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Innovation in the Hungarian food economy

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Abstract: The paper investigates the innovation process in the Hungarian agri-food sector using the concept of open innovation. The empirical analysis is based on the data from a 2011 survey of more than 200 small and medium size agricultural producers, food processors and retailers. There is determined the impact of open innovation and a company's absorptive capacity on the innovation performance employing two stage approaches. First, a cluster analysis is applied to categorise companies based on their open innovation absorptive capacity, firm and managerial characteristics. Second, using semi--non parametric probit models, there is found that open innovation positively influences the innovation performance for the product and market innovation. Estimations indicate that the absorptive capacity has positive impacts on the technological- and organisational innovation and on innovation propensity. The results suggest that there exists a considerable heterogeneity both within and between the supply chain segments regarding to the innovation performance.

Key words: absorptive capacity, food chain, open innovation, SMEs

The former communist countries have to face big difficulties and deficiencies in the course of food production with regard the quantity but especially the quality. The most severe problems have disappeared after 1989, albeit the differences in productivity and the technological progress between the Middle-European and West-European countries have sustained (Steffen and Stephan 2008). The difference is especially great in the agriculture and food industry. At the current growth rate of technical progress, the convergence between the Middle- and Western European countries will be a very slow process (Gorton et al. 2006). Very often they would need a further progress in technology, in the creation of new products and in procurement procedures, which steps would require a further substantial innovation and investment activities (Steffen and Stephan 2008). Notwithstanding that the Middle-European countries have got some cost advantages compared to the West-European ones – which are mainly due to some foreign direct investments – they hardly can show up these pros at the global level.

Therefore, our main concern should concentrate on the quality and innovation issues, which underpin and determine the sustainable competitiveness on the long run. In the recent debates, the researchers concatenate the regional differences in economic performance with the differences in innovation achievements (Abreu et al. 2008). Policy decision makers are devoting more and more attention to the question, how they could effectively influence the innovation systems in order to moderate the regional differences in economic growth. Within the core of this approach, there are the local resources and institutions, which can create an appropriate innovative environment where the benefits and profits deriving from knowledge share are also distributed among enterprises and local institutions (Cooke 2001). This attitude is very closely related to the concept of open innovation which is based on the fact that enterprises (especially small- and medium sized ones) are increasingly using resources outside the boundaries of the firms in order to accelerate innovation (Chesbrough 2003, 2006). While there is a considerable research dealing with the importance of open innovation in the high-tech industries, the number of research studies in food industry is minimal (see e.g. Enzing et al. 2011). At the same time, according to Archibugi et al. (1991),

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the open innovation can especially be interesting for the food enterprises, which (in general circumstances) are more dependent on economic resources outside the industry than the other branches.

The paper investigates the innovation process in the Hungarian food economy. Food industry plays an important role in Hungary with a substantial positive trade balance. Innovation is the fundamental prerequisite in keeping the international competitiveness of the Hungarian food export. Our research can contribute to better understanding of the functioning of the innovation process in the Hungarian food chains, which might be useful both for policy decision makers and practitioners. This analysis concentrates on the characterization of the degree in open innovation at different level of the food chain. The research is based on an empirical survey carried out in 2011 in the Central Hungary Region covering agricultural producers, processors and retailers. In our sample, we have included exclusively SMEs. It allows us to derive broader implications for the members of the SME community, which are important players of the European food industry. In this paper, we concentrate the analysis on the factors influencing the innovation performance, with a special regard to different segments of the innovation activities.

The paper is organised as follows. The next section briefly reviews the literature of the open innovation paradigm. We pay a special attention to the relation between the open innovation and the absorptive capacity of the firms. In addition, we derive hypotheses on the relationships between the effects of openness and the absorptive capacity of the innovation performance. The empirical analysis includes two steps. First, we apply the cluster analysis in which companies are categorised based on their open innovation absorptive capacity, firm and managerial characteristics. Second, we analyse the determining factors of the innovation performance with a special regard to openness, absorptive capacity, firm and managerial characteristics applying a semi nonparametric probit model. Finally, we conclude.

THE ROLE OF OPEN INNOVATION AND ABSORPTIVE CAPACITY

The concept of open innovation was introduced by Chesbrough (2003). The open innovation systems are cited more and more frequently as a notable special mechanism of organizing the innovation processes. The basic idea comes from the observation that "by enlarging your 'research organization' you may be able to tap into a much larger pool of ideas and find such ideas faster than if you limit yourself to the traditional, closed innovation model" (Torkkeli et al. 2009: 178). However, there is a drawback. When sharing knowledge, there is a risk of reducing the potential uniqueness of innovations that are developed. This will lead to increased competitive pressures and limit the possibilities of future profits (Torkkeli et al. 2009). Therefore, open innovation is no guarantee for the success and several authors have studied the conditions under which participating in an open innovation system is more likely to lead to success than failure.

A firm's absorptive capacity (Cohen and Levinthal 1990) and the existence of complementary assets (Teece 1986; Teece et al. 1997) are identified as crucial prerequisites for the success of open innovation. In an open innovation system – in its purest form – all information resources are shared among all participants. In other words, exclusive information has been disclosed. In such an environment, differences in the innovation performance between firms crucially depend on the firm's capacity to acquire and use the available information optimally. Complementary assets – such as the proprietary R&D knowledge, the distribution or service networks and manufacturing capabilities – can be decisive in providing such an edge over competitors.

Absorptive capacity which is based on the more intense application of intangible assets makes the firms able to choose information sources vital for their future functioning. Indicators of the absorptive capacity relate e.g. to the access to skills and external networks. The benefits of openness are therefore crucially dependent on the existence of the complementary resources and the absorptive capacity. While we have explained the difference between both concepts in the previous paragraph, the literature – especially empirical studies – often uses both terms interchangeably (Dries et al. 2012). The reason for this may be related to the difficulty in finding independent proxies for the two concepts. For the reasons of simplicity, in the remainder of this paper we will use absorptive capacity to indicate a combination of a firm's tangible and intangible resources that define 'the ability of a firm to acknowledge the value of new external information, to assimilate it and apply it to its activities' (Cohen and Levinthal 1990). As such, it could be thought of as encompassing the concept of complementary resources.

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Several authors have investigated the complementarity between absorptive capacity and the effective management of external knowledge flows in open innovation systems (Escribano et al. 2009; Barge-Gil 2010). The resource-based view of the firm supports this thesis and suggests that the benefits from combining new and existing knowledge are more likely to occur when based on complementarity rather than similarity (Teece 1986; Harrisson et al. 2001). Following the work by Kostopoulos et al. (2011), we will therefore analyse the innovation performance taking into account not only the direct impacts of external knowledge inflows and absorptive capacity, but also the indirect effect of external knowledge mediated by the existence of potentially complementary internal resources (absorptive capacity). As such, we test two separate hypotheses.

Hypothesis 1:

Open innovation – as evidenced by reciprocity in the external information flows – has a direct positive effect on the innovation performance

Hypothesis 2:

Absorptive capacity – i.e. a firm's own resources and capabilities – has a direct positive effect on the innovation performance

The next section will present empirical evidence on the innovation process in the Hungarian agri-food sector. Because only SMEs have been included, the dataset is likely to underrepresent the total innovation efforts in the Hungarian food industry (especially the in-house innovation is likely to occur more frequently in large enterprises). However, focusing on SMEs is interesting when investigating the openness of the innovation process. Several authors claim that openness creates unique benefits for small firms. Because they have limited access to internal resources to dedicate to the innovation process, they have a greater need to be open to external sources of knowledge. Furthermore, small firms are more vulnerable to the internal innovation project failures as these could compromise the viability of the whole firm. Finally, some authors also suggest that small firms are in a better position than large firms to reap the benefits of open innovation because they are more flexible and can respond more quickly to opportunities. An open innovation process may therefore be more important in the context of SMEs (Rothwell and Dodgson 1994; Bayona et al. 2001; Tether 2002; Barge-Gil 2010; Nieto and Santamaria 2010).

THE SAMPLE AND KEY VARIABLES

To investigate the SMEs' open innovation and to test the determinants of innovation performance, a questionnaire was designed and data were collected from the central region of Hungary in 2011. The sample covers three stages of food chain: producers, processors and retailers. We conducted face-to-face interviews with each respondent[1]. The survey includes information on the "Knowledge accumulation and use in the food industry" as well as on the "Cooperation and clustering as the keys of intense and effective business". In addition to the main data and activities of the enterprises, we have collected data on cooperation and clustering, knowledge, research and innovation management and some financial information. The sample was drawn on the Central Statistical Office' database and the surveyed 231 firms include 64 producers, 59 processors and 109 retailers. The SMS are defined as the firms with less than 250 employees.

The innovation performance was measured on different areas (Battisti and Stoneman 2010) of innovation (technology, product, organization and market). We put the question "When did you change last time your technology/product/organization/market: within a year, in one-two years, in two-three years, three-four years or more than four years?"[2] For measuring the average innovation performance, we took the average value of the four areas of innovation (propensity).

Different indicators have been used in the literature to measure openness in the innovation process and the absorptive capacity. For the former, we use the level of reciprocity in the external knowledge transfer throughout the supply chain. A second indicator measures the reciprocity in external knowledge transfer between competitors. To proxy the absorptive capacity, we use a measure of the company's own R&D expenditures (this is in line with empirical studies by Stock et al. (2001), Cassiman and Veugelers (2002), Oltra and Flor (2003) and Belderbos et al. (2004)).

Apart from our emphasis on the role of the openness of the innovation process and a company's ab-

[1]Interviews have been carried out by BSc students of the "Rural Development Engineer" program of Corvinus University of Budapest. Questionnaire is available upon request from the authors.

[2]The greater number refers to slower innovation.

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Table 1. Description of the explanatory variables

Areas of innovation	
Technological innovation	When did you start to use this technology in your major activity?
Product innovation	When did you start to produce this product?
Organizational innovation	When did you change your organisational structure?
Market innovation	When did you change your marketing (input and output) channels last time?
Innovation propensity	Average of the individual innovation areas
Open innovation and absorptive capacity	
Openness_chain	Is there reciprocity in the knowledge sharing in the supplier-buyer chain?
Openness_rivals	Is there reciprocity in the knowledge transfer among the rivals?
R&D_ratio (absorptive capacity)	R&D/turnover
Supply chain segment	
Producer	Dummy: 1 if the respondent SME is agricultural producer
Processor	Dummy: 1 if the respondent SME is food processor
Retailer	Dummy: 1 if the respondent SME is food retailer
Manager attributes	
Managerial experience	Managerial experience in years
Qualification of the manager	Finished studies ranking from primary school to university degree
Internal characteristics of the enterprise	
Size	Total turnover in 2010 ranked in nine categories
Qualified employees	Ratio of employees able to use computer
External attributes of the enterprise	
Export connections	Dummy: 1 if the enterprise directly sells abroad
Change of business partner	In your opinion, how hard is to change your partner?

sorptive capacity, we derive a number of additional determinants from the literature (Avermaete et al. 2004; Abdelmoula and Etienne 2010). Therefore, we also have included the managerial characteristics, the internal and external specificities of the company, as well as the level of the food chain which the firm is belonging to. Table 1 gives an overview of variables affecting the innovation performance.

The existence of the most recent innovations is not very common in the sample. The average values of different areas of innovation are more than three, except the market innovation (Table 2). The highest values refer to the technological and organizational innovation. It suggests that these companies apply at least three-four years old technology, or rather since that time, they did not perform any organizational innovation. We can observe the lowest value with regard to the market innovation; however, it can refer also to the uncertain business partnership as well.

Questions relating to open innovation show that the knowledge sharing within the supply chain is higher than among the firm and its competitors. The average value of the absorptive capacity is very low which is shown by the less than 5% ratio of the R&D expenditures compared to the total turnover. The average managerial experience is around 15 years and the average manager has finished at least high school. The average sized firm has got around 10–15 million HUF (roughly 33 500–50 000 €) turnover a year. About 70% of employees is able to use computer at the basic level. At the same time, as an average, only 17% of the SMEs sell directly abroad. It is usually difficult to change the business partner.

As the next step, we were curious whether there are differences among the means at different levels of the food chain (Table 3). According to our calculations, the processors are the most ahead in the technological and market innovation. The agricultural producers are lagging behind on each area of innovation, which is not surprising because there are much less possibilities for innovation in the raw material production than in any other phases of the chain. The retailers are on top with regard to the organizational innovation and innovation propensity.

The openness towards competitors is the largest at the farmers and the lowest at the processors. It is

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Table 2. Descriptive statistics of variables

	N	Mean	St. dev.	Min	Max
Technological innovation	221	4.15	1.29	1	5
Product innovation	204	3.24	1.64	1	5
Organizational innovation	209	3.98	1.46	1	5
Market innovation	223	2.84	1.62	1	5
Innovation propensity	193	3.61	1.09	1	5
Openness_chain	227	2.13	1.23	1	5
Openness_rivals	228	2.96	1.28	1	5
Absorptive capacity	223	0.91	0.97	0	3
Managerial experience (year)	230	14.75	10.82	1	50
Qualification of manager	230	7.03	2.33	2	12
Size	212	5.17	1.81	1	9
Ratio of qualified employees	226	69.51	32.40	0	100
Export connections	230	0.17	0.38	0	1
Change of partner	208	3.99	1.14	1	5

Source: Own estimation based on the survey

interesting that agricultural producers seem to be more experienced and educated at the same time. The retailers have more trust in legal institutions than the other two groups. The ratio of qualified employees is the highest at the retailers.

FACTORS DETERMINING THE INNOVATION PERFORMANCE

Results are demonstrated in two steps. First we summarize the estimations calculated by cluster analysis, and then we introduce the results of the semi nonparametric ordered probit model.

Cluster analysis

We employ the cluster analysis with k-means. Both the Calinski–Harabasz pseudo-F index as well as the Dude-Hart index identifies three clusters. Table 4 includes the means of the three clusters, while Figure 1 shows the individual clusters along the supply chain segments. The **first cluster** is the biggest one as far as the number of firms is concerned. It can be characterized as having the highest absorptive capacity and ratio of qualified employees, but the size of the enterprises is the smallest ("*smart small*" firms). The **second cluster** consists of the smallest number of firms, where the enterprises are the most open ones (including export relations), they are the biggest ones according to size, have the most experienced and educated managers, but at the same time, they have got the lowest ratio of qualified employees ("*open big*" firms).

The **third cluster** covers those enterprises where the average values of the variables are the lowest,

Table 3. Means of variables along the food chain

	Farmer	Processor	Retailer	Kruskal-Wallis test
Technological innovation	4.44	4.14	3.90	0.3929
Product innovation	**3.72**	**3.05**	**3.20**	**0.0405**
Organizational innovation	**4.18**	**4.52**	**3.72**	**0.0442**
Market innovation	**3.42**	**2.59**	**2.86**	**0.0138**
Innovation propensity	**3.94**	**3.57**	**3.42**	**0.0238**
Openness_chain	3.02	2.77	2.63	0.7229
Openness_rivals	**2.08**	**1.59**	**1.72**	**0.0001**
Absorptive capacity	0.98	1.16	0.80	0.1260
Managerial experience (year)	**19.92**	**15.57**	**10.11**	**0.0001**
Qualification of manager	**7.66**	**6.80**	**6.39**	**0.0305**
Size	5.16	5.55	5.34	0.7686
Ratio of qualified employees	**54.58**	**63.95**	**77.93**	**0.0001**
Export connections	0.14	0.21	0.17	0.8170
Change of partner	3.96	3.98	4.39	0.2290

Source: Own estimation based on the survey

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Table 4. The results of the cluster analysis

	Smart small	Open big	Constrained medium
Openness_chain	2.10	**2.65**	*1.77*
Openness_rivals	2.96	**3.13**	*2.58*
Absorptive capacity	**1.21**	0.94	*0.68*
Managerial experience (year)	13.90	**19.26**	*12.94*
Qualification of manager	7.27	**7.65**	*6.37*
Size	*5.02*	**5.94**	5.28
Ratio of qualified employees	**98.37**	*14.87*	54.14
Export connections	0.21	**0.23**	*0.12*
Change of partner	3.80	4.06	**4.43**
N	89	31	65

Source: Own estimation based on the survey

except size and the difficulties of partner change. In other words, this cluster can be illustrated as one where the openness and the absorptive capacity are the lowest, there are relatively uneducated managers and the dependence from the biggest sales partners is very high ("*constrained medium*" firms).

The distribution of segments (levels of chain) within the three clusters is considerable different from each other (Figure 1). The first and third cluster are dominated mainly by retailers, while the second one is dominated by agricultural producers. It can imply that we have two types of retailers. In one group, the absorptive capacity and the ratio of qualified employees is high, while in the other group, there is a relatively small level of openness and less educated managers. We also can tell the difference between two groups of farmers. In the first group, we can see a high level of openness and well educated managers,

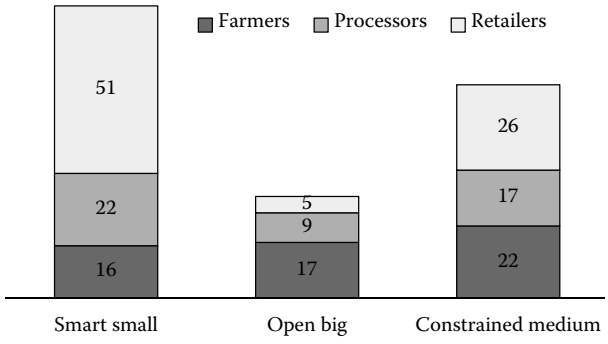

Figure 1. Number of firms across clusters

Source: Own estimation based on the survey

while in the second one, there are just the opposite characteristic firms. The distribution of processors is the most homogenous among the clusters, albeit their ratio is the highest in the second cluster.

Econometric analysis

Because the answers on innovation are based on the 1–5 Likert scale, we can estimate various discrete choice models in order to test our hypotheses. However, the semi parametric literature emphasises that the parametric estimators of discrete choice models are known to be sensitive to departure from the distributional assumptions. Various estimators have been developed for correcting this restrictive nature of parametric models (Stewart 2004). In this paper, we apply the semi-nonparametric approach of Gallant and Nychka (1987).

Table 5 shows the results of the semi-nonparametric ordered probit models. Our outcomes imply that the factors determining the innovation performance may be dissimilar in different areas of innovation. The openness towards competitors may increase the introduction time of innovation in the field of technology and product, while there is no significant effect on other areas. The openness along the supply chain affects differently the introduction time of innovation on the different fields. In the case of the product and market innovation, the openness along the supply chain decreases the introduction time of innovation, supporting our first hypothesis. At the same time, the results are opposite with regard to the technological- and organisational innovation as well as the with the innovation propensity. The absorptive capacity decreases the introduction time of the technological- an organisational innovation and the of the innovation propensity, supporting our second hypothesis.

The managerial and firm specific variables show more or less consistent results. Surprisingly, the managerial experience rather sets back than helps in quickly introducing innovations in the fields of technology, product and market. The effect of the qualification of managers is rather a stimulus for the introduction time of the product and market innovation, while there is a negative effect on the general innovation propensity. According to the average surmise, the greater enterprises are on the edge of the organisational and market innovation. Interestingly, there is no significant effect of the qualified em-

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Table 5. The results of the semi-nonparametric ordered probit model

	Technology	Product	Organisation	Market	Innovation propensity
Openness_chain	**0.457*****	**0.212***	0.123	0.116	0.092
Openness_rivals	**0.172****	**–0.253****	**0.207****	**–0.218****	**0.155***
Absorptive capacity	**–0.686*****	–0.107	**–0.313****	0.031	**–0.358****
Managerial experience (year)	**0.034*****	**0.044*****	–0.001	**0.037*****	0.006
Qualification of manager	0.028	**–0.175*****	0.052	**–0.115****	**0.164****
Size	0.084	0.136	**–0.165****	**–0.242*****	–0.064
Ratio of qualified employees	0.004	0.002	–0.002	–0.001	0.002
Export connections	**0.707*****	–0.048	**–0.800***	–0.194	0.187
Change of partner	0.067	**0.166****	**0.213****	**0.222****	0.031
Retailer	–0.287	0.126	**–1.281*****	0.212	**–1.232*****
Farmer	–0.072	0.432	**–0.790***	0.466	**–1.149*****
N	182	175	171	182	171

Significance levels *** 1%; ** 5%; * 10%

Source: Own estimation based on the survey

ployees on the innovation performance. The export connections rather draw back the quick technological innovation and promote the organisational one. At the end, compared to the processors, belonging to producers or retailers increases the chance of a faster innovation in the fields of the organisational innovation and innovation propensity.

DISCUSSION AND SUMMARY

Innovation performance is identified as the key factor of competitiveness. Innovation is even more relevant in the context of the Hungarian agri-food sector, a sector that has traditionally been internationally oriented but that also suffers from the legacy of the former communist rule in which the quality and innovative content of products and services was not a priority. The paper has looked specifically at the role of openness in the innovation process and the firm's absorptive capacity for explaining the innovative performance.

We find that open innovation is seen as a natural practice of the agri-food SMEs because of two reasons: (*a*) from the technological point of view, the whole chain behaves like a mature industry where the break-through type of innovation is very rare and incremental innovations occur in the intense consultation with buyers, suppliers and other business partners- and institutions, and (*b*) the SMEs do not have enough financial, labour and infrastructural capacity to carry out their own conventional closed type (R&D) of innovation.

We investigated four areas of innovation: the technology, product, organization and market innovation. The estimations reveal that there are differences between the innovation areas. The product and market innovation move very close to each other, which is a good indication of the validity of our analysis. The organizational innovation lags behind the technological one, what also proves that organizational changes are usually following the introduction of new technologies. The results highlight significant differences between the three levels of the food chain with respect to their innovation activities (except the technological innovation). The product innovation is the fastest at the processors, the organizational innovation at the retailers and the market innovation again at the processors level. However, as the average innovation, the retailers show up the highest propensity.

We do not observe any significant difference in openness with the downstream and upstream partners, but we can say that there are significant alterations in openness to competitors at different levels of the chain.

The results of the cluster analysis indicate that the enterprises of the sample are dividing into three groups: smart small, open big and constrained medium ones. This classification of the firms may expose a development path for them: the enterprises belonging to the first cluster may improve their performance if they put a more emphasis on openness, while the

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"open big" firms may make more progress if they develop their absorptive capacities. At the same time, the "constrained medium" position as a trap may threaten both of them.

The semi-nonparametric ordered probit model results imply that the knowledge transfer arriving through open networks to the firms can positively influence the innovation performance just in the field of the product and market innovation. Furthermore, the absorptive capacity of the enterprises can positively affect the innovation progress first of all in the fields of the technological- and organisational innovation, as well as of the innovation propensity. Our results suggest that there exists a considerable heterogeneity both within and between the supply chain segments as well as between the different fields of innovation with regard to the innovation performance.

The empirical results reveal that there exists an ambiguous assessment of open innovation among the food-chain SMEs and open innovation does not necessarily promote the innovation process. Consequently, our first hypothesis is only partly accepted. This proposition is valid just in case of the product and market innovation. However, our second hypothesis seems to be more generalized: the absorptive capacity almost in most areas helps in introducing the innovative solutions.

The analysis indicates that the policy makers would need more targeted innovation development programs in order to solve the tight innovation bottlenecks. These programs should target first of all at expanding the absorptive capacities of the chain's enterprises. We also need a further research in order to investigate whether the restricted use of open innovation systems in the Hungarian food enterprises is much linked to the cost and benefits of the creation of such systems.

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