Ways to Boost Firms' Innovation within Innovation Ecosystems: Case of European ICT Firms

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Abstract: Latest studies show that innovation ecosystems have a significant impact on the ability to innovate and the firms´ innovation absorption in different regions of the world, as well as in various industries. Therefore, the development of innovation ecosystems is at the forefront of interests of both entrepreneurs and the public sector and elected representatives. ICT firms are an important segment in all developed countries. These are firms that depend on the ability to produce innovation. Therefore, in this segment, it is possible to realize the research focused on the impact and significance of the various determinants of innovation ecosystems. The aim of this paper is to analyze the various determinants of innovation ecosystem within ICT industries in 10 European countries. It is possible to find determinants influencing ICT firms' innovations across EU countries. We have found that "information resources" and "ability to co-operate" are main determinants with the highest influence on innovation outputs (and or course on firms´ competitiveness). Knowledge transfer from academia or in-house research is also other important determinants. However, ICT firms prefer in-house research or purchasing knowledge in the open market. The results can be used for definition of political implications and for preparing public policies, including government spending programs.

1 INTRODUCTION

In the rapidly changing globalized world, firms are pushed to find new sources of competitive advantage. Innovations play a key role and represent one of the most recognized sources of this competitive advantage, specifically within information and communications technology (ICT) industries. Innovations in these industries are substantial and increasingly seen as an important determinant of the competitiveness of individual regions, but also of entire economies (Lee at al. 2016). Houben and Kakes (2002) conclude that ICT investment is a crucial input into the production function of each firm - ICT can affect its productivity and overall economic growth. From this conclusion essential it can be implied that ICT has the potential to influence the growth of individual economies, including different macroeconomic indicators. These statements are supported by the conclusions of other studies that demonstrate the fundamental impact of ICT on the production of innovative production (Jorgenson et al., 2011; Kim et al. 2014; Díaz-Chao et al., 2015). Therefore, firms entering ICT markets must dynamically respond to the changes (on the supply and/or demand side), flexibly adapt to them, or find various ways to come up with innovations within their innovation ecosystems.

Formerly, firms have primarily focused on their internal sources (such as R&D and creativity) to respond issues mentioned above and to protect their original knowledge and competitive advantage. It is clear from observing the practice that many companies are not willing to make major restructuring changes. These companies prefer to maintain their current status and often do not invest in their development and competitiveness (Narula, 2002). However, this "lock-in strategy" brings not only advantages but also disadvantages such as inability to share knowledge, the costs of research and development and significant investments into R&D facilities and technologies (Prokop and Stejskal, 2017). On the other hand, firms that are part of business networks, business clusters, or regional innovation systems see various opportunities for self-development (can compare their situation with This paper aims situation of other interrelated firms) and that offer to firms a

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variety of ways to boost their innovation potential and to create successful innovations. Interactions (external and internal) between firms in network as well as between other entities (e.g. universities, scientific research organizations, governmental and support bodies, etc.) create an important entrepreneurial ecosystem based on cooperation and knowledge transfer, which many innovative theories (open innovations, triple-helix etc.) considers as a basis for the ability to generate commercialize changes (Jiao et al. 2016).

Aforementioned drivers of innovations, however, influence firms' performance in different ways. This leads to the situation that not every firm achieves successful innovations within its innovation environment. Therefore, the ability of a firm to produce successful change varies greatly and depends on its ability to exploit potentially available resources (including ICT as a crucial production factor). These differences in the use of production factors are often linked to the quality and efficiency of the functioning of regional innovation systems or ecosystems (Nam and Barnett, 2010). Our study is therefore focused on analysis within ICT industries in 10 European countries (the Czech Republic, Cyprus, Bulgaria, Estonia, Slovenia, Croatia, Hungary, Lithuania, Portugal, and Romania) together. It allows us to find innovation determinants influencing ICT firms´ innovation across these countries and to provide benchmarks and practical policy implications.

This paper is structured as follows. Next part includes a literature review focused on innovation determinants and ecosystems. Third part describes data and methods. Next, results are shown and discussed. In the last part, we discuss conclusions and implications for firms and innovation policies.

2 LITERATURE BACKGROUND

Hundreds of research studies around the world have shown that innovation is a key driver of competitiveness and economic growth. The dependence between the firm's ability to generate innovation and its economic success and the firm's economic growth has been demonstrated. Khin et al. (2010) show in their study that there are significant differences in the ability to generate output in ICT firms through new products or services. ICT firms that are unable to generate innovation lose their competitive advantage, do not reach high sales and lose their market share in (often international) markets. On the contrary, the production of innovations provides an advantage over other firms; it strengthens the market position and has the potential to increase the market share and profit of the firm. That´s why, innovations contribute to other economic subjects such as customers (or society as a whole) and strengthens the knowledge economy attributes. To achieve the described benefits, it is essential for the firm to apply the innovation approach responsibly, and (i) be willing to react dynamically, (ii) have a strategic plan involving the production of innovations as an important corporate aim, and (iii) have internal processes adapted to innovations production. Moreover, firms are not isolated and therefore they must to deal with the rapidly changing innovation ecosystems including external economic subjects to collaborate with and bring important knowledge assets to the firm as inputs to innovation processes (Pellikka and Ali-Vehmas, 2016).

The described processes occurring in innovation ecosystems have gradually caused a high dependence of economic entities (including firms) on information and communication technologies and services (Yunis et al., 2018). Innovative ecosystems are systemic and complex systems that emphasize the importance of links between collaborators (both internal and external), among which information but also knowledge transfer takes place. The ability to make effective use of ICT differentiates individual roles in the ecosystem (including, for example, the role of government as a rule maker or innovative policies, financial schemes, and frameworks) (Oh et al., 2016). By participating in the innovation ecosystem, the firm can successfully face various challenges (whether external or internal) (Adner and Kapoor, 2010). On a number of circumstances and influences that come from external environment (exogenous: industry, strength of globalization, increased dependence on ICT, willingness to cooperate in a given industry, etc.), or from internal firm environment (endogenous: quality of workers, setting up innovation processes, firm strategy, management, etc.) (Verbano et al. 2015). Endogenous variables can be influenced by behavior and decision making of the firm. Moreover, thanks to these variables, the firms are fundamentally different. Ketata et al. (2015) emphasizes that the ability of a firm to produce sustainably innovation is precisely the ability of the firm to work with the external and internal variables of the firm's innovative ecosystem. Following arguments above, we propose own conceptual framework (see Fig. 1) that include both external and internal factors, operating within firms´ innovation ecosystems that

represent most recognized determinants of innovations. These are information sources, cooperation, research and development, creativity and skills. Scholars agree that the ICT industry is very specific based on the Schumpeterian patterns of innovation. Firms in the ICT sector have high opportunity applications and diversified knowledge base with high variability over time, short product life cycles and rapidly changing technologies. This corresponds to the fact that ICT firms face rapid technological change and, therefore, are heavily involved in R&D and cooperation activities whose intensity seems to be a central moderator of innovations (Stejskal et al., 2018; Bustinza et al., 2019). Collaborating with supply chain partners, competitors, universities, research organizations, and governmental bodies leads to synergies, spill-over effects (including knowledge spill-over effects) and faster and cheaper innovation (Tojeiro-Rivero and Moreno, 2019). A number of other studies have shown that a the amount of knowledge that a firm obtains from various information sources (from clients, consultants, universities, scientific journals, conferences etc.) is an important determinant of innovative absorption and capacity. Creativity and different types of managerial skills are other determinants of this group (Leiponen and Helfat, 2010).

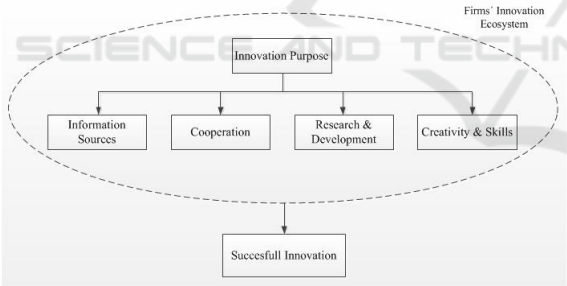

Figure 1: Conceptual framework

To find innovation determinants influencing ICT firms´ innovation across selected European countries and to provide benchmarks and practical policy implications, we define following research question: RQ: Which determinants boost firms´ innovation within ICT industries in the EU?

3 DATA AND METHODOLOGY

The study uses survey data from Community Innovation Survey (CIS) 2008-2010. It is a research organized by Eurostat every second year and concerns innovation, science and research questions in different firms in many EU member states (the questionnaire is the same in all participating countries). The CIS questionnaire works with its own definition of innovation: "a new or significantly improved good or service introduced on the market." Variables are binary; therefore, logistic regression analysis was employed.

This allowed to explain the relationship between a set of explanatory variables and discrete responses. The discrete (binary response Y of an individual unit) can be only two values, denoted by 0 or 1. Other studies (Schneider and Spieth, 2013; Prokop et al., 2019)) used the same approach using binary logistic regression models dealt with ICT industries in the following countries: the Czech Republic, Cyprus, Bulgaria, Estonia, Slovenia, Croatia, Hungary, Lithuania, Portugal, and Romania. Primary data was truncated by Eurostat during the pre-processing phase. This analysis worked with the pre-processed data set of 10,799 ICT firms. Employed models had to identify the variables that have a significant impact on firms´ innovation production across EU countries (in the research sample). And the analysis uses a combined set of all ten EU countries. This procedure gives the possibility to analyze the results of a whole group of countries and to define the implications that apply in each analyzed country.

Independent variables (inputs) as follow (see Fig. 1) were selected for analysis in accordance with the above-mentioned literary research and data availability in the CIS questionnaire. We also include control variables occurring within firms´ innovation environment.

4 RESEARCH RESULTS

Results in Table 2 show that information sources, cooperation, and R&D represent most significant sources of firms´ innovation within ICT industries in selected countries. More specifically, variables as follows “information sources” in framework of the enterprise or enterprise group, “clients or customers”, “conferences and scientific journals” and “trade/technical publications” are the most significant information sources that positively boost ICT firms´ innovation. The results support the thesis

Table 1. Independent variables

Information Sources	within the enterprise or enterprise group (SENTG); suppliers of equipment, materials, components, or software (SSUP); clients or customers (SCLI); competitors or other enterprises in your industry (SCOM); consultants and commercial labs (SINS); universities or other higher education institutions (SUNI); government, public or private research institutes (SGMT); conferences, trade fairs, exhibitions (SCON); scientific journals and trade/technical publications (SJOU); professional and industry associations (SPRO)
Cooperation	cooperation arrangements on innovation activities (CO)
Research and development	engagement in intramural R&D (RRDIN); engagement in extramural R&D (RRDEX); engagement in acquisition of external knowledge (ROEK); engagement in training for innovative activities (RTR)
Creativity and skills	graphic arts/layout/advertising (SGALA); design of objects or services (SDOS); multimedia - combining audio, graphics, text, still pictures, animation, video, etc. (SMED); web design (SWDS); software development (SSWD); market research (SMKR); engineering/applied sciences (SENAP); mathematics/statistics/database management (SMSDM)
Control variables	national market/other regions of the country (MARNAT); other EU/EFTA/CC market (MAREUR); public funding from central government (FUNGMT); public funding from the EU (FUNEU); enterprise part of a group (GP)

Source: own processing

Table 1 Results of Analyses

		p-value	Beta
Information sources	SENTG	.022**	.115
	SSUP	.000***	-.218
	SCLI	.000***	.315
	SUNI	.741	-.024
	SCOM	.069*	.106
	SINS	.009***	-.148
	SGMT	.200	-.105
	SCON	.004***	.176
	SJOU	.003***	.200
	SPRO	.007***	-.179
Cooperation	CO	.000***	.688
Research and development	RRDIN	.000***	.439
	RRDEX	.776	.034
	ROEK	.000***	.436
	RTR	.000***	.391
Creativity and skills	SGALA	.417	.053
	SDOS	.010**	.172
	SMED	.021**	.153
	SWDS	.948	-.004
	SSWD	.010**	-.152
	SMKR	.461	-.045
	SENAP	.249	.085
	SMSDM	.491	-.047
Control variables	MARNAT	.559	-.071
	MAREUR	.325	-.099
	FUNGMT	.275	.164
	FUNEU	.029**	-.322
	GP	.743	.035

Legend: * statistically significant at p=.10, ** at p=.05 and *** at p=.01
Source: own processing

that ICT firms are dynamic, and their production is dependent on the availability of new information and knowledge. Therefore, the results confirm the assumption that ICT firms will acquire new knowledge in a variety of ways, including knowledge transfer within an enterprise group or transfer from the academic sector (Chen et al., 2018). Based on these conclusions, it is possible to confirm that the knowledge sector is an important cooperation partner for ICT enterprises. Therefore, cooperation and sharing of information allow firms to use different types of knowledge (especially tacit) from internal or external sources and create a new product. ICT firms are aware of the importance of knowledge resources and are trying to use every opportunity to acquire commercializable knowledge. The results confirm the findings of the study (Yunis et al., 2018), which argue that ICT firms must be able to adapt quickly to market changes, customer requirements and wishes, and use all new opportunities to supply the market with their own innovative products. It increases the importance of clients and customers as a significant source of information. Journals, conference papers, and technical publications consequently provide firms with information about new ideas and inventions that are crucial for innovations.

As we mentioned above and showed in Table 2, firms´ research and development represent another significant determinant of ICT innovations. Pieri et al. (2018) stated in their study that research and development (as an activity) has great potential to influence firm innovation processes. Their study confirms the importance of R&D for increasing productivity, economic growth, the emergence of knowledge spill-over effects in cooperative and knowledge-based networks. In our study, we show that internal R&D, gaining knowledge through acquisition and using various types of training are the most significant R&D activities in selected European countries. These results are in accordance with Sakakibara and Porter (2001) which pointed that internal research activities and knowledge acquisition in this form is effective and dynamic for innovation processes of ICT firms.

Variables "training for innovative activities" and "acquisition of external knowledge" increase the potential of ICT firms through the learning processes. In addition, these activities motivate them to connect or interact with other firms in the environment (Huang et al., 2015; Kim, Kim, and Koh, 2014).

Surprisingly, creativity and skills did not play such an important role in the process of ICT firms´ innovation. Design and multimedia are only determinants that helped to boost these activities. No significant relationship was examined for some variables. Obviously, ICT companies are using other assets to generate innovation. It is possible to assume that ICT companies are often focused only on one of the determinants of "creativity and skills", which reduces the meaning of the results. For two variables (market research and engineering / applied sciences) negative relationships were recorded, which can be justified by the low sample rate.

Control variables showed identical results to other studies. The same results are also found for funding from the European Union budget, which leads to an increase in bureaucracy and a high degree of inefficiency due to time delays.

This section also includes limitations of this study. The limitation is mainly due to the quality of the primary data, the frequency of the sample and the restrictions on ICT companies. It can be assumed that the sample is large enough that any statistical errors or deviations will not significantly affect the results. Similarly, it should be noted that the results can only be applied to the research sample, not to all farms.

5 CONCLUSIONS

Our study focused on analyzing the determinants of the innovation ecosystem that ICT companies use to innovate. The results show that many of the determinants examined have a real and real impact on competitiveness and innovative absenteeism. Earlier studies underline the importance of the innovation ecosystem, the results of our study are in line and supportive.

It should be noted that ICT firms in a specific economic environment, the European Union, have been examined. We must confirm that it represents an unconventional market environment where public bodies (both transnational and national or regional) significantly influence the emergence, evolution and functioning of the innovation ecosystem in individual countries as well as across the European Union. In our opinion, this is a non-replicated environment that can be perceived as a laboratory in the context of the global economy.

Our results strongly emphasize the role of cooperation and innovative resources, largely also by the influence of R&D organizations. This is mainly due to the efforts of public policies and strategies tied to European strategic documents, which aim at a high level of competitiveness using

modern technologies and knowledge. This fundamentally affects ICT firms, as these external political processes influence the internal processes of these firms.

The resulting knowledge- and cooperation-based environment significantly influences ICT firms, thus it is creating the significant pressure on other firms (as well as on suppliers or customers). They must adapt and cultivate their knowledge potential to make them attractive to ICT companies. It is therefore a typical manifestation of the existence of triple-helix relations between economic subjects.

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