https://doi.org/10.17221/60/2018-AGRICECON

Networking theory of innovation in practice – The Hungarian case

Aron TOROK*, Jozsef TOTH, Jeremias Mate BALOGH

Corvinus University of Budapest, Budapest, Hungary

*Corresponding author: aron.torok@uni-corvinus.hu

Torok A., Toth J., Balogh J.M. (2018): **Networking theory of innovation in practice – The Hungarian case**. Agric. Econ. – Czech, 64: 536–545.

Abstract: According to the European Innovation Scoreboard (2017) report, Hungary's summarised innovation score is 67.4 against the EU28 average of 102. This implies that the Hungarian economy has got rather serious disadvantages in the European Union community. This statement is more pronounced in the case of the food industry. From an innovation point of view food industry is seen as a slow one, which is lagging behind the technology pushed possibilities, but sometimes behind the customers' desires and requirements as well. In our research, we determine why the food companies in Hungary do not engage in innovation activities and if they do so, what are the main drivers of their innovation performance? We use the Community Innovation Survey (CIS 2012a) data and employ double hurdle estimation because of the nature of the innovation distribution. This method also helps in overcoming the selection bias problem, which necessarily occurs in this situation. Results prove that networking scope as well as networking intensity, play an important role in explaining innovation performance. The size and market obstacles are also significant factors.

Keywords: Community Innovation Survey, food industry, Hungary, innovation activity, networking

Hungary is a moderate innovator; over time its innovation performance has declined by 3.5% relative to that of the European Union (EU) in 2010. According to the report of the European Innovation Scoreboard (2017)[1], the Hungarian summarised innovation score is 67.4 against the EU28 average of 102. This score declined from 70.9 to 67.4 between 2010 and 2016 implying that the Hungarian economy has got rather serious disadvantages in the EU community.

In Hungary, the food sector plays an important role with a high level of export share and positive trade balance. In contrast, since 1990 the domestic sales of Hungarian food companies decreased by 40%. In addition, the innovation activities of the Hungarian food industry are far below the level needed for improving competitiveness (EFOSZ 2016).

Understanding the relationship between innovation and performance in both large and small firms is relevant for researchers, policy-makers, and managers of large and small companies alike. Understanding the innovations and their relationship with firm performance become even more relevant since the EU stated, in March 2000 in Lisbon. The underlying rationale is that encouraging firms to innovate will lead to better economic performance (higher growth, more jobs, and higher wages) (Sirelli 2000).

Furthermore, in the last decades, the biotechnology, the process-atomisation, new food processing and packaging techniques have been only partly implemented in food industry companies; that is especially true for the Hungarian food sector (Menrad 2001).

Analysing the innovation in the EU food sector, Sneep (1994) concluded that the institutional network, the relations with research institutes, universities and agricultural boards is important in innovation management of Dutch agro-food companies. Baregheh et al. (2012)

[1]The European Innovation Scoreboard (2017) provides a comparative analysis of innovation performance in EU countries, other European countries, and regional neighbours. It assesses the relative strengths and weaknesses of national innovation systems and helps countries identify areas they need to address.

Supported by the National Research, Development and Innovation Office of Hungary (K 120563 – Innovation resilience in food production and consumption).

https://doi.org/10.17221/60/2018-AGRICECON

found that small and medium-sized food enterprises (SMEs) in the UK are more engaged in product and process innovations than in packaging, position and paradigm innovations.

Information used in innovation process may come from different sources via company networking such as sales force, suppliers, universities, conferences, journals, visits to the factories, and not only in the pastry or bread industry but also in the other food sectors such as delicatessen and ready-to-serve meals (Traill and Grunert 1997).

Gellynck and Kühne (2008) suggest that the members of traditional food chain networks in Italy, Hungary and Belgium focused mainly on product innovation and least on organisational innovation. On the other hand, the partners in traditional food networks focus mainly on innovation related to product characteristics (e.g., new size, form and packaging) without changing the traditional character of the product.

Moreover, Gellynck and Kühne (2010) highlighted that the lack of understanding the benefits of networking activities for innovation, the lack of trust, the lack of knowledge of appropriate methods or skills, and the lack of financial and physical resources could be considered as the main barriers for innovation in the traditional food networks. Gellynck and Kühne (2010) pointed out that the successful SMEs use their networks to overcome lacks of knowledge and information to create possibilities of joint use of resources.

Gellynck and Kühne (2008) found that in Italy and Hungary, process innovation was not considered feasible for traditional food products or it was seen as a deviation from specifications established by a producer consortium. Furthermore, in Hungary, there is a little collaboration between the direct food chain members, due to the lack of competent partners and scarce information exchange between the chain partners (Gellynck and Kühne 2010).

Based on these empirical studies, we can conclude that innovation, especially benefit from the advantages of the innovation network is still limited in the European food industry. This paper provides an empirical test of hypotheses of the role of networking scope and intensity in explaining innovation performance. Our research question is: How the networking activities affect innovation in Hungarian food processing industry? More specifically, we analyse the scope and intensity of the innovation network connections in Hungarian food processing sector based on the EU's Community Innovation Survey (CIS 2012a) data for 2012.

MATERIALS AND METHODS

In this paper, we outline a conceptual framework for depicting the network theory of innovation. Innovation networks are generally considered as means to share R&D costs, gain access to rare resources, manage complex innovation processes, cope with technological uncertainty and create learning opportunities (Pyka 2002, Buchmann and Pyka 2012b). In general, there is an increasing trend in firms' practice that the firms carry out innovation with their network partners instead of in-house R&D. In addition, the firms are looking for partners beyond the boundaries of their organisation, mainly with other firms, universities, research organisations and government agencies (Rampersad et al. 2010). Existing literature on firms' networks (Levinson and Asahi 1996; Dyer and Singh 1998; Dyer and Nobeoka 2000) has widely discussed and accepted networks of firms as a crucial factor for innovation, knowledge creation and inter-organisational learning (Podolny and Page 2000).

According to the social capital theory, a firm's external network's form is a major contributor to its performance (Leenders and Gabbay 1999).

In general, the SMEs use external innovation more than large firms, as they consider alliances or network as ways to extend their technological competences (Rothwell 1991; Edwards et al. 2005). Therefore, innovation in SMEs already had an external focus, since their collaborations tend to be limited to strategic alliances with larger firms (Rothwell and Dodgson 1994).

The SMEs consider external sources as means of getting access to marketing and sales channels at the later stages of innovation, while open innovation focuses typically more on the early stages of innovation, addressing external technology sourcing and networking with technology providers and innovative companies (Vanhaverbeke and Cloodt 2006).

Zeng et al. (2010) confirmed that levels of inter-firm cooperation (partners including customers or clients, suppliers, and competitors) for SMEs are positively associated with their innovation performance.

In the last few decades, university-industry collaborations have attracted considerable attention. A large body of literature has pointed to the importance of scientific research for a technological change, innovation, and economic performance. Aissaoui (2014) identified the effect of collaborations with public research organisations on firms' innovative performance. Using the French Community Innovation Survey, he concluded that collaborating

https://doi.org/10.17221/60/2018-AGRICECON

with universities and other public research organisations increases the firm's innovative performance.

Various empirical studies found support for the idea that interactions with public research organisations positively influence firms' innovative performance (Aissaoui 2014). For instance, cooperation with universities is shown to be positively associated with innovative sales in the Netherlands, Germany, and Sweden (Mansfield 1996; Belberdos et al. 2004; Aschhloff and Schmidt 2008). As a result, empirical evidence is to be found confirming whether collaborations with public research organisations could significantly improve firms' innovative performance.

In contrast, cooperation with customers, suppliers and other firms play a more distinct role in innovation for SMEs than horizontal cooperation with research institutions, universities and government agencies (Zeng et al. 2010).

Colurcio and Russo-Spena (2013) concluded that food SMEs are orientated to collaboration with partners for innovation. The cooperation in innovation networks brings mutual benefits and partners cooperate at the same level. However, the innovation openness is focused on some privileged relationships with few partners often belonging to the current network of SMEs where long-lasting relationship alleviates trust concerns. Moreover, they highlight the importance of trust in innovation relationships. In addition, for the more knowledgeable SMEs the interaction for innovation allows the access to a broader network of connected relationships and a better position in value networks.

Chesbrough (2003) suggests that many innovative firms have shifted to an 'open innovation' model, using a wide range of external actors and sources to help them achieve and sustain innovation. There are two factors influencing the success of open innovation. First, the factor called absorptive capacity that depicts access to skills and external networks. Second, complementary resources that include proprietary R&D knowledge, distribution or service networks, and manufacturing capabilities (Fertő et al. 2016).

Gilsing and Nooteboom (2005) provided an empirical study on the density and strength of ties in innovation networks in the Dutch multimedia and pharmaceutical biotechnology industry. They aimed to distinct between exploration versus exploitation and found a stronger sectoral effect in how exploration and exploitation settle in network structural properties than was anticipated thus far.

Innovative companies generally establish linkages with other actors and access the external knowledge in order to benefit from the dynamic effects of interactive processes. Indarti and Postma (2013) showed that the quality of interaction as indicated by the depth of knowledge absorbed from various external parties and intensity of interaction (i.e., tie intensity) are better predictors of product innovation than the diversity ofinteraction. An understanding of the contribution of external networks to innovation is essential for the effective management and functioning of these networks. Buchmann and Pyka (2012a) outlined a conceptual framework for depicting network evolution patterns of interfirm innovation networks and analysed the dynamic evolution of an R&D network in the German automotive industry. They suggested that the structural positions, the actor and dyadic covariates describing characteristics of the firms' knowledge bases are influential determinants of network development.

Laursen and Salter (2006) analysed links search strategy to innovative performance and found that searching widely and deeply is curvilineal related to the performance using a large-scale sample of the industrial firms. They claimed that the firms which are more open to external sources or search channels are more likely to have a higher level of innovative performance. They concluded that the searching a variety of search channels can provide ideas and resources that help firms gain and exploit innovative opportunities.

Fertő (2016) tested that the scope and depth of openness to external organisations has a curvilinear (inverted U-shape) effect on innovative performance. He concluded that positive relationships exist between the scope/depth of open innovation and firms' performance. Moreover, he found that a curvilinear (inverted U-shape) impacts of scope/depths on the open innovation exist on firms' performance only at the phase of the idea development. Chen et al. (2011) analysed how the innovative performance is affected by the scope, depth, and orientation of firms' external search strategies in China. They analysed the use of the science, technology, innovation, doing, using and interacting innovation modes. Their finding suggested that the greater the scope and depth of openness for both innovation modes improves innovative performance indicating that open innovation is also relevant beyond science and technology-based innovation.

On the whole, the empirical literature suggests that in the life of the small and medium-sized food companies, the external sources or knowledge (customers, clients, suppliers, competitors, and other food supply

https://doi.org/10.17221/60/2018-AGRICECON

chain members), as well as cooperation with other SMEs, would be the most important factors for innovation.

There are three dimensions of external searching strategies: i) the scope of the external search focuses on the diversity of the external sources of innovation (Laursen and Salter 2006); ii) the depth of a firm's external search is defined as the extent to which firms draw on different external sources (Laursen and Salter 2006); iii) the orientation of a firm's external search refers to the role of different types of external actors in enhancing the innovative performance of firms (Chen et al. 2011).

Theoretical considerations, empirical findings and preliminary analysis of our data suggest that the companies' innovation decisions consist of two stages: first they choose whether to deal with innovation issues at all. If they are not motivated and/or forced to do so, and if their market does not extort them into this direction, they probably wouldn't do it. The innovation activities and the innovative products and processes inherently encompass a certain amount of risk, which can be avoided if the company does not deal with it. Our data prove that the majority of Hungarian food processors does not carry out any innovation activity. Therefore, we had to look after an appropriate method which takes into consideration the specific problem of selection bias: not all firms should be taken into consideration when we determine the factors influencing the innovation performance, just the ones, which really do it. The double hurdle estimation came handy for this purpose. The Cragg's (1971) hurdle model combines a selection model that determines the boundary points of the dependent variable with an outcome model that determines its non-bounded values. In this model, individual firms carry out zero or a positive amount of innovation, with (possibly) different factors determining each of these choices.

Hurdle models are characterised by the relationship $y_i = s_i h_i^*$, where y_i is the observed value of the dependent variable. The selection variable s_i, is one if the dependent variable is not bounded and zero otherwise, while h_i^* is the continuous latent variable that is only observed when $s_i = 1$. In the Cragg model, the lower limit that binds the dependent variable is zero so the selection model is:

$$s_i = \begin{cases} 1 & \text{if } z_i\gamma + \varepsilon_i > 0 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

where z_i is a vector of explanatory variables, γ is a vector of coefficients, and ε_i is a standard normal error term (Stata User's Guide Release 15 2017).

According to the methodological approach, we make a difference between the two sets of hypotheses. The first hypothesis refers to the selection, the other one to the outcome parts of the model. In the selection phase, we postulate the probability whether a company deals with any innovation, while in the outcome one we predict the quantity of total innovation activity of the companies. We also control for openness, market obstacles, and company size.

Selection hypotheses

Literature of innovation network suggests that innovative firms are using a wide range of external skills, network relations, information sources in order to achieve and improve innovation performance (Chesbrough 2003; Chen et al. 2011; Fertő et al. 2016). According to Indarti and Postma (2013), we suppose that networking intensity is a good predictor of whether the firms are engaged in innovation at all. If the firm's network relations are more intensive (using more and more sorts of external information sources), it provides companies more information on where to innovate. If network relationships are not significant (its intensity is close to zero), the information and new ideas are not important for them. Consequently, they are not interested in carrying out innovation.

H1: The higher is the intensity of cooperation with information sources, the higher is the propensity of food SMEs to innovate.

The firms innovate to meet the unsatisfied needs of consumers. In order to control for this feature, a binary variable is used describing if the firm aimed to enter into new markets and/or to increase its market share (Aissaoui 2014). Therefore, the openness is a good indicator, whether the firm is forced to innovate by the global competition.

H2: The more the food company is exposed to global competitiveness the higher the willingness to innovate is.

We also consider a binary variable which identifies firms which faced obstacles linked to the market that has hampered their innovation activities (Aissaoui 2014). If they are not, probably they are less motivated for making any kind of inherently risky innovation activity.

H3: Market obstacles in Hungarian food processing enterprises force a company's innovation performance.

https://doi.org/10.17221/60/2018-AGRICECON

The very low (close to zero) values of variables representing *H*1–*H*3 suggest that food companies are not getting into innovation.

Outcome hypotheses

The scope and orientation of firms' external search strategies significantly affect innovative performance. The greater scope of openness for innovation modes improves innovative performance indicating that open innovation is also relevant beyond science (Chen et al. 2011). The scope of the external search focuses on the diversity of external sources of innovation (Laursen and Salter 2006).

H4: The wider the scope of a firm's innovation networks is, the higher the innovation performance is.

Schumpeter (1942) argues that large firms have the resources that enable them to address the risks associated with innovation activities in line with the resource-based view of a firm (Wernerfelt 1984).

Fernandes et al. (2013) confirmed that innovating products, processes, organisations or introducing already existing products into new markets influenced the performance measured through the firm's turnover. In consequence, we control the firm's size measured as the company's total turnover.

H5: Company's size provides a resource base for the firm's innovation activity.

The open way of innovation articulates a certain behavioural aspect of activity of those who communicate openly with business partners about new business ideas. We can state that they share their knowledge with these partners. Naturally, they expect from these people the same behaviour. They do it because they perceive that the outcome from performing that behaviour is positive, therefore they will have a positive attitude towards performing that behaviour (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980). Vicente et al. (2015) also pointed out that innovation capability is the firm capacity to develop a new product through the combination of innovation behaviour, strategic capability, and internal technological process. The aspiration of the strategic approach to innovation indicates a positive attitude towards innovation performance[2].

H6: Strategic importance (degree of importance) of introducing new or significantly improved goods or services is positively related to innovation performance.

The dependent variable of the regression depicts whether the enterprise has performed product, process, organisation or market innovation during the past three years. More specifically, these activities encompass new or significantly improved methods of manufacturing or producing goods or services, improved logistics, delivery or distribution, supporting activities for processes, new business practices, organising external relations and marketing practices.

Networking scope is representing how many kinds of external sources the enterprises have been used for acquiring new ideas for the innovation. A total count of any information sources (internal within the enterprise or enterprise group, market sources such as client, suppliers, competitors and consultants, education, research institutes, and other sources – conferences, journals, professional and industry associations) has been counted. In the CIS (2012a) survey data, question 6.1[3] was used to measure innovation scope.

Networking intensity was generated by summing the importance of all kind of information sources and cooperation for innovation activities (market sources, education and research institutes, other sources: e.g., conferences, trade fairs, exhibitions), except internal innovation. We also used the answers of question 6.1 from CIS (2012b) survey. It should be noticed that we were not taking into consideration the answers 'not used' (because it indicates no importance at all) in the CIS (2012a) data. These questions were dedicated to researching the sources of information and co-operation for product and process innovation, representing networking activity in the invocation process. We applied total turnover in 2012 expressed in EUR as company size.

[2]CIS (2012b) Question 11.2: During 2010–2012, how important were each of the following strategies for reaching your enterprise's goals? The degree of importance: introducing new or significantly improved goods or services.

[3]CIS (2012b) Question 6.1: During the three years 2010–2012, how important to your enterprise's innovation activities were each of the following information sources? Include information sources that provided information for new innovation projects or contributed to the completion of existing projects. The aggregated number of all sources refers to networking scope and aggregated number of importance refers to networking intensity.

https://doi.org/10.17221/60/2018-AGRICECON

The strategic behavioural variable captures the importance of introducing new or significantly improved goods or services.

In addition, we used the market openness[4] variable for international markets depicting foreign geographic markets (other EU and all other countries) in which enterprise sell goods or services between 2010 and 2012.

Finally, market obstacles variable[5] expresses that in strong competing situation companies necessarily have to innovate. Otherwise, they are lagging back (strong price competition, intense competition on product quality, reputation or brand, lack of demand, innovations by competitors, the dominant market share held by competitors).

To explore the innovation networks in food Hungarian industry and to test the determinants of innovation performance, the dataset was collected from the 2012 Community Innovation Survey (CIS 2012a), by a harmonised survey questionnaire. Data were provided by the Eurostat (2018) after we have been accredited for handling individual (micro) data. We applied CIS NACE rev 2. statistical classification of economic activities (manufacture of food products, beverages, and tobacco products) in the European Community for our analysis (Eurostat 2018).

Sample size (440 companies belonging to 10–12 NACE rev 2. categories) can be characterised as follows: 193 companies have under 50 employees (small), 188 firms employed more than 50 and less than 250 workers (medium), and 59 enterprises had at least 250 employees or more (large). In our database, the share of small companies is relatively high (44%) compared to another company size (medium 43% and large 13%) indicating that the smaller Hungarian food companies are dominating the sample.

The CIS survey collected information on the enterprise's innovations and innovation activities during the three years 2010 to 2012 inclusive in Hungary. Innovation was defined as the introduction of a new or significantly improved product, process, organisational-, or marketing method by the enterprise. Innovation must have characteristics or intended uses that are new or which provide a significant improvement over what was previously used or sold by the enterprise. However, innovation can fail or take time to prove itself. An innovation need only be new or significantly improved for the enterprise. It could have been originally developed or used by other enterprises (CIS 2012b).

Descriptive statistics of the variable can be found in Table 1.

Dependent variable capturing innovation performance take values from 0 to 10. It shows how many innovation activities were implemented in the past three years among the ten innovation platforms (Table 1).

The maximum value of the networking intensity (external information sources) variable is 30, while the Hungarian firms used only 28 as maximum sources

Table 1. Descriptive statistics of variables

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Networking intensity	440	3.12	6.25	0	28
Networking scope	440	1.58	3.10	0	10
Innovation performance	440	1.29	1.97	0	10
Strategic behaviour	440	1.73	0.96	0	3
Market obstacles	440	9.87	3.48	0	15
Market openness	440	1.80	1.01	0	3
Total turnover in 2012 (EUR)	439	20 600	53 500	87 122	514 000

Source: own calculation based on CIS (2012a) Hungary

[4]Market openness (open) variable refers to the CIS (2012b). Question 1.3, in which geographic markets did your enterprise sell goods and/or services during the three years 2010– 2012? The aggregated answers for 'other European Union or associated countries' or 'all other countries'.

[5]CIS (2012b) Question 11.3: During 2010–2012, how important were the following factors as obstacles to meeting your enterprise's goals? The aggregated answers for the degree of importance for subquestions (strong price competition, strong competition on product quality, reputation or brand, lack of demand, innovations by competitors, the dominant market share held by competitors).

https://doi.org/10.17221/60/2018-AGRICECON

Table 2. Types of innovation in the Hungarian sample

Type of innovation	Frequency
No innovation	253
New or significantly improved goods	83
New or significantly improved services	3
New or significantly improved methods of manufacturing	40
New or significantly improved logistics	10
New or significantly improved supporting activities	23
New business practices for organising procedures	49
New methods of organising work responsibilities and decision making	45
New methods of organising external relations with other firms	23
Significant changes to the aesthetic design or packaging of a good or service	103
New media or techniques for product promotion	77
New methods for product placement or sales channels	56
New methods of pricing goods or services	54

Source: own calculation based on CIS (2012a) Hungary

for generating possible innovation. It predicts that Hungarian food processing firms did not exploit a higher level of their networking relations.

Networking scope variable (number of innovation activities) ranges between 0 and 10 (its maximum value is 12) (Table 1). It should be noted that 253 firms have 0 values, indicating that 57,5% of Hungarian food companies do not have any innovation activity for higher innovation performance.

The variable which shows the strategic importance of introducing new or significantly improved goods or services ranges from 0 to 3 (zero, low, medium and high importance).

RESULTS AND DISCUSSION

Our paper analysed in what kind of innovation activities the food processing companies in Hungary engage and if they do so, what are the main drivers of their innovation development focusing on the role of innovation networking.

Table 2 suggests that 253 of Hungarian firms do not innovate at all. Product innovation (83) is the second popular activity in food companies. Regarding the process innovation (improved methods of manufacturing) only 40 companies were dealing with this kind of innovation activity. The frequency of organisational innovation (new business practices, organising work responsibilities and decision making, as well as organising external relations) are said to be limited in the sample. Finally, from market innovation activities, the significant changes to the aesthetic design or packaging of a good or service (103) was the most popular innovation area.

Following the activity of design or packaging, the new media or techniques for product promotion (77) was also considerable.

The lowest frequencies can be observed in case of the new or significantly improved services (3), new or significantly improved logistics (10), new methods of organising external relations with other firms (23). By contrast, these innovation activities should be very important in order to compete with the growing Hungarian and EU's markets.

In sum, the food sector can be considered as a slow industry in Hungary. Therefore the packaging and the marketing of goods or services were the most important innovation activity. In contrast, improved services and logistical solutions (service innovation) and information sources from networking were not frequently used compared to the popularity of the organisation and market innovation in Hungary.

Table 3 presents the results of double hurdle estimation of innovation network tails on innovation performance in the Hungarian food industry. Both selection and outcome model hypotheses were confirmed by the estimation. Regression results prove that the number of networking tails (scope), as well as networking intensity, play an important role in explaining innovation performance in the food industry. Furthermore, the firm's openness to

https://doi.org/10.17221/60/2018-AGRICECON

Table 3. Cragg's double hurdle regression results

	Linear	Exponential
Outcome model		
Total turnover (log)	0.207**	0.053**
Strategic behaviour	0.866***	0.203***
Networking scope	0.255***	0.062***
Constant	–3.640**	–0.608
Selection model		
Strategic behaviour	0.247***	0.247***
Market openness	0.312***	0.312***
Market obstacles	0.061**	0.061**
Networking intensity	0.212***	0.212***
Constant	–2.217***	–2.217***
Pseudo R^2	0.2148	0.2138
Number of observations	439	439

*,**,*** represent $p < 0.1, 0.05, 0.01$, respectively

Source: own calculation based on sample data

foreign markets (extra EU) and strategic goals for enhancing innovation stimulate innovation performance similarly. It contributes to the behavioural theory of innovation. Market obstacles also stimulate the Hungarian food companies to go forward the competition and to accelerate its innovation activity to preserve its market position. We can state that the innovation performance similarly and significantly depends on the company's size and its strategic goals. The importance of the company's size suggests the validity of the Schumpeterian model of innovation.

In conclusion, those companies who were able to innovate in Hungarian food processing industry generally had a positive strategic vision and maintained a well-developed innovation network relationship.

CONCLUSION

Even though the food sector plays an important role in Hungary, the food processing sector is a modest innovator, and its innovation performance has declined constantly in last years. This implies that the Hungarian food industry has got rather serious disadvantages in innovation performance compared to the other EU member states.

Understanding the relationship between innovation and performance in both large and small firms is relevant for researchers, policy-makers, and managers. Since the Hungarian CIS (2012b) data contain mainly food companies with less than 250 workers, we focused on the innovation activity of the small and medium-sized enterprises. Our paper analysed whether the food companies in Hungary did engage in innovation activities and if they did so, what were the main drivers of their innovation performance.

Firstly, we explored the impact of innovation network intensity (modes of cooperation) and networking scope (networking sources) on innovation performance in the Hungarian food industry. Secondly, our selection hypotheses tested the role of international openness and market obstacles to innovation. Thirdly, control variables as company size and strategic goals were also tested.

Our data were derived from the EU Community Innovation System (CIS 2012b) survey in 2012, by a harmonised survey questionnaire.

We employed Cragg (1971) double hurdle linear and exponential model to estimate the role of innovation networks on innovation performance. This method also helps in overcoming the selection bias problem.

Regarding the regression, the linear and exponential estimations give similar results. In the selection model, the market obstacles have a less significant effect than in the outcome model. Openness and strategic behaviour are equally important in both estimations.

Outcome model shows that if the network relationships (networking scope, how many information sources they utilise) were intense, the food companies deal with several kinds of innovation activities (*H*4). Furthermore, the total turnover of a firm representing company size (*H*5) is an important driver of innovation (Girma and Hanley 2009, Fernandes et al. 2013). The importance of strategic behaviour (*H*6) shows that it is highly significant both in outcome and selection models as well ($p < 0.01$). In the outcome model, it means that the higher the importance of strategic innovation behaviour the more are the companies doing innovation.

The selection model results suggest that companies internationally not exposed to the global market requirements are less likely to innovate because they are not forced to be innovative by their competitors (*H*2). The market obstacles (*H*3) were also determinant factors of the firm's innovation decisions in line with Aissaoui (2014). Moreover, estimation results prove that the low networking intensity (*H*1) predict a low level of innovation activity in the Hungarian food industry (Chesbrough 2003; Chen et al. 2011; Fertő et al. 2016).

The low level of firm's attitude and strategic innovation goals also concludes a low level of innovation

https://doi.org/10.17221/60/2018-AGRICECON

activity in line with the theory of reasoned action (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980; Indarti and Postma 2013).

In summary, based on our empirical analysis we were able to prove the validity of all of our hypotheses.

In conclusion, those companies who were able to innovate in Hungarian food processing industry generally had a positive strategic vision and well-maintained innovation network relationships.

Further research would focus on comparing the Hungarian result with CIS data of other EU member states in order to explore cross-country differences of innovation networking in the food sector.

REFERENCES

Aissaoui S. (2014): A double–hurdle model for innovative performance: the role of university-industry collaborations. International Journal of Innovation and Applied Studies, 9: 1087–1096.

Ajzen I., Fishbein M. (1980): Understanding Attitudes and Predicting Social Behaviour. Englewood Cliffs, NJ, Prentice-Hall.

Aschhloff B., Schmidt T. (2008): Empirical evidence on the success of R&D cooperation – Happy together? Review of Industrial Organization, 33: 41–62.

Baregheh A., Rowley J., Sambrook S., Davies D. (2012): Innovation in food sector SMEs. Journal of Small Business and Enterprise Development, 19: 300–321.

Belberdos R., Carree M., Diederen B., Lokshin B., Veugelers R. (2004): Heterogeneity in R&D cooperation strategies. International Journal of Industrial Organization, 22: 1237–1263.

Buchmann T., Pyka A. (2012a): The Evolution of Innovation Networks: The Case of the German Automotive Industry. FZID Discussion Papers No. 70–2013. University of Hohenheim, Center for Research on Innovation and Services (FZID). Available at: https://www.econstor.eu/bitstream/10419/71188/1/738555983.pdf (accessed Nov, 2017).

Buchmann T., Pyka A. (2012b): Innovation networks. In: Dietrich M., Krafft J., Elgar E. (eds): Handbook on the Economics and Theory of the Firm. Edward Elgar Publishing Limited Cheltenham: 466–484.

Chesbrough H. (2003): Open Innovation. Harvard University Press: Cambridge, MA.

CIS (2012a): Data of Community Innovation Survey of the European Union. Conducted in Hungary, 2012. Eurostat, European Union.

CIS (2012b): The Community Innovation Survey 2012. The harmonised survey questionnaire, July 23, 2012. Eurostat, European Union. Available at http://ec.europa.eu/eurostat/documents/203647/203701/Harmonised+survey+questionnaire+2012/164dfdfd-7f97-4b98-b7b5-80d4e32e73ee (accessed Nov, 2017).

Colurcio M., Russo-Spena T. (2013): Collaborative Innovation – A Focus on Food SMES in Agricultural and Biological Sciences. Chapter Food Industry, January 16, 2013. INTECH. Available at http://dx.doi.org/10.5772/54616 (accessed Nov, 2017).

Cragg J. (1971): Some statistical models for limited dependent variable with application to the demand for durable goods. Econometrica, 39: 829–944.

Dyer J.H, Nobeoka K. (2000): Creating and managing a high performance knowledge sharing network: The Toyota case. Strategic Management Journal, 21: 345–367.

Dyer J.H, Singh H. (1998): The relational view: cooperative strategy and sources of interorganizational competitive advantage. Academy of Management Review, 23: 660–679.

Edwards T., Delbridge R., Munday M. (2005): Understanding innovation in small and medium-sized enterprises: a process manifest. Technovation 25: 1119–1120.

EFOSZ (2016): Hungarian National Association of food processors. EFOSZ, Hungary. Available at http://www.efosz.hu/prioritasok/versenykepesseg/ (accessed Nov, 2017).

European Innovation Scoreboard (2017): European Innovation Scoreboard – Report. European Commission. Available at: https://ec.europa.eu/docsroom/documents/23923/attachments/1/translations/en/renditions/native (accessed Nov, 2017).

Eurostat (2018): Methodological working papers NACE Rev. 2 Statistical classification of economic activities in the European Community. Office for Official Publications of the European Communities, Luxembourg. Available at: http://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF (accessed May, 2018).

Fernandes C.I., Ferreira J.J.M., Raposo M.L. (2013): Drivers to Firm Innovation and their Effects on Performance: An International Comparison. MPRA Paper No. 46776, 17 May 2013. NECE – Research Unit, University of Beira Interior and NECE. Available at: http://mpra.ub.uni-muenchen.de/46776/ (accessed May 2018).

Fertő I. (2016): The influence of external technology sources on the performance of Hungarian food economy. In: Proceedings EAAE 152nd Seminar on Emerging Technologies and the Development of Agriculture, Novi Sad, Sept 30–Aug 1, 2016.

Fertő I., Molnár A., Tóth J. (2016): Borderless ideas – open innovation in the Hungarian food chain. British Food Journal, 118: 1494–1515.

https://doi.org/10.17221/60/2018-AGRICECON

Fishbein M., Ajzen I. (1975): Belief, Attitude, Intention, and Behaviour: An Introduction to Theory and Research. MA: Addison-Wesley, Reading.

Gellynck X., Kühne B. (2008): Innovation and collaboration in traditional food chain networks. Journal on Chain and Network Science, 8: 121–129.

Gellynck X., Kühne B. (2010): Horizontal and vertical networks for innovation in the traditional food sector. International Journal of Food System Dynamics, 2: 123–132.

Gilsing V.A., Nooteboom B. (2005): Density and Strength of Ties in Innovation Networks: An Analysis of Multimedia and Biotechnology (February 2005). CentER Discussion Paper No. 2005–41. Organization, Tilburg. Available at: https://ssrn.com/abstract=706851 http://dx.doi.org/10.2139/ssrn.706851 (accessed Nov, 2017).

Girma S.H., Hanley A. (2009): R&D and exporting: a comparison of British and Irish firms. Review of World Economics, 144: 750–773.

Indarti N., Postma T. (2013): Effect of networks on product innovation: Empirical evidence from Indonesian SMEs Journal of Innovation Management, 1: 140–158. Available at: http://www.open-jim.org/article/view/14 (accessed Nov, 2017).

Chen J., Chen Y., Vanhaverbeke W. (2011): The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms. Technovation, 39: 362–373. Available at https://doi.org/10.1016/j.technovation.2011.03.002. (accessed Nov, 2017).

Laursen K., Salter A.J. (2006): Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. Strategic Management Journal, 27: 131–150. Available at https://doi.org/10.1002/smj.507 (accessed Nov, 2017).

Leenders R.T.A., Gabbay S.M. (1999): The structure of advantage and disadvantage. In: Leenders R.T.A., Gabbay S.M. (eds): Corporate Social Capital and Liability. Kluwer, New York: 1–16.

Levinson N., Asahi M. (1996): Cross-national alliances and interorganizational learning. Organizational Dynamics, 24: 50–63. Available at https://doi.org/10.1016/0090-2616(95)90071-3 (accessed Nov, 2017).

Mansfield E. (1996): The modern university: contributor to industrial innovation and recipient of industrial R&D support. Research Policy, 25: 1047–1058.

Menrad K. (2001): Innovations at the borderline of food, nutrition and health in Germany – A systems' theory approach. Agrarwirtschaft, 50: 331–341.

Podolny J.M., Page K.L. (1998): Network forms of organization. Annual Review of Sociology, 24: 57–76.

Pyka A. (2002): Innovation networks in economics: from the incentive-based to the knowledge-based approaches. European Journal of Innovation Management, 5: 152–163.

Rampersad G., Quester P., Troshani I. (2010): Examining network factors: commitment, trust, coordination and harmony. Journal of Business & Industrial Marketing, 25: 487–500.

Rothwell R. (1991): External networking and innovation in small and medium-sized manufacturing firms in Europe. Technovation, 11: 93–112.

Rothwell R., Dodgson M. (1994): Innovation and size of firm. In: Dodgson M. (ed.): Handbook of Industrial Innovation. Edward Elgar Publishing Limited, Aldershot: 310–324.

Schumpeter J.A. (1942): Capitalism, Socialism and Democracy. Harper, New York.

Sirelli G. (2000): Innovation and firm performance, summary of session C. In: Proceedings Conference Innovation and Enterprise Creation: Statistics and indicators, France, Nov 23–24, 2000.

Sneep A.G. (1994): Innovation management in the Dutch agro/food industry. Thesis Publishers, Amsterdam.

Stata User's Guide Release 15 (2017): Stata User's Guide Release 14. Stata.com. Available at https://www.stata.com/manuals/rchurdle.pdf (accessed Nov, 2017).

Traill B., Grunert G.K. (1997): Product and Process Innovation in the Food Industry. Chapman & Hall, London.

Vanhaverbeke W., Cloodt M. (2006): Open innovation in value networks. In: Chesbrough H., Vanhaverbeke W., West J. (eds): Open Innovation: Researching a New Paradigm. Oxford University Press, New York.

Vicente M., Abrantes J.L., Teixeira M.S. (2015): Measuring innovation capability in exporting firms. INNOVSCALE International Marketing Review, 32: 29–51.

Wernerfelt B. (1984): A Resource-Based View of the Firm. Strategic Management Journal, 5: 171–180.

Zeng S.X., Xie X.M., Tam C.M. (2010): Relationship between cooperation networks and innovation performance of SMEs. Technovation, 30: 181–194.

Received February 14, 2018
Accepted May 17, 2018
Published online December 7, 2018