

The Influence of Public Support on University-Industry-Government Collaboration: the Case of the Czech Republic, Slovakia, Hungary and Romania

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Abstract

European, national governments and regional authorities, in recent times, are actively encouraging technology transfer from universities to industries as a fulfilment of the well embraced “third mission” of universities. To pursue this, governments have mediated this process by enacting and enforcing legislative instruments and efficiently appropriating research outcomes by providing public funding support structures to aid universities in their research commercialization efforts. The paper aims to examine various public funding schemes available for firm’s innovation collaborations and how they influence firm’s cooperation. Using data from the Eurostat’s Community Innovation Survey (2012–2014) and the binary logistic regression model, we found that funding from the central government was a significant determinant influencing firm’s collaborations with universities, other enterprises in the enterprises group and with government research centres. Conversely, funding from local authorities and the EU was largely insignificant in influencing firm’s collaborations with other enterprises and the government. Practical policy recommendations will be also provided to strengthen firm’s collaboration.

Keywords

Public funding, government, university, firms, collaboration, innovation

JEL code

H5, H7, O30

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INTRODUCTION

Funding of research and development activities as part of supportive public policies for research gradually gained fame after the end of the second world war as an established means of boosting regional innovation and growth. Fueled by the linear model innovation, the years following the 20th century, in the European Union witnessed the portion of real gross domestic product apportioned for expanding the foundation of scientific and technological purposes for both private and public entities increasing although stagnated sometimes, it never significantly reduced (David, Hall and Toole, 1999). However, for universities, government support has appeared to have diminished recently (Beaudry and Allaoui, 2012) even as governments in their new-found role, commercialized one sector or collaboratively conducted basic research to generate a stable flow of income to supplement research funds for the academia.

Furthermore, this principle has been furthered on by activists of the new growth theory and has established a strong connection with long run economic growth and endogenous forces such as human capital, knowledge spill-over from interactions of regional players and information technology. Chiefly hinged on the reliance of knowledge as an asset with no diminishing return, it is believed that the creation of interactive relationship between firms and institutions that provide human capital, i.e. universities, coupled with the support of funding institution activates knowledge sharing and transfer among these players, generating new and innovative ideas when merged with current knowledge and consequently boosting productivity and growth in knowledge-based economy.

In an effort to assess the relevance of public support, Schneider and Veugelers (2010) attempted to discover the public policy measures that had been implemented across the European Union to support Young Innovative Companies (YIC's) and found newness, smallness and high R&D (research and development) intensity of such firms made them highly innovative with access to finance very crucial. Falk (2007) also surveyed 1 200 Austrian firms to identify the degree of need of public funds and concluded that increased innovation inputs do not necessarily lead to more innovation output and, in a similar way, behavioral changes which he termed as constituting only of intermediate results should be economically justifiable either at the micro or macro-level. Other researches have focused on the design and impact of public policy measures oriented at boosting technology transfer activities and university-industry relations, specifically those that hinged on official processes such as licensing, trademarks, patenting and generation of spin-offs (Goldfarb and Henrekson, 2003; Mustar and Wright, 2010). However, they were criticized as focusing only on single country experience (Kochenkova, Grimaldi and Munari, 2016).

Considering the relevance of collaborative research among enterprises (Stejskal, Meričková and Prokop, 2016), among universities (Bozeman and Slade, 2013), inter-sector scientific collaboration (Lakitan, Hidayat and Herlinda, 2012) the synergetic effects of collaboration and widespread essence of knowledge spillover arising (Acs and Audretsch, 2010) and its essence widely entrenched courtesy of the New growth theories, the goal of this research is to assess the impact of public funds – local, national and supranational – on collaborative research of enterprises, universities and public organizations among selected Eastern European countries.

The remainder of the paper is structured as follows: the next sections deal with the progressive views of public policy support to research, the third sections touches the methodology of conducting the research on the selected countries, fourth section provides details of the discussion on the results acquired and the final part concludes the paper.

1 REVIEW OF LITERATURE

The public sector plays quite important role in providing support to regional players. Public support consists of a myriad of activities performed on behalf of the government such as the catalyst, facilitator and advocate of business ideas, regulation of institutional and organizational activities via legislation and policy structuring, financing public and private R&D activities and even creatively planning the preferred

urban structure of cities at the local level (Herliana, 2015). However, public funding as it is relatively the most obvious and tangible form of public support will be mainly focused on.

Public funding of research and regional innovation attempts have made a critical part of most national and regional innovation support schemes especially in the CEEC, i.e. Central and Eastern European Countries (Radosevic and Lepori, 2009). Their regulatory capacity and financial prowess have eased off the difficulty in sourcing funds for regional players whilst maintaining transparency and accountability in a regional innovation system even as it also complements private funding (Un and Montoro-Sanchez, 2010). Impact of funding for regional players has revealed mixed reactions from various researchers. Lundvall (2010) researched on the National systems of Innovation and various interventions of the public sector in regional innovation systems. Dodgson et al. (2011), in his research, also talked of the public sector as financial contributor to private firms and concurred with Fehr, Rosenborg and Wiegard (2012) on the need for capital funding that are tailored for small and medium sized enterprises. This, he believed, will allow innovative new firms to introduce socially useful products to their market niches.

Research on sources of innovation of manufacturing sectors in Slovakia and Hungary revealed that in as much as firms can acquire knowledge for innovation internally or via cooperation, Slovak firms derived their innovation from in-house activities and other sources such as scientific journals and conferences while Hungarian firms relied on market sources such as cooperation with clients or customers from the private sector for their innovation as well as from scientific journals (Odei and Stejskal, 2018) researched on sources of innovation between Slavic Schakenraad (2013) demonstrated a positive relationship between the formation of technology partnerships and firm-level innovation. His findings also supported the findings of Guellec and Van Pottelsberghe de la Potterie (2002) whose research also revealed a positive correlation between R&D in government labs, universities and market sector total factor productivity growth in 16 OECD countries whilst controlling for other factors. The admonishing of the role of public sector as an active financier in the regional indigenous and exogenous network as well as research of Coccia (2012) concurred to the positive effects of public financial support, underlines the irreplaceable need of public funds to support regional research initiatives even as it is argued to accentuate the evidence of failures of the market. (Lundvall, 2010; Edquist, 2010).

The assimilation of industrial and political interest into that of academia heralded new pathways of collaborative research and equally blurred the traditional role the public sector and the other helices (Benner and Sandstrom, 2000). Although the public sector is now even involved in redirecting academic work oriented to commercial usage (Benner and Sandstrom, 2000) in generating economic growth in the knowledge economy, it possesses a comparably higher capacity in assisting with funding for locally initiated and international collaboration whilst also ensuring better coordination of actors in networks (Lepori, 2011). Firm collaboration has been proven to have extensive impact on firm growth, innovation and regional productivity (Audretsch and Feldman, 2004; Zang, Shu and Malter, 2010; Odei, 2017). Wennberg, Wiklund and Wright (2011) compared university and industry spin offs finding that performance of corporate spin offs in terms of sales growth and survival is higher than university spin offs, but not for employment growth further adding up to the essence of knowledge overflow from sector-wide cooperation. Whilst industrial collaboration with university is adjudged to inject more practical and realistic expectations into the theoretical knowledge imparted, there is also the fear that such alliance could rather affect the research output of universities (Feller, 2005; Garvey, 2014). Consequently, if such perceivably detrimental alliances are continuously viewed as inimical to the diffusion and open access of knowledge, it may risk changing the perspective of policy makers that seeks to favour collaborative alliance to rather opt for the short- term pros of industrial research rather than the more informative findings from collaborative research (Dosi et al., 2006).

In the CEEC, funding patterns changed in the last two decades owing more to economic restructuring and two systemic changes: opening of previously closed research systems and the introduction

of the principle of quality (Radosevic and Lepori, 2009). Institutional uncertainty including disrupted production, technology and trade linkages hindered funding in the early 90's, however, incremental institutional changes in the early 2000's coupled with an increasing international assistance, accession plans into the EU despite a reducing public funding, did boost the growth and has continued up till now. GERD/GDP increased with the injection of EU structural funds among CEEC, especially in the Czech Republic and Estonia (Radosevic and Lepori, 2009). Currently, the introduction of Horizon 2020 EU funding program for research and development and prior ones have added to the comprehensiveness of funds for transnational research, industrial and entrepreneurial support, not just to academia and firms but also to the local and regional authorities. As funds from the public sector have a higher potential of ensuring effectiveness due to their control capacity and reliability, it becomes curious to assess their tendency to influence firms to research collaboratively with regional players even as it is proven to have multiplier effects on regional productivity.

Regarding the impact of the public funds on these regional players, Kang and Park (2012) assessed small- and medium-sized biotechnology enterprises (SMEs) in South Korea for the impact of governmental support on output and found direct and indirect influence of governmental support on the innovation output of SME's in biotechnology. Guo, Guo and Yang (2016) also found firms performing significantly better technologically and in commercializing outputs compared with other firms. Bruneel, Deste and Salter (2010) drew data from a large-scale survey and public records to research on the barriers of university-industry collaboration in UK. Results revealed that collaborative research lowers orientation-related barriers and that higher levels of trust reduced barriers of universities orientation and to the transactions involved in working with partners of these universities. Aside financial incentives, incubation support in the form of science parks, entrepreneurial support, venture capital has a positive influence on universities spin off activities (Odei and Stejskal, 2018); Teodorescu and Andrei (2011) also researched on cooperation of Eastern European countries regarding scientific literature and found international cooperation in science and social sciences becoming more frequent and extensive, playing far greater role today in the production of scientific knowledge in these countries. Tochkov and Nenovsky (2011) researched on efficiency of public funds in the educational system in Bulgaria and revealed inefficiencies in public schools compared with private schools. Ebersberger (2005) also researched on impact of public funding on innovation efforts of Finnish firms focusing on input and output additionality. He concluded that on average, public funding increases private innovation efforts of firms that received the funding, in both nominal and real terms. Public funding was also found, average, to increase the innovation output of funded firms but ultimately this sort of funding was considered to be most efficient when meant to stimulate collaborative innovation activities.

However, in as much as several scholarly researches on these countries have been conducted, most of them have focused on their growth over the past decades (Radosevic and Lepori, 2009; Kozak, Bornmann and Leydesdorff, 2015). There has not been an extensive assessment of the exclusive impact of funds from a defined public sector on collaboration in CEEC in a triple helix context: enterprises, universities and public institutions. It is sought to assess the impact of respective public funds ranging from the local, national and European Union perspective on collaboration of firm's collaborative research with enterprises, universities and public sectors in selected Central and Eastern European countries. This research intends to prompt the various inquests and checks on the dissemination of funds, their defined usage versus actual usage to improve accountability and ensure effectiveness of funds if the contrary is proved. The objective is to identify the impact of Local, National and supranational funds on collaborative scientific research involving universities, industries and the government (Public). Based on findings which revealed firms as initiators of cooperation (Goet et al., 2017) and knowledge capabilities increases with bigger public funding (Aschoff, 2010; De Blasio, Fantino and Pellegrini, 2015), we establish the hypothesis that:

H1a: Local public funding has a significant influence on affecting firm collaboration with other firms.

H1b: Local public funding significantly influences firm collaboration with universities.

Un and Montoro-Sanchez (2010) also asserts due to the control prowess of the public sector and the consistent transparency and accountability checks at the regional and National level, firms are forced to align such funds even more with the intended purposes. Hence the following hypothesis:

H1c: Local public funding does not influence firm collaboration with government research firms.

H2a: National funding does influence cooperation of firms with other firms.

H2b: National funding significantly affects firm collaboration with universities.

H2c: National funding does influence firm cooperation with government research institutes.

As Bronzini and Iachini (2014) suppose that business usually prefer to invest in cooperation with internally generated funds and may even acquire other knowledge in national and international markets, we further hypothesise that:

H3a: European Funds are not significant in instigating firm cooperation with other firms.

H3b: European funds do not influence firms to cooperate with universities.

H3c: Funds acquired at the European level does not influence firm cooperation with government research centers.

2 METHODOLOGY AND SOURCES OF DATA

Data for the empirical analysis was taken from the Eurostat's Community Innovation Survey (CIS) conducted between 2012 and 2014. In the Community Innovation Survey, firms are asked to indicate their sources of funding and partners they collaborate with. Many studies have used the CIS data to study firm level innovation, public support and firm's collaborations (Prokop et al., 2017; Archibugi and Filippetti, 2018).

Given the binary character of the dependent variable (firm's collaborations with other entities) the logistic regression model was used. The goal of logistic regression model is to examine the best fitting model to describe the relationship between the dichotomous dependent variable and a set of independent variables (Harrell, 2015). The logistic regression is often used if the independent variables contain a mixture of both continuous and categorical variables (Dayton, 1992; Hosmer and Lemeshow, 2000,). In our study, the probability of a dichotomous outcome (e.g. cooperation or non-cooperation) is related to a set of explanatory variables (financial determinants of R&D, see Table 1). The reduced form of the binomial logistic model can be expressed as:

$$\text{Co_op} = \beta_0 + \beta_1 \text{FUNLOC} + \beta_2 \text{FUNMGT} + \beta_3 \text{FUNEU} + \varepsilon, \quad (1)$$

where Co_op represents firms' cooperation, β_0 is the intercept term, β_1 , β_2 , and β_3 are the coefficients associated with explanatory variables of local funding (FUNLOC), national funding (FUNMGT) and funding from the European Union (FUNEU) and ε is the error term. A positive intercept means that barring all independent variables, there is still a likely probability of occurrence of the event and the higher the figure, the higher the likeliness; a negative one however, explains that barring all interference of the independent variable, there is an unlikely probability of occurrence of the event. The more negative it is, the more unlikely it is to occur. A positive beta coefficient means that the log of odds increases as the corresponding independent variable increases. Negative beta coefficient, on the other hand, denotes an unlikely occurrence of the event as the independent variable increases. Three dependent and independent

variables were selected for this research. The independent variables were mainly financial variables classified by their source: namely local, national and European Union funding provided to support research activities research activities of enterprises, universities and government research centres. These have been duly explained in Table 1.

Table 1 Variables used in the model

Independent Variables	FUNLOC, FUNGMT, FUNEU
Dependent variables	CO11, CO61, CO71

Note: FUNLOC – Funding from local government, FUNGMT – Funding from National state, FUNEU – Funding from the European Union, CO11 – Firms collaboration with other firms, CO61 – Firms' collaboration with Universities, CO71 – Firms' collaboration with government research institutes.

Source: Author's own compilation

3 RESULTS AND ANALYSIS

The focus of this paper is to analyse how public support influences firm's collaboration. Probability of three main sources of funding and how they influence firm's collaborations within the enterprise group, with universities and with government research centers was analyzed. The results are shown in Table 2.

Table 2 Effect of funding on firms' collaboration within the enterprise group

Country	Romania	Czech Republic	Hungary	Slovakia
	β (p value)	β (p value)	β (p value)	β (p value)
	Tjur r^2 -0.06	Tjur r^2 -0.16	Tjur r^2 -0.20	Tjur r^2 -0.76
Constant	-3.158	-2.439	-2,122	-2.491
FUNLOC	0.305 (0.694)	0.072 (0.834)	-0.188 (0.765)	1.537 (0.093) *
FUNGMT	0.895 (0.051) *	0.323 (0.048) **	0.175 (0.400)	1.402 (0.003) ***
FUNEU	-0.408 (0.474)	-0.448 (0.011) **	0.161 (0.404)	0.176 (0.696)
Number of observations	7 662	5 449	5 152	2 888

Note: *** significant at $p < 0.01$, ** significant at $p < 0.05$, * significant at $p < 0.10$.

Source: Own calculation

From Table 2 it can be evidenced that funding from local or regional governments influenced firm's collaborations with other firms in the enterprise group. This was statistically significant and positively influenced firm's collaborations in Slovakia thereby fulfilling *H1a*. This meant that Slovak firms that received local funding were more likely to collaborate with other enterprises in the group. Slovak firms cooperating receiving local funds are highly likely to increase with increased local funding. In countries like the Czech Republic, Romania and Hungary, local funding did not influence firm's collaborations effectively rejecting *H1a*. Contrastingly, in Table 3, in all the remaining countries, local funding from regional authorities did not influence the likelihood of firm's collaborations with universities effectively rejecting *H1b* for all countries. Table 4 has also demonstrated that local funding statistically influenced firm's collaboration with government research institutions in the Czech Republic and showed a high probability of occurrence of cooperation proved by a positive coefficient. It was also statistically insignificant

in determining firm's collaboration in the remaining countries, hence *H1c* was rejected in the Czech Republic and accepted in other countries. The result is similar to the findings of other studies (Levén et al., 2014; Maietta, 2015; Acosta et al., 2015).

Public funding from the central government was also a significant source of funding for manufacturing firms in the countries under study. Table 2 shows that central government funding influenced firm's collaborations with other firms in the enterprise group in Romania, the Czech Republic and Slovakia and the odds of cooperation within enterprises in these countries were highly likely. Considering their coefficient, Slovakia would be even more likely to have more cooperation with other enterprises compared to the Czech Republic and Romania when central government funding is supplied. Per contra, central government funding was not statistically significant in Hungary effectively ensuring that *H2a* was accepted in all countries except Hungary.

In Table 3, public funding from the National level was positive and statistically significant in influencing firm's collaborations with their local universities. Implying that manufacturing firms in these countries were highly likely to collaborate with universities for their sources of knowledge and innovations increased. This effectively accepted *H2b* in all countries assessed. Although in all countries under study, public funding proved to be significant, it was highly significant and more likely in Slovakia as can be seen with the highest coefficient in Table 3 (1.864).

Lastly, public funding from central government was also statistically significant in influencing firm's collaborations with government research centers. This meant that apart from universities, public research centers were the preferred choice of collaborative partner for manufacturing firms and firms receiving public funding were highly probable to collaborate with public research institutions. This was also statistically significant for all countries effectively. The study also corroborates the findings of (Aschoff, 2010; Goel et al., 2017).

Table 3 Funding influence on firm's collaboration with universities

Country	Romania	Czech Republic	Hungary	Slovakia
	β (p value)	β (p value)	β (p value)	β (p value)
	Tjur r^2 -0.06	Tjur r^2 -0.60	Tjur r^2 -0.5	Tjur r^2 -0.82
Constant	-2.906	-2.220	-1.422	-2.104
FUNLOC	0.828 (0.101)	0.406 (0.202)	-0.172 (0.695)	1.064 (0.255)
FUNGMT	0.928(0.009) ***	1.601 (0.000) ***	0.757 (0.000) ***	1.864(0.000) ***
FUNEU	0.705 (0.043) **	0.679 (0.000) ***	0.204 (0.161)	1.157(0.000) ***
Number of observations	7 662	5 449	5 152	2 888

Note: *** significant at $p < 0.01$, ** significant at $p < 0.05$, * significant at $p < 0.10$.

Source: Own calculation

Funding from the European Union has also been instrumental in supporting firm's collaboration with other entities. The results in Tables 2, 3 and 4 have shown that firms receiving EU funding showed a strong significance to cooperation and a high likelihood of collaborating with local universities in Romania, the Czech Republic and Slovakia evidenced by their coefficient. This rejected *H3b* for all countries but Hungary. Conversely, EU funding was not significant in supporting firm's collaboration with other firms in Hungary, Romania and Slovakia affirming *H3a* in these countries except for the Czech Republic.

Similarly, EU funding influenced firm's collaborations with universities in all the countries under study but Hungary. Hungarian firms that received EU funding did not show any significant influence on cooperation and were not likely to collaborate within the enterprise group or with universities. Lastly, the results have also shown that EU funding influenced firm's collaborations with government research centers only in Romania, but it was not significant in influencing the probability of firm's collaboration with government research centers in Hungary, the Czech Republic and Slovakia. This confirmed *H3c* in all countries except Romania. The results are similar to the findings of Rõigas et al. (2018). They found out that firms receiving funding support from the EU are more likely to cooperate with universities. While firms in new EU member states such as Hungary receiving funds from the EU were not likely to collaborate with universities.

However, in Tables 2, 3 and 4, the negative intercept recorded for all countries receiving local funding, national and European funding shows the unlikely probability of cooperation happening without the interference local, national or European Union funding going further to entrench the credence of funding for cooperation.

Table 4 Funding influence on collaborations with Government

Country	Romania	Czech Republic	Hungary	Slovakia
	β (p value)	β (p value)	β (p value)	β (p value)
	Tjur r^2 -0.25	Tjur r^2 -0.25	Tjur r^2 -0.50	Tjur r^2 -0.58
Constant	-2.736	-3.342	-2.664	-2.885
FUNLOC	0.392 (0.438)	0.895(0.004) ***	0.153 (0.787)	0.796 (0.502)
FUNGMT	2.245 (0.00) ***	1.920(0.000) ***	0.710 (0.001) ***	1.885 (0.000) ***
FUNEU	0.899 (0.003) ***	0.359 (0.163)	0.299 (0.162)	0.591 (0.187)
Number of observations	7 662	5 449	5 152	2 888

Note: *** significant at $p < 0.01$, ** significant at $p < 0.05$, * significant at $p < 0.10$.

Source: Own calculation

CONCLUSIONS

The focus of this paper is to examine the influence of public support on firm's collaborations. Hence, it was sought to provide an empirical insight into how public funding supports collaboration among firms, universities and government research centers. Financial support from central governments and the EU can increase the probability of firms' collaboration with other entities because it can help overcome the obstacle of shortage of finance that hinders them from partnering other institutions for knowledge sharing and innovation. Data from the Eurostat Community Innovation Survey (2012–2014) and the binary logistics model was used whilst funding from local or regional authorities, central government and the EU were used as the explanatory variables.

Three different models were used to assess how funding influenced firm's collaboration within the firms, universities and with government research institutions. The analysis conducted affirmed *H1a* in Slovakia and rejected it for all other countries assessed. *H1b* was rejected in all countries assessed and *H1c* was rejected in the Czech Republic but, however, accepted in all other countries. *H2a* was accepted in all countries except Hungary whilst *H2b* and *H2c* were accepted in all countries assessed. *H3a* was also accepted in all other countries except the Czech Republic,

H3b was rejected among all countries considered except for Hungary and *H3c* was also confirmed in all countries but Romania.

The results strongly support the pivotal role played by central government funding in firm's collaborations. Firms receiving funding from the local government were more likely to cooperate with other firms only in Slovakia, however, local funding only strongly influenced firm's collaborations with government research centers in the Czech Republic. Firms receiving funding from their central government were also found to be more likely to collaborate with other enterprises in the enterprise group, with universities and with government research centers. Among all the funding sources considered for this paper, it is worth noting that central government funding was largely identified as most significant source for collaboration with all entities considered. Lastly, firms receiving EU funding were found to be more likely to collaborate with universities, this was particularly true for Romania, the Czech Republic and Slovakia. It was also a significant source of funding for firms that collaborated with government research centers in Romania.

Policy recommendations are therefore provided on how various funding sources can be used to increase firm's collaborations with other triple helix entities. Funding from local authorities is currently not a reliable source for firms aiming to cooperate with other entities probably because these authorities do not have huge funds to allocate to managing firm's collaboration. Local authorities can therefore strengthen their funding for industries by providing other non-financial benefits such as tax reliefs and other sweetener policies for firms aiming to cooperate for innovation purposes. Secondly, governmental support measures should focus more on promoting the efficient use of EU funding schemes for firm's cooperation with universities, other enterprises with the group and with government research centers.

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