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INNOVATION COLLABORATIONS OF FIRMS: THE CASE OF HUNGARIAN MULTINATIONAL COMPANIES ¹

Multinational companies (MNCs) are geographically widespread production networks that can coordinate operations and activities in more than one country. MNCs transfer innovations, expertise, knowledge and advanced technologies to their host countries through their subsidiaries. Therefore, multinational companies are seen as transfer intermediaries distributing international technologies and innovations. MNCs help to bridge the existing technology gap between developed and developing countries. Due to the multilocation nature of MNCs, the study aims to examine the various drivers that influence Hungarian MNCs' R&D collaborations, making them choose to collaborate either with local partners or with partners in the countries of their headquarters. The paper reports on the preliminary findings of an on-going comparative research focused on understanding the key drivers of innovations and competitiveness in Hungary. For our empirical analysis, drawing on data from the Eurostat's harmonized Community Innovation Survey 2010–2012, we used the probit regression model. Since many studies have shown that innovation processes in companies are based on the same principles or similar framework, it is possible to generalize the results of the analysed data and successfully put the recommendations into practice. Our analysis provided mixed results; it has demonstrated that marketing orientations, expenditures devoted to research and development, absorptive capacity, firm size as well as funding support provided to Hungarian MNCs influenced their choice of collaborating partners. Hungarian MNCs were highly probable to collaborate with both local and foreign partners in the enterprise group, while preferring to cooperate with local universities rather than foreign ones.

Keywords: collaborations, enterprises, funding, Hungary, innovations, knowledge, multinational companies, subsidiaries, technology transfer, universities

1. Introduction

There is growing interconnection between the countries' national innovation systems and the global innovation system [1, 2]. The fusing of the national innovation systems with the global innovation networks means that countries are becoming more integrated and dependent on knowledge, innovation and technology obtained from foreign sources [3]. The global innovation system embodies all the networks of connected organizations such as industries, universities, and governments producing diverse knowledge and skills needed to generate complex technologies to the mar-

ket [4], as well as all the commercial transactions and the knowledge transfers across nation states. Countries with lowly developed innovation potentials and technologies really need support to boost their innovation system; they can mainly look up to multinational companies to realize their innovation capabilities [5]. Technology transfer from technologically advanced developed countries to developing countries through multinationals enhances technological abilities of host developing countries [6]. MNCs are conduits of globalization as they can diversify their host countries' research and development base by combining knowledge and expertise from their headquarters and that of their host countries to generate novel knowledge and innovation [7]. MNCs serve as the mainstay of

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the global value chains, coordinating production among countries. This fact makes them an imperative channel for bartering goods and services, knowledge and capital across countries.

The globalization of innovation offers both threats and opportunities for host countries. Transnational corporations (TNCs) have significantly increased the size and numbers of their global innovation networks. They are expanding and extending their intentions to join forces with both foreign and local universities, being acknowledged as the main propellers of research and development (R&D) and internationalization [5]. MNCs' process of fostering closer and intense partnerships with local industries, research institutions (universities, private and other public research centres) and governments (both local and international) can significantly facilitate the absorption and appropriation of knowledge emanating from abroad [8]. This makes multinational companies crucial intermediaries for diffusing international knowledge and technologies. MNCs mainly transfer technologies to developing countries by means of foreign direct investment [9]. Multinational subsidiaries can also have synergies with local universities, this can be a mechanism to boost local R&D activities leading to enhanced local technology transfers and learning [10].

Owing to the enormous contributions MNCs can provide to their host nations, authorities and policy makers are intervening in the business environment to facilitate and regulate their operations [11]. Interventionist approaches such as favourable investment climate make multinational firms very successful creating synchronous effects in the host countries' gross domestic products (*GDP*), government revenues, employment, and value added among others. Local and central governments alike are providing financial supports to bait MNCs to invest in their local economies [12]. These enticing incentives provided by governments such as tax waivers or reduced taxes and subsidies can animate MNCs to transfer technology, thus plunging the cost of technology. This drastic decrease in cost of technology could aid the research and development capabilities of host country [13]. Such public supports can also increase the propensity of MNCs to cooperate with local institutions to increase their innovation potential. Governments' support for innovations, technology and knowledge transfers is routed in the spillover effect it can have on the entire economy [14].

The paper aims to contribute to the literature in two main ways. Firstly, we contribute to the literature on technology transfers that focuses on

multinational firms and how they influence the national and local innovations systems in various countries. We conceptualize the different partners MNCs can collaborate with for their innovation needs. Secondly, we investigate the factors that influence MNCs' choice of collaborative partners. We intend to focus on the factors that enable MNCs' collaborations with other members in the enterprise group, where they can collaborate with local enterprise groups in their subsidiaries' countries or the enterprise group of their headquarters countries. Universities have also become dependable partners for firms' collaboration due to their research focus. Thus, we focus on whether MNCs would prefer to cooperate with local universities or with foreign universities in their headquarters countries. To the best of our knowledge, there are no studies on MNCs collaborations focused on the aforementioned topic and factors influencing the choice of collaborators in Hungary and other Eastern European countries.

The rest of this paper is structured as follows. The next section describes the theoretical background. In the methodology section, we explained the methodology and sources of data. The results and analysis section elaborate on the empirical results. The conclusions and implications section concludes the paper by summarizing the most important findings, and discussing several implications for policy-makers, firms and universities.

2. Theoretical Background

Numerous determinants influence the propensity of multinational firms to collaborate with other partners in their host countries or with partners in countries of their headquarters and the rest of the world. Firm size has been used as a determinant that can influence firm's collaboration propensities [15, 16]. The study conducted by Teirlinck & Spithoven [17] in Belgium revealed that small firms were less likely to engage in research cooperation as opposed to medium-sized and large firms. Smaller firms do not possess the internal resources such as absorptive capacity and funding to forge collaborations as opposed to larger firms. Large firms are endowed with more internal resources to enter into innovation collaborations [18]. Development of new products is usually associated with lofty fixed costs and investment. This factor plays in large firms' favour because they have better access to external investment.

Grants and financial support provided by local, central governments and the European Union (EU) can be a driving factor for multinational firms' collaborations with local actors, such as universities

and other industries within the enterprise group. These financial supports can help both MNCs and local partners to overcome the shortage of finances that can be a barrier to the local innovation system. Cross-country analysis has suggested that financial support encourages firms to renew their participation in R&D collaboration to initiate new collaborations [19]. The research conducted by Hottenrott & Lopes-Bento [20] revealed that the Belgian government offers financial support for small and medium scale enterprises that collaborate with subsidiaries.

Another important factor that influences MNCs collaboration decision is the tranche they spend on R&D to boost the development of new products and services. Investment in R&D substantially surges the likelihood of innovation. In this regard, firms that spend more on R&D are more likely to collaborate with other entities for obtaining knowledge and innovation. Investing in R&D has the biggest impact on the propensity to offer new products. This fact suggests that innovation is inclined to knowledge acquisition, and this can emanate from both internal and external sources. Internally, firms can acquire knowledge within their narrow confinements through regular in-house knowledge development, research and development, education and training for innovation activities. Conversely, external knowledge can be derived from external research and development, acquisition of machinery and other intangible technologies such as software [21, 22].

Similarly, the firms' human capital can also increase their likelihood of engaging in innovation collaborating with other partners. According to Thornhill [23], skilled workforce is a key factor for successful innovation. Skilled workforce can easily learn, adopt and apply new technologies. The proportion of employees that have graduated with university degrees influence the probability of offering new products and services, and enhances the prospect of investing in R&D. Skilled human capital stimulates the learning infrastructure at the industry level [24].

The market environment in which firms find themselves is also likely to influence their innovation collaborations. Multinational firms operate in tense global competitive environment. MNCs that export their goods and services are likely to increase their fixed costs on innovation to cover broader customer base, so they resort to exports to support their innovation capabilities. Exporting can push domestic producers into tougher competition that can enable innovations. Because foreign products have high quality, local firms have to adopt these technologies to

stand the intense competition from abroad [25]. Similarly, firms' involvement in the global value chain means they have export their intermediate or finished goods and services that would facilitate the acceptance of foreign technologies [26]. Firms that export are probable to carry out process innovations and in-house R&D. The studies of Crespi and Zuñiga [27] on firms exporting in Argentina and Colombia revealed that they were more probable to invest in R&D leading to new product development. Baldwin and Gu [28] also found out that exporters in Canada were 10 percent more likely to invest in collaborative R&D. They concluded that exporting and going into new markets helps firms to upgrade their knowledge production processes and improve their knack to absorb new technologies.

With the above-mentioned determinants in mind, we aimed to establish the crucial factors that influence collaborations of multinational firms in Hungary with other enterprises and universities. MNCs play pivotal role in Hungary, employing about 35 % of private sector workforce and contributing about 60 % of the GDP and about 65 % to the country' export [29]. Despite their enormous contributions, little is known about their innovation collaborations and their choice of collaborating partners. This paper intends to fill this gap and contribute to the literature on MNCs in Hungary and Eastern Europe.

3. Data and Method

Since the concept of innovations is a continuous process, it can be understood through both recent happenings and various contributory factors that accounted for the build-up. We seek to provide a comprehensive study on the various factors that have contributed to stimulating firm-level innovations in Hungary. Therefore, we begin this comparative empirical analysis with the data from the Eurostat Community Innovation Survey (CIS) conducted in the period between 2010 and 2012. Our use of this dataset constitutes an introductory investigation into understanding the origin of the recent advances in innovations in Hungary at the firm level. The CIS is a harmonized survey designed to provide information on enterprises innovativeness. The surveys are usually conducted every two years by the EU member states and other member countries of the European Social Survey (ESS). For the 2010–2012 survey, the number of surveyed Hungarian enterprises was 5,152. Out of these, we used the stratified sampling to select 1147 enterprises that were multinational firms, having their headquarters in other European countries and other parts of the world. We assessed whether

Description of variables used

Variables	Descriptions
<i>Dependent variables</i>	
COLEG	Assumes the value of 1 when firms collaborated with other enterprises within the local enterprise group and 0 meaning otherwise
COFEG	Assumes the value of 1 when firms collaborated with other enterprises within the foreign (European) enterprise group and 0 meaning otherwise
COLUNI	Assumes the value of 1 when firms collaborated with national universities and 0 meaning otherwise
COFUNI	Assumes the value of 1 when firms collaborated with other European universities and 0 meaning otherwise
<i>Independent variables</i>	
MARLOC	Takes the value of 1 if firms serve the domestic or regional market (within country) and 0 meaning otherwise
MARNAT	Takes the value of 1 if firms serve the national or other market within the country and 0 meaning otherwise
MAREUR	Takes the value of 1 if firms serve other markets in the European Union and 0 meaning otherwise
RRDIN	Expenditures on intramural R&D, takes the value of 1 if firms engaged in intramural R&D and 0 meaning otherwise
RRDEX	Expenditures on extramural R&D, takes the value of 1 if firms engaged in extramural R&D and 0 meaning otherwise
RMAC	Expenditures on machinery acquisitions, takes the value of 1 if firms engaged in acquisition of machinery and 0 meaning otherwise
ROEK	Expenditures on acquisition of external knowledge, takes the value of 1 if firms acquired external knowledge and 0 meaning otherwise
RTR	Expenditures on training for innovative activities, takes the value of 1 if firms engaged in training for innovative activities and 0 meaning otherwise
FUNLOC	Takes the value of 1 if firms received funding for product and/or process innovation from local or regional authorities and 0 meaning otherwise
FUNGMT	Takes the value of 1 if firms received funding for product and/or process innovation from the central government and 0 meaning otherwise
FUNEU	Takes the value of 1 if firms received funding for product and/or process innovation from the European Union and 0 meaning otherwise
EMPUD	Percentage of firm's employees with university degree in 2012
<i>Control variables</i>	
Large firms	Large firms that have between 250–499 employees
SMEs	Small and medium enterprises that have between 50–249 employees

these multinational companies collaborate with either local or foreign partners.

Table 1 below represents the list of variables used in our studies and contains detailed information about the dependent variables, independent variables and the control variables. The dependent variables used in our econometric model specification are COLEG, COFEG, COLUNI and COFUNI. The COLEG variable is a dummy variable that takes the value of 1 if the firm had collaborated with other enterprises or partners within the Hungarian enterprise group and 0 meaning otherwise. Similarly, the COFEG variable assumes the value of 1 when firms had collaborated with other enterprises within the foreign (European) enterprise group and 0 meaning otherwise. The COLUNI variable assumes the value of 1 if firms had collaborated with Hungarian universities and 0 meaning otherwise. Lastly, the COFUNI variable takes the value of 1 when firms collaborated with

other universities in other European countries and 0 meaning otherwise

With regards to our independent variables, the MARLOC variable takes the value of 1 if firms serve the domestic or regional market (within country) and 0 meaning they don't. The MARNAT variable takes the value of 1 if firms served the national or other market within the country and 0 meaning otherwise. The MAREUR variable takes the value of 1 if firms served other markets in the European Union and 0 meaning otherwise. The RRDIN variable refers to expenditures on intramural R&D, taking the value of 1 if firms had engaged in intramural R&D and 0 meaning otherwise. The RRDEX variable refers to expenditures on extramural R&D, taking the value of 1 if firms engaged in extramural R&D and 0 meaning otherwise. The RMAC variable is expenditures on machinery acquisitions, it takes the value of 1 if firms had engaged in acquisition of machinery and 0 meaning

Table 2

Estimated probit results. (All multinational firms)

Variables	COLEG	COFEG	COLUNI	COFUNI
MARLOC	0.589 (0.265) ⁺	-0.291(0.177) ⁺	0.302(0.206)	0.241(0.408)
MARNAT	5.801(0.000)	-0.106(0.251)	0.026(0.292)	-0.078(0.537)
MAREUR	-0.700(0.248) ^{***}	0.812(0.241) ^{***}	-0.072(0.236)	5.592(0.000)
RRDIN	-0.035(0.206)	0.106(0.146)	0.398(0.159) ^{**}	0.607(0.291) ^{**}
RRDEX	0.322(0.200)	0.040(0.153)	0.953(0.156) ^{***}	0.565(0.272) ^{**}
RMAC	0.843(0.273) ^{***}	0.458(0.175) ^{***}	0.237(0.196)	-0.235(0.333)
ROEK	0.352(0.211) ⁺	0.463(0.171) ^{***}	0.047(0.182)	-0.004(0.295)
RTR	0.159(0.214)	0.453(0.153) ^{***}	0.424(0.175) ^{**}	0.081(0.293)
FUNLOC	0.673(0.540)	-0.306(0.196)	-0.578(0.496)	0.923(0.605)
FUNGMT	-0.196(0.272)	-0.315(0.196)	0.469(0.196) ^{**}	-0.212(0.315)
FUNEU	-0.288(0.265)	0.189(0.191)	-0.098(0.213)	0.462(0.287)
EMPUD	0.212(0.080) ^{***}	0.143(0.059) ^{**}	0.065(0.065)	0.162(0.107)
LARGE FIRMS	-0.102(0.306)	0.553(0.267) ⁺	0.561(0.309) ⁺	0.349(0.546)
SMALL FIRMS	-0.311(0.301)	0.330(0.264)	0.223(0.308)	0.002(0.543)
LR (X^2)	73.137 ^{***}	77.943 ^{***}	118.244 ^{***}	35.008 ^{***}
log Likelihood	222.907	409.206	326.162	120.238
Pseudo R^2	0.306	0.239	0.365	0.247
N	1147	1147	1147	1147

Source: Own calculations, robust standard errors in parentheses.

*** Parameter significant at 99 % level.

** Parameter significant at 95 % level.

* Parameter significant at 90 % level.

otherwise. The ROEK variable refers to firms' expenditures on acquisition of external knowledge, taking the value of 1 if firms had acquired external knowledge and 0 meaning otherwise. The RTR variable denotes firms' expenditures on training for innovative activities, it takes the value of 1 if firms had engaged in training for innovative activities and 0 meaning otherwise. The FUNLOC variable takes the value of 1 if firms had received funding for product and/or process innovation from local or regional authorities and 0 meaning otherwise. The FUNGMT variable takes the value of 1 if firms received funding for product and/or process innovation from the central government and 0 meaning otherwise. The FUNEU variable takes the value of 1 if firms received funding for product and/or process innovation from the European Union and 0 meaning otherwise. The EMPUD variable refers to the percentage of firm's employees that had university degrees in 2012. The large firm variable refers to firms that have between 250–499 employees and the SMEs variable refers to Small and Medium enterprises that have between 50–249 employees.

Given the binary character of the dependent variable (collaborations with local or foreign partners), we used the probit model. We chose the probit regression model because it is a well-known model for analysing binary and ordinal variables

[30]. Numerous studies have used the probit regression model to determine firms' collaborations [31–33]. [34] offers the following formula for the probit regression:

$$\text{prob}(Y_i = 1 | X_i) = \int_{-\infty}^{x_i\beta} \phi(t) dt = \Phi(X_i'\beta), \quad (1)$$

when a firm is collaborating with other partners ($Y_i = 1$) and when it is not collaborating ($Y_i = 0$) with their choice of collaborating partners dependent on the vector X' .

4. Results

The explanatory power (pseudo R^2) of our probit models, as shown in Tables 2 and 3, ranges between 24 % and 38 %. Although, these percentages can be assumed very low, they still indicate that our regression models have statistically significant explanatory powers. The low levels signify that the estimated probabilities or likelihood of MNCs collaborating with partners in the local and foreign enterprise groups as well as with local and foreign universities are less likely or at low levels. Table 2 reports four models for probit estimates for all Hungarian multinational firms.

In our model with COLEG, meaning MNCs' collaborations within the local enterprise group, some of the drivers are positive and statistically significant, implying that there is a higher propen-

Estimated probit results (MNCs with headquarters in other EU countries)

Variables	COLEG	COFEG	COLUNI	COFUNI
MARLOC	0.485(0.278)*	-0.257(0.197)	0.448(0.232)*	0.143(0.432)
MARNAT	5.266(0.000)	-0.238(0.284)	-0.070(0.330)	0.422(0.641)
MAREUR	-0.707(0.263)***	0.735(0.254)***	-0.182(0.255)	5.102(0.000)
RRDIN	0.030(0.224)	0.205(0.161)	0.557(0.176)***	0.663(0.313)*
RRDEX	0.262(0.220)	-0.104(0.172)	0.918(0.174)***	0.482(0.299)
RMAC	1.026(0.306)***	0.539(0.193)***	0.397(0.220)*	-0.257(0.355)
ROEK	0.432(0.231)*	0.546(0.193)***	0.243(0.204)	0.098(0.325)
RTR	-0.036(0.241)	0.443(0.175)**	0.135(0.201)	-0.098(0.335)
FUNLOC	0.760(0.564)	0.068(0.515)	-0.077(0.555)	1.168(0.644)*
FUNGMT	-0.116(0.303)	-0.187(0.225)	0.462(0.227)*	-0.239(0.355)
FUNEU	-0.376(0.296)	0.062(0.216)	-0.025(0.238)	0.432(0.314)
EMPUD	0.228(0.086)***	0.139(0.066)**	0.035(0.072)	0.157(0.118)
LARGE FIRMS	-0.040(0.326)	0.697(0.295)**	0.552(0.337)	0.519(0.585)
SMEs	-0.265(0.324)	0.442(0.291)	0.252(0.337)	0.004(0.581)
LR (X ²)	65.476***	73.370***	100.556***	33.834***
log Likelihood	194.156	339.838	269.163	103.785
Pseudo R ²	0.319	0.270	0.377	0.274
N	953	953	953	953

Source: Own calculations, robust standard errors in parentheses.

*** Parameter significant at 99 % level.

** Parameter significant at 95 % level.

* Parameter significant at 90 % level.

sity of Hungarian MNCs to collaborate with other local partners. The variables MARLOC, RMAC, ROEK and EMPUD are all statistically significant suggesting that MNCs that focus on the domestic market, those engaged in machinery acquisition and those that have employees with university degrees are highly probable to collaborate with other firms in the Hungarian enterprise group. In a stark contrast, MNCs with their markets oriented towards other European countries are less probable to collaborate with local partners in the same enterprise group. Surprisingly, incentives support provided by the local and central governments as well as by the EU were not statistically significant to influence MNCs' collaborations with other firms in the Hungarian enterprise group. This can be attributed to the fact that MNCs have their own financial support and mostly do not rely on governmental supports. Our findings are consistent with other earlier findings in similar studies [35, 36, 37].

Similarly, in our COFEG model, positive coefficients and statistical significance demonstrate that Hungarian MNCs are inclined to collaborate with other partners in the foreign enterprise group in other countries. MNCs with local market focus are less likely to collaborate with foreign partners in the same enterprise group as shown by the negative coefficient. Those with foreign market orientations are highly probable to collabo-

rate with other partners in the foreign enterprise group. When it comes to the acquisition of machinery, seeking external knowledge and training for innovation activities, Hungarian MNCs choose to collaborate with partners in the foreign enterprise group. Foreign partners in different parts of the world have advanced technologies, so it is not surprising they are the preferred partners for Hungarian MNCs [38]. Again, firm size is also a determinant that influenced firms' collaborations with foreign enterprises in the enterprise group. Large firms are highly probable to collaborate with other foreign counterparts. These large firms have the financial capabilities and can therefore collaborate with foreign partners for their innovation needs [39].

In the model with COLUNI, the variables RRDIN, RRDEX, RTR, and our control variable large firms are all positive and statistically significant. This fact suggest that Hungarian MNCs are likely to depend on Hungarian universities for their intramural and extramural R&D as well as for their innovation trainings. This is consistent with the findings of [40, 41]. What is more, the funding support from the central government is statistically significant and positive in influencing MNCs' collaborations with Hungarian universities. This fact has been substantiated by numerous studies such as [42, 43, 44]. Firm size also influences their

collaborations decisions. Larger MNCs in Hungary are highly probable to collaborate with Hungarian universities, considering the fact that large firms have comparatively higher innovation expenditures than SMEs; thus, they are more likely to cooperate with local universities for their knowledge and innovation [45].

In our last model COFUNI, MNCs only collaborated with foreign universities for their intramural and extramural R&D, as seen from the positive coefficients of these variables. This clearly shows that foreign universities are not the preferred partners for Hungarian MNCs' collaboration. This result confirms the findings of [43]. According to Zhang & Harzing [46], the lack of collaboration among MNCs and local partners can be attributed to language differences that usually exist between the host country and the MNCs headquarters. This factor hinders effective and productive R&D collaborations. Hungarian public research institutions are incapable of transmuting scientific results into commercial success due to their lack of necessary intangible capital, partially because they have an underdeveloped technology market [47].

Additionally, we run a different model with MNCs that have their headquarters in other European countries. We found out that a total of 953 MNCs had their headquarters located in other EU countries. We focused on revealing if MNCs in Hungary are more likely to collaborate with partners in their headquarters countries or with partners in their host country. The results are shown in Table 3 below.

From Table 3, the model with the COLEG variable shows that Hungarian MNC subsidiaries with their headquarters in other European countries are likely to collaborate with other enterprises in the Hungarian enterprise group. Those subsidiaries that focus on the Hungarian markets are likely to collaborate with other local enterprises. Though the MAREUR variable is statistically significant, it suggests that there is a negative association between MNCs' collaborations with other partners in the Hungarian enterprise group because that is not their market focus. Again, Hungarian MNC subsidiaries are likely to collaborate with other local firms for their machinery acquisition as well as for their acquisition of external knowledge. Subsidiaries that have higher absorptive capacities are also probable to collaborate within the enterprise group. Interestingly, funding was not a factor that influenced subsidiaries' collaborations within the enterprise group. Our results substantiate similar studies by [39, 48].

In our model with COFEG, the variables MAREUR, RMAC, ROEK, RTR, EMPUD, and large

firms are all positive and statistically significant. This fact suggests that MNC subsidiaries in Hungary are highly likely to collaborate with other enterprises in other European countries. Their market focus is an influential driver of this kind of cooperation. What is more, when it comes to their innovation activities and the expenditures, they expend on them. It is highly probable that subsidiaries that acquire external knowledge do so from the other countries but not from Hungarian enterprises. Concerning training for innovation activities, MNC subsidiaries are probable to collaborate with other enterprises from the rest of Europe for their machinery acquisition, external knowledge and their training needs. MNCs with higher absorptive capacity are also probable to cooperate with foreign enterprises, probably due to the advanced levels of technology, especially in Western Europe where most of these MNCs have their headquarters [49]. The results in Table 2 once again demonstrate that large firms are likely to cooperate with foreign enterprises in other countries, particularly with enterprises in countries where their headquarters are located. Foreign subsidiaries seldom cooperate with indigenous companies for their R&D [50].

Finally, in our COLUNI model, Hungarians MNC subsidiaries are highly likely to collaborate with Hungarian universities for their intramural and extramural R&D as well as for their machinery acquisitions. Funding from the central government was also a driver of MNC subsidiaries' collaborations with Hungarian universities. This is contrary to [51] claim that Hungary is a worst performer that is inefficient with respect to public investments in innovation. Size is not statistically positive meaning it did not contribute to collaborations of MNCs, which have their headquarters in other European countries, with Hungarian universities. Lastly, the model with the COFUNI variable has demonstrated that subsidiaries in Hungary only collaborate with foreign universities for their intramural R&D; their collaborations are influenced by funding support from local governments. Local funding highly influenced subsidiaries' collaborations with foreign universities as seen by the highest coefficients across all the models (1.168).

5. Conclusions

Our research focused on the collaboration between multinational subsidiaries in Hungary and the factors influencing their choice of collaborative partners. This paper aimed to provide new empirical understandings about the determinants of local and foreign partners that enter into synergies with multinational companies. Our empirical

analysis produced mixed results. The market focus was a significant determinate that influenced Hungarian multinational firms' collaborations with other industries locally and internationally. Firms focusing on the local market were likely to collaborate with partners in the local enterprise group, and vice versa.

Hungarian MNCs investing in the acquisition of machinery were highly likely to collaborate with both local and foreign enterprises. This fact indicates that they supplement the low levels of technology in Hungary by collaborating with partners in their headquarters countries. Similarly, MNCs were likely to depend on both local and foreign enterprises for their external knowledge with our results showing that they were highly probable to depend on foreign enterprise groups for this kind of knowledge. Moreover, foreign enterprise groups were the preferred choice for MNCs training activities. This choice can be attributed to the fact that the Western European countries have well established educational systems.

Firm size also influenced MNCs' collaboration propensities. Large MNCs were likely to collaborate with other partners in the countries of their headquarters. This might be because large firms have the financial might to cross borders to acquire new knowledge and technologies in comparison with small firms.

MNCs in Hungary also collaborated with both local and foreign universities for their innovation and knowledge. Our findings showed that, for obtaining intramural and extramural activities, MNCs were likely to cooperate with local universities as well as foreign universities. Hungarian universities were the preferred choice for MNCs subsidiary for training for innovative activities. Large firms also preferred local universities for their knowledge and innovation probably due to their proximity. Funding provided by local governments influenced MNCs collaborations with Hungarian universities.

We also found out that the headquarters of these MNCs also played key roles in influencing their collaborations decisions. In general, firms oriented their market to their headquarters countries as seen by the positive and significant results. Other enterprises in headquarters countries were the preferred choice for collaborations for machinery acquisitions, external knowledge and training for innovation activities, as all the indicators were significant and positive. Large MNCs in Hungary were highly probable to collaborate with other enterprises in their headquarters countries.

However, they preferred to collaborate with local universities rather than with universities in

their headquarters for their intramural and extramural R&D and machinery acquisitions. Central government funding influenced MNCs' collaborations with Hungarian universities while local funding influenced their collaborations with universities in their headquarters. Surprisingly, size was not a significant determinant that influenced both MNCs' collaborations with both Hungarian and other universities in their headquarters countries.

Our analysis shows that MNCs subsidiaries in Hungary collaborated with Hungarian partners (enterprises and universities). Policies aimed at encouraging foreign direct investments (FDI) such as subsidies are probable to attract knowledge production within MNCs subsidiaries. Because domestic firms were the preferred choice for MNCs' collaborations, their expenditures on intramural and extramural R&D increased their propensities to collaborate with these local partners. Policy makers in Hungary can provide local industries and universities with funding support that will go a long way to ensure that companies can collaborate with both local and foreign actors. This approach can help in bridging the knowledge and innovation gap.

Despite our use of CIS data for the period from 2010 to 2012, this study is relevant and interesting for the current times because it brings new insight into how MNCs can transfer knowledge and technologies to low and moderate innovative countries like Hungary. From the perspective of knowledge transfer, MNCs subsidiaries in Hungary can take advantage of their ability to interact with both domestic and foreign partners and markets to boost technology transfers. Additionally, we have shown the various factors that are highly probable to influence MNCs' interactions with domestic and foreign partners. Our results can serve as a practical guide to managers of MNCs in Central and Eastern Europe with low innovation potentials, as we have shed more light on the relevant R&D partners they can effectively interact with to achieve sustainable innovations.

It is generally known that in diverse environments innovation waves occur and develop at different speeds. This research provides clear information on time-tested innovation principles and determinants in a selected business ecosystem. The paper presents results that can be applied in practice, as there are no fundamental changes in innovation schemes and processes in this area. This research can be followed up by other studies to replicate whether the recommendations and conclusions positively influence the innovation capacity and absorption of companies or not.

This study is limited by the fact that it narrowly focused on multinational companies in Hungary. Hence, it cannot be used for generalization purposes. Therefore, we would recommend conducting further similar studies in other countries to substantiate our findings.

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References

1. Sachwald, F. (2008). Location choices within global innovation networks: the case of Europe. *The Journal of Technology Transfer*, 33(4), 364–378. DOI: 10.1007/s10961-007-9057-8.
2. Bruche, G. (2009). The emergence of China and India as new competitors in MNCs' innovation networks. *Competition & Change*, 13(3), 267–288. DOI: 10.1179/102452909X451378.
3. Walshok, M. L., Shapiro, J. D. & Owens, N. (2014). Transnational innovation networks aren't all created equal: Towards a classification system. *The Journal of Technology Transfer*, 39(3), 345–357. DOI: 10.1007/s10961-012-9293-4.
4. Rycroft, R. W. & Kash, D. E. (2004). Self-organizing innovation networks: implications for globalization. *Technovation*, 24(3), 187–197. DOI: 10.1016/S0166-4972(03)00092-0.
5. Vahlne, J. E. & Johanson, J. (2017). The internationalization process of the firm—a model of knowledge development and increasing foreign market commitments. In: *International Business* (pp. 145–154). Routledge.
6. Awate, S., Larsen, M. M. & Mudambi, R. (2015). Accessing vs sourcing knowledge: A comparative study of R&D internationalization between emerging and advanced economy firms. *Journal of International Business Studies*, 46(1), 63–86. DOI: 10.1057/jibs.2014.46.
7. Song, J. (2014). Subsidiary absorptive capacity and knowledge transfer within multinational corporations. *Journal of International Business Studies*, 45(1), 73–84.
8. Dahan, N. M., Doh, J. P., Oetzel, J. & Yaziji, M. (2010). Corporate-NGO collaboration: Co-creating new business models for developing markets. *Long range planning*, 43(2–3), 326–342. DOI: 10.1016/j.lrp.2009.11.003.
9. Jordaan, J. A. (2013). Firm heterogeneity and technology transfers to local suppliers: Disentangling the effects of foreign ownership, technology gap and absorptive capacity. *The Journal of International Trade & Economic Development*, 22(1), 75–102. DOI: 10.1080/09638199.2013.745282.
10. Di Nauta, P., Merola, B., Caputo, F. & Evangelista, F. (2018). Reflections on the role of university to face the challenges of knowledge society for the local economic development. *Journal of the Knowledge Economy*, 9(1), 180–198. DOI: 10.1007/s13132-015-0333-9.
11. Lu, J., Liu, X., Wright, M. & Filatotchev, I. (2014). International experience and FDI location choices of Chinese firms: The moderating effects of home country government support and host country institutions. *Journal of International Business Studies*, 45(4), 428–449. DOI: 10.1057/jibs.2013.68.
12. Perlmutter, H. V. (2017). The tortuous evolution of the multinational corporation. In: *International Business* (pp. 117–126). Routledge
13. Rottig, D. (2016). Institutions and emerging markets: effects and implications for multinational corporations. *International Journal of Emerging Markets*, 11(1), 2–17. DOI: 10.1108/IJoEM-12-2015-0248.
14. Marano, V., Tashman, P. & Kostova, T. (2017). Escaping the iron cage: Liabilities of origin and CSR reporting of emerging market multinational enterprises. *Journal of International Business Studies*, 48(3), 386–408. DOI: 10.1057/jibs.2016.17.
15. Miotti, L. & Sachwald, F. (2003). Co-operative R&D: why and with whom? An integrated framework of analysis. *Research policy*, 32(8), 1481–1499. DOI: 10.1016/S0048-7333(02)00159-2.
16. Cassiman, B. & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management science*, 52(1), 68–82. DOI: 10.1287/mnsc.1050.0470.
17. Teirlinck, P. & Spithoven, A. (2013). Research collaboration and R&D outsourcing: Different R&D personnel requirements in SMEs. *Technovation*, 33(4–5), 142–153. DOI: 10.1016/j.technovation.2012.11.005.
18. Tether, B. S. (2002). Who co-operates for innovation, and why: an empirical analysis. *Research policy*, 31(6), 947–967. DOI: 10.1016/S0048-7333(01)00172-X.
19. Gök, A. & Edler, J. (2012). The use of behavioural additionality evaluation in innovation policy making. *Research Evaluation*, 21(4), 306–318. DOI: 10.1093/reseval/rvs015.
20. Hottenrott, H. & Lopes-Bento, C. (2012). (International) R&D collaboration and SMEs: The effectiveness of targeted public R&D support schemes. *Research Policy*, 43(6), 1055–1066. DOI: 10.1016/j.respol.2014.01.004.
21. Grigoriou, K. & Rothaermel, F. T. (2017). Organizing for knowledge generation: internal knowledge networks and the contingent effect of external knowledge sourcing. *Strategic Management Journal*, 38(2), 395–414. DOI: 10.1002/smj.2489.
22. Monteiro, F. & Birkinshaw, J. (2017). The external knowledge sourcing process in multinational corporations. *Strategic Management Journal*, 38(2), 342–362. DOI: 10.1002/smj.2487.
23. Thornhill, S. (2006). Knowledge, innovation and firm performance in high-and low-technology regimes. *Journal of business venturing*, 21(5), 687–703. DOI: 10.1016/j.jbusvent.2005.06.001.

24. Egbetokun, A. A., Siyanbola, W. O., Sanni, M., Olamide, O. O., Adeniyi, A. A. & Ireferin, I. A. (2008). What drives innovation? Inferences from an industry-wide survey in Nigeria. *International Journal of Technology Management*, 45(1–2), 123–140. DOI: 10.1504/IJTM.2009.021524.
25. Cornaggia, J., Mao, Y., Tian, X. & Wolfe, B. (2015). Does banking competition affect innovation? *Journal of financial economics*, 115(1), 189–209. DOI: 10.1016/j.jfineco.2014.09.001.
26. Coe, N. M., Dicken, P. & Hess, M. (2008). Introduction: Global production networks: debates and challenges. *Journal of Economic Geography*, 8(3), 267–269. DOI: 10.1093/jeg/lbn006.
27. Crespi, G. & Zuniga, P. (2012). Innovation and productivity: evidence from six Latin American countries. *World development*, 40(2), 273–290. DOI: 10.1016/j.worlddev.2011.07.010.
28. Baldwin, J. R. & Gu, W. (2004). Trade liberalization: Export-market participation, productivity growth, and innovation. *Oxford Review of Economic Policy*, 20(3), 372–392. DOI: 10.1111/1540-5982.t01-2-00006.
29. Dobrai, K., Farkas, F., Karoliny, Z. & Poór, J. (2012). Knowledge transfer in multinational companies—evidence from Hungary. *Acta Polytechnica Hungarica*, 9(3), 149–161.
30. Cappellari, L. & Jenkins, S. P. (2003). Multivariate probit regression using simulated maximum likelihood. *The Stata Journal*, 3(3), 278–294.
31. Muscio, A. & Pozzali, A. (2013). The effects of cognitive distance in university-industry collaborations: some evidence from Italian universities. *The Journal of Technology Transfer*, 38(4), 486–508. DOI: 10.1007/s10961-012-9262-y.
32. Cardamone, P., Pupo, V. & Ricotta, F. (2015). University Technology Transfer and Manufacturing Innovation: The Case of Italy. *Review of Policy Research*, 32(3), 297–322. DOI: 10.1111/ropr.12125
33. Oyelaran-Oyeyinka, B. & Adebowale, B. A. (2017). University-industry collaboration as a determinant of innovation in Nigeria. *Institutions and Economies*, 4(1), 21–46.
34. Rasiah, R. & Govindaraju, C. V. (2009). University-industry R&D collaboration in the automotive, biotechnology and electronics firms in Malaysia. *Seoul Journal of Economics*, 22(4), 529–550.
35. Figueiredo, P. N. (2011). The role of dual embeddedness in the innovative performance of MNE subsidiaries: evidence from Brazil. *Journal of management studies*, 48(2), 417–440. DOI: 10.1111/j.1467-6486.2010.00965.x
36. Guimón, J., Chaminade, C., Maggi, C. & Salazar-Elena, J. C. (2017). Policies to attract R&D-related FDI in small emerging countries: Aligning incentives with local linkages and absorptive capacities in Chile. *Journal of International Management*, 24(2), 165–178. DOI: 10.1016/j.intman.2017.09.005.
37. Li, M. H., Cui, L. & Lu, J. (2018). Varieties in state capitalism: Outward FDI strategies of central and local state-owned enterprises from emerging economy countries. In: *State-Owned Multinationals* (pp. 175–210). Palgrave Macmillan, Cham.
38. Berry, H. (2015). Knowledge inheritance in global industries: The impact of parent firm knowledge on the performance of foreign subsidiaries. *Academy of Management Journal*, 58(5), 1438–1458. DOI:10.5465/amj.2013.0724.
39. Guimón, J. & Salazar-Elena, J. C. (2015). Collaboration in innovation between foreign subsidiaries and local universities: evidence from Spain. *Industry and Innovation*, 22(6), 445–466. DOI: 10.1080/13662716.2015.1089034.
40. Giuliani, E., Gorgoni, S., Günther, C. & Rabellotti, R. (2014). Emerging versus advanced country MNEs investing in Europe: A typology of subsidiary global–local connections. *International Business Review*, 23(4), 680–691. DOI: 10.1016/j.ibusrev.2013.06.002.
41. Athreye, S., Batsakis, G. & Singh, S. (2016). Local, global, and internal knowledge sourcing: The trilemma of foreign-based R&D subsidiaries. *Journal of Business Research*, 69(12), 5694–5702. DOI: 10.1016/j.jbusres.2016.02.043.
42. Munari, F., Rasmussen, E., Toschi, L. & Villani, E. (2016). Determinants of the university technology transfer policy-mix: A cross-national analysis of gap-funding instruments. *The Journal of Technology Transfer*, 41(6), 1377–1405. DOI: 10.1007/S10961-015-9448-1.
43. Røigas, K., Mohnen, P. & Varblane, U. (2018). Which firms use universities as cooperation partners?—A comparative view in Europe. *International Journal of Technology Management*, 76(1–2), 32–57.
44. Prokop, V. & Stejskal, J. (2018). Determinants of Innovation Activities: Public Financing and Cooperation: Case Study of Czech Republic and Hungary. In: *Modeling Innovation Sustainability and Technologies* (pp. 77–91). Springer, Cham.
45. Belderbos, R., Carree, M., Lokshin, B. & Sastre, J. F. (2015). Inter-temporal patterns of R&D collaboration and innovative performance. *The Journal of Technology Transfer*, 40(1), 123–137. DOI: 10.1007/s10961-014-9332-4.
46. Zhang, L. E. & Harzing, A. W. (2016). From dilemmatic struggle to legitimized indifference: Expatriates' host country language learning and its impact on the expatriate-HCE relationship. *Journal of World Business*, 51(5), 774–786. DOI: 10.1016/j.jwb.2016.06.001.
47. Szalavetz, A. (2014). Innovation in Hungary—The Impact of EU Accession and Integration into Global Value Chains. *International Journal of Management and Economics*, 42(1), 40–59. DOI: 10.2478/ijme-2014-0042.
48. Santangelo, G. D., Meyer, K. E. & Jindra, B. (2016). MNE subsidiaries' outsourcing and insourcing of R&D: The role of local institutions. *Global Strategy Journal*, 6(4), 247–268. DOI: 10.1002/gsj.1137.
49. Cavusgil, S. T. & Knight, G. (2015). The born global firm: An entrepreneurial and capabilities perspective on early and rapid internationalization. *Journal of International Business Studies*, 46(1), 3–16. DOI: 10.1057/jibs.2014.62.
50. Sass, M. & Szalavetz, A. (2013). Crisis and upgrading: The case of the Hungarian automotive and electronics sectors. *Europe-Asia Studies*, 65(3), 489–507. DOI: 10.1080/09668136.2013.779463.

51. Pop Silaghi, M. I., Alexa, D., Jude, C. & Litan, C. (2014). Do business and public-sector research and development expenditures contribute to economic growth in Central and Eastern European Countries? A dynamic panel estimation. *Economic Modelling*, 36, 108–119. DOI: 10.1016/j.econmod.2013.08.035.

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