Size of a company is considered as a contingency because size of a company in terms of number of employees does not change overnight and depends on labour market and overall conditions of the economy. Therefore, size of the company is considered as a control variable and a contingency, and is expected that larger companies will have more benefit in terms of generated revenues from new products.

Complexity of the product

Complexity is usually measured in number of components, newness, or number of functions designed into the product (Griffn, 1997; Murmann, 1994; Novak and Eppinger, 2001). However, Kim and Wilemon (2012) in their research found that this complexity also brings new growth opportunities in (58% of responders), and possible competitive advantage (59.4% of responders). Caniato and Größler (2015) researched product complexity in new product development (NPD). Although, as Kim and Wilemon (2012) show, complexity of the product should increase new product potential developments, Caniato and Größler (2015) found no impact of complexity on new product performance measures. The impact of complexity on manufacturing performance has not been clearly articulated in the previous empirical studies despite the widely expected negative relationship between them (Park and Okudan Kremer, 2015). For example, Paulonis and Norton (2008) and Burkett (2008) show that the higher is complexity of products, more complicated is the supply chain and with that raises the risk of operating performance failures. Vachon and Klassen (2002) show that the more complex is the product it might lead to poor delivery performance. Ferrer and Ketzenberg (2004) observe that the lead time increases with the number of parts. By analogy, complexity would also affect new product performance. We hypothesize that complexity of the new product will increase time to market for new product, delaying revenues from these new products, affecting negatively rate of return from sales of new products.

Research methodology

Hypotheses

Our question is, do companies in transition countries, such as Slovenia and Croatia, find their ideas internally as in developed countries or, from customers as in developing countries. New to the market innovations may include new to the world innovations, but it is less likely that such innovations would evolve from our small and less developed countries such as Slovenia and Croatia.

In the form of hypothesis this would be:

- H1a,b: Information acquired through the different sources is positively associated with the introduction of different types of innovation (product/market).
  Since there is still no proof that innovations do in fact generate growth or profitability through objective measures (Varis and Littunen, 2010) in this research we look how different sources of innovation affect revenues from new products. Therefore our second hypothesis is:
- H2a,b: Information acquired through the different sources is positively associated with the revenues from different types of innovation (product/market).
  All this hypotheses are subject to control variables of size and complexity of the product.

European Manufacturing survey

The European Manufacturing Survey (EMS), coordinated by the Fraunhofer Institute for Systems and Innovation Research – ISI, is the largest European survey of manufacturing activities (ISI, 2015). EMS questionnaire is very extensive (8 condensed pages). The survey's questions concern manufacturing strategies, the application of innovative organizational and technological concepts in production, cooperation issues, production off-shoring, servitisation, and questions of personnel deployment and qualification. In addition, data on performance indicators such as productivity, flexibility, quality and returns is collected. The survey is conducted among manufacturing companies (NACE Revision 2 codes from 10 to 32) having at least 20 employees. The main objectives of EMS project are to find out more about the use of production and information technologies, new organizational approaches in manufacturing and the implementation of best management practices (Palcic et al. 2015). The underlying idea of the question design is to have a common part of questions constantly over several survey rounds, to modify other common questions in the respective survey round corresponding to current problems and topics from the field of innovations in production and to give space for some country or project specific topics. The survey is conducted on a three-year basis and new concepts are added to the questionnaire, while obsolete concepts were excluded. The survey round in 2012 had extensive changes especially in the technology part.

In order to collect valid data permitting international comparisons, the EMS consortium employs various procedures recommended by the Survey Research Centre to avoid problems arising from different languages and national peculiarities in terminology. First, the basic questionnaire is developed in English and then translated including backwards translation. Second, in each participating country pre-tests are conducted. Third, identical data harmonization processes is applied (Bikfalvi et al, 2014).

The questionnaire was sent to Chief Executive Officer of the manufacturing company in March 2012, but the filing was done by several persons, usually by operations management and accounting. After two weeks companies are called by telephone and asked to fill in the questionnaire or to name the reasons why they cannot respond to the questionnaire. The questionnaire was sent to all manufacturing companies with over 20

employees (no sampling was needed) and obtained 120 fully filled-in questionnaires which represent an 8% response rate in Croatia and 89 from Slovenia (11,25% response rate). Non-response base was tested with $\chi 2$ test between early and late responders and there was no significant difference between responders. The sample consists of 209 companies from Slovenia and Croatia.

Representativeness of the sample was checked by size and industry and it shows generalizability for Croatian and Slovenian manufacturing.

Measures

Each company was given a possibility to check all the idea generating sources. The proposed sources were R&D/engineering, production, customer service, CEO/plant management, customer/user, supplier, research units, conferences and trade shows. That means a company could have checked more than one source. Each source is coded as 0-not using it and 1-using the source. The dependent variables were questions concerning the innovation results – both for incremental and new to the market innovations. Also for each type of innovation responders had to evaluate share of revenues generated by new products, as well as average development time.

Results

Table 1 presents the number of companies that introduced new products in Slovenia and Croatia.

Table 1 – Number of companies introducing new products by size of the company

	Number of companies introducing a new product*	Number of companies introducing products new to the market*	Share of turnover generated by new products [%]**	Share of turnover from products new to the market [%]**
20-50 employees	35	13	11,558	9,36
50-250	51	19	7,916	8,37
> 250	32	18	9,02	11,88
Total	118 (57%)	50 (24%)	9,396	9,87
* No statistical differences between proportions according to size of the company ** No statistical differences between means of revenues generated by new products between small and large companies				

This descriptive result is not in line with Krawczyk (2013). Poland being also a transition country showed that there is a difference in innovation output in small and large companies. In our sample, neither the number of companies innovating nor revenues from new products differ between small and large companies. Table 1 shows that small companies generate on average 11,6% of revenues from new (incremental) products, and large companies only 9,0% of revenue. However the T – test showed no statistical significance for our sample. The same effect is found for revenues from products new to the market. Small companies on average generate 9,4%, while large companies on average 11,9%. Again, the Student T-test showed no significant difference.

Table 2 presents the researched sources of ideas for new product, developed in accordance to OSLO manual.

Table 2 – Sources used for idea generation

	Idea comes from	% of companies using that source
Internal sources	R&D/engineering	39,6
	production	19,3
	customer service	42,1
	CEO/plant management	23,4
External sources	customer/user	70,6
	supplier	14,7
	research units	6,1
	conferences and trade shows	22,8

From the internal sources own R&D (39,6%) and customer service (42,1%) are the dominant source for new ideas. For external sources ideas are primarily collected from customers (70,6%). However, a new product will be generated through an iterative process of problem solving including mostly employees from the company, so final result or an innovation does not solely rely on source of the idea. The role of customer in NPD is well described in Lynch et al. (2016).

As a statistical method we chose regression analysis because it captures synergistic relationships between variables but does not require as restrictive assumptions as, e.g. discriminant analysis. With regression we also avoided one noteworthy impediment identified by Davidsson and Wiklund (2000), who state that using current variables to predict past processes breaks with the principle that the cause must precede the effect. Covariance between variables is also checked, as it is a standard output of the SPSS software package. Multicollinearity diagnosis shows the highest variance inflation factor (VIF) of 3,761 (lower than 10) in accordance with prescriptions of Meyers et al. (2006) and Kutner et al. (2004). Table 3 presents four different regression models, for four dependent variables, used to test our four hypotheses.

Table 3 – Results of four different regression models based on the dependent variable

	Model 1 Dependent variable New products		Model 2 Revenues from new products		Model 3 Product new to the market		Model 4 Revenues from products new to the market	
Idea comes from	Standard. Coeffic. Beta	Sig.	Standard. Coeffic. Beta	Sig.	Standard. Coeffic. Beta	Sig.	Standard. Coeffic. Beta	Sig.
R&D/engineerin	**0,303**	**0,000**	0,076	0,345	**0,167**	**0,036**	0,002	0,983
production	0,049	0,503	0,039	0,615	-0,077	0,316	0,011	0,882
customer service	0,074	0,307	-0,020	0,802	-0,007	0,931	0,145	0,055
CEO/plant	0,079	0,275	0,017	0,829	0,072	0,345	-0,079	0,293
customer/user	**0,163**	**0,020**	0,127	0,092	0,082	0,270	0,031	0,671
supplier	0,017	0,813	0,003	0,968	-0,064	0,394	-0,025	0,738
research units	0,032	0,643	-0,011	0,883	0,099	0,183	-0,055	0,448
conferences	0,093	0,191	0,005	0,948	**7,104**	**0,014**	-0,080	0,281
complexity	0,012	0,865	0,030	0,706	0,058	0,451	**-0,154**	**0,016**
size	0,006	0,938	-0,005	0,953	0,132	0,096	0,069	0,377
R		0,353		0,163		0,456		0,550
R^2		0,124		0,027		0,208		0,302
F		2,917		0,535		5,560		9,198
Sig		**0,003**		0,847		**0,000**		**0,000**

We obtain results that for incremental innovations own R&D and customers are important (Model 1, Table 4). By our descriptive statistics in Table 2, those sources of

ideas are dominantly used. On the other hand, for innovations new to the market own R&D and conferences are important (Model 3, Table 3). So even though descriptive statistics in Table 2 shows that 70% of companies use customers as source of ideas for radical innovations this source does not have an effect. This proves our first hypothesis that different sources will affect different innovations. This might be explained by the fact that incremental innovations are usually some answer to customer's problems. On the other hand, innovations new to the market have to be looked for outside of the company's market, and in our case the most fruitful source for this type of innovation are trade fairs and conferences coupled with already possessed knowledge in own R&D.

Hypothesis H2: Information acquired through the different sources is positively associated with the revenues from different types of innovation (product/market) was not confirmed. Revenues from new products (market success) does not depend on source of innovation. Probably collaboration of different company's departments and marketing are more important to the success of a new product then the source of the idea. This is in line with McAdam and McClelland (2002) who state that idea generation is a different process from commercialisation of a new product. This is in line with Chandra and Neelankavil (2008) who state that the quality of innovation idea is more important than its source. However, an interesting finding was found in generating revenues from products new to the market. It seems that, more complex is the product, less revenue it will bring. One possible explanation is that companies for complex product have to invest a significant amount upfront, and some of revenues from new products are reinvested for that. There is also a question of newness to the market. On the average, in our sample, 54% of products are sold abroad. Are the products new to the market solely for the domestic market or some of these new products represent also new products on exporting markets? This shows that the more complicated is the innovation, more risky are the outcomes. Our findings are not in line with Caniato and Größler (2015) who found no impact of complexity on new product performance measures. We actually have a negative effect on revenues from new products (new to the market) for complex products and the model is significant. This actually proves previous findings that complexity has negative effects.

There is a contradictory result regarding the size of the company. We divided the sample into three groups (20-50 employees 32,5% of companies, 50-250 employees 43,1%, and over 250 employees 24,4% of companies). Our results in Table 3 (significance for the variable size) show that actually introduction of new products (both incremental and radical) and share of revenues do not depend on size. For all sizes, the same innovation sources are used. This might be because our constraint of having at least 20 employees is enough for having at least one person employed for R&D. However, on average, all companies in Slovenia and Croatia have less than 1% employed in R&D. Our findings are not in line with Krawczyk (2013) and Varis and Littunen (2010) who show that size of a company matters.

Conclusion

This paper contributes to the growing body of literature on the innovative activities and information sourcing practices of firms in a regional context. Our main objective was to find out whether different sources of information and different cooperative relationships are associated with the introduction of different types of innovation in two transition countries; Slovenia and Croatia. Furthermore, we also analysed whether the performance, in terms of share of revenues from new product, is related to the introduction of different types of innovation.

In general, our findings give support to the recent studies suggesting that the introduction of different types of innovation is indeed associated with the utilization of

different kinds of information sources and collaborative relationships (Varis and Littunen, 2010; Bigliardi and Dormio, 2009; Tödtling; et al., 2009; Freel and de Jong, 2009). For both type of innovation (incremental or market) we found different sources as important for innovation. For modified products own R&D and customers are important while for market innovations R&D and conference and trade fairs are important. This finding however, proves the necessity of R&D as a vital component to innovation (whether incremental or market) in contrast to findings of Varis and Littunen, (2010) who find that small companies can be innovative even without own R&D. Our finding is in line with absorptive capital literature (Cohen and Levinthal, 1990), that knowledge (possessed in one's own R&D department) is necessary for adding value to new information from other sources.

Our findings are contradictory when size of the company is in question. For incremental innovation, irrespective of size R&D and customers are the primary source of innovation. This might be maybe explained by our constraint that we do not look at micro companies having less than 20 employees. Maybe having 20 employees is enough for having at least one person in R&D. On average less than 1% of employees are employed in R&D.

Revenues from different types of innovation (product/market) do not depend on source of innovation. Probably collaboration of different company's departments and marketing are more important to the success of a new product then the source of the idea. This is in line with McAdam and McClelland (2002) who state that idea generation is a different process from commercialisation of a new product, and in line with Chandra and Neelankavil (2008) who state that the quality of idea is more important than its source. However, our results are not in line with Koen et al. (2014) who did find significant positive relationships between opportunity identification and innovation results both for incremental and radical innovation. However, their research is a unique three yearlong longitudinal project, hard to replicate.

Interesting anomaly was found in generating revenues from products new to the market. It seems that, more complex is the product, less revenue it will bring. One possible explanation is that companies for complex product have to invest a significant amount upfront, and some of revenues from new products are reinvested for that. This shows that the more complicated is the innovation, more risky are the outcomes. Therefore, as contingency are affected, only complexity of the product matters.

Acknowledgement: This work is supported by Croatian National Foundation, Grant no. O-1861-2014-3535.

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