European Association of Agricultural Economists

140th EAAE Seminar
Theories and Empirical Applications on Policy and Governance of Agri-food Value Chains
Perugia (Italy), 12-13 December 2013

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Innovation in the Hungarian Food Economy [1]

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1. Introduction

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 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 further progress in technology, in creation of new products, in procurement procedures which steps would require 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 global level.
Therefor our main concern should concentrate towards the quality and innovation issues, which underpin and determine the sustainable competitiveness on the long run. In the recent debates 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 can they 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 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 use resources outside the boundaries of the firms in order to accelerate innovation (Chesbrough, 2003; 2006). While there is considerable research dealing with the importance of open innovation in the high-tech industries, the number of research studies in food industry is vanishing (see e.g. Enzing et al., 2011). At the same time according to Archibugi et. al., (1991) 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 important role in Hungary with substantial positive trade balance. Innovation is fundamental prerequisite in keeping the international competitiveness of the Hungarian food export. Our research can contribute to better understanding of the functioning of innovation process in the Hungarian food chains, which might be useful both for policy decision makers and practitioners. Our investigation 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 Central Hungary Region covering agricultural producers, processors and retailers. In our sample we have included exclusively Small- and medium Sized Enterprises (SMEs). It allows us to derive broader implications for the members of the SME community, which are important players of the European food industry. The first results of the survey are published in Dries et. al., (2012). In this paper we extend the analysis and based

on the previous results focusing on the factors influencing the innovation performance, with special regard to different segment of the innovation activities.
The paper is organised as follows. The next section briefly reviews the literature of open innovation paradigm. We pay special attention to the relation between the open innovation and absorptive capacity of the firms. In addition, we derive hypotheses on the relationships between the effects of openness and absorptive capacity on the innovation performance. The empirical analysis includes two steps. First, we apply 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 innovation performance with special regard to openness, absorptive capacity, firm and managerial characteristics applying a semi nonparametric probit model. Finally, we conclude.

2. 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 notable special mechanism of organizing 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, p. 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 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) 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 innovation performance between firms crucially depend on a firm's capacity to acquire and use the available information optimally. Complementary assets – such as proprietary R&D knowledge, 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 absorptive capacity relate e.g. to access of skills and external networks. The benefits of openness are therefore crucially dependent on the existence of complementary resources and 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. The reason for this may be related to the difficulty in finding independent proxies for the two concepts. For 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.
Several authors have investigated the complementarity between absorptive capacity and the effective management of external knowledge flows in open innovation systems (Barge-Gil,

2010; Escribano et al., 2009). 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 work by Kostopoulos et al. (2011) we will therefore analyse 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 external information flows – has a direct positive effect on innovation performance

Hypothesis 2:
Absorptive capacity – i.e. a firm's own resources and capabilities – has a direct positive effect on 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 total innovation efforts in the Hungarian food industry (especially 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 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 (Barge-Gil, 2010; Bayona et al., 2001; Nieto and Santamaria, 2010; Rothwell and Dodgson, 1994; Tether, 2002).

3. The sample and key variables

In the following part of the study we introduce our analysis about the open innovation process in the Hungarian food chain. In order to do this we carried out a survey aiming at the agricultural SMEs in the Central Hungarian Region. Our analysis covers firms involving in agricultural production, primary and further procurement of agricultural goods as well as food retailers with less than 250 employees. Within them we had micro-, mezo- and small enterprises alike. We collected 231 interviews based on standardized questionnaire. In the final sample we had 64 agricultural producers, 58 food processors and 109 retailers.

The innovation performance was measured by different questions referring to the diverse areas of innovation (technology, product, organization and market). The question was about when did you introduce the innovation in question: within a year, in one-two years, in two-three years, three-four years or more than four years. For measuring the average innovation performance we took the average value of the four areas of innovation.

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

Apart from our emphasis on the role of the openness of the innovation process and a company's absorptive capacity, we derive a number of additional determinants from the literature (Avermaete et al., 2004; Abdelmoula and Etienne, 2010). Therefor 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.

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 individual innovation areas
Open innovation and absorptive capacity	
Openness_chain	Is there reciprocity in knowledge sharing in the supplier-buyer chain?
Openness_rivals	Is there reciprocity in 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 sell abroad
Change of business partner	In your opinion, how hard is to change your partner?

The existence of most recent innovations is not very common in the sample. Average values of different areas of innovation are more than three, except market innovation (table 2). The highest values refer to 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 organizational innovation. We can observe the lowest value with regard the market innovation; however it can refer also to uncertain business partnership as well.

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 survey

Questions relating to open innovation show that knowledge sharing within the supply chain is higher than among the firm and competitors. The average value of 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 33500 – 50000 €) turnover a year. About 70% of employees is able to use computer at 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.

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 survey

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 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 organizational innovation and innovation propensity.

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

4. Factors determining 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.

4.1. Cluster analysis

We employ cluster analysis with k-means. Both the Calinski–Harabasz pszeudo-F index as well as the Duda–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. The second cluster consist 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, the most experienced and educated managers, but at the same time they've got the lowest ratio of qualified employees.

Table 4
The results of cluster analysis

	cluster 1	cluster 2	cluster 3
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 survey

The third cluster covers those enterprises where the average values of the variables are the lowest, except size and difficulties of partner change. In other words this cluster can be illustrated as one where the openness and absorptive capacity is the lowest, there are relative uneducated managers and the dependence from the biggest sales partners is very high.

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

Figure 1
Distribution of segments across the clusters

Source: Own estimation based on survey

4.2. Econometric analysis

Because the answers on innovation are based on 1-5 Lickert scale, we can estimate various discrete choice models in order to test our hypotheses. However, semi parametric literature emphasise that parametric estimators of discrete choice models are known to be sensitive to departure from 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 model. 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 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 technological- and organisational innovation as well as the with the innovation propensity. The absorptive capacity decreases the introduction time of technological- an organisational innovation and the of the innovation propensity, supporting our second hypothesis.

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

Source: Own estimation based on survey
Note: Significance levels *** 1%; ** 5%; * 10%

The managerial and firm specific variables show more or less consistent results. It's a bit surprising that the managerial experience rather set back than help in quickly introducing innovations on the fields of technology, product and market. The effect of qualification of managers is rather stimulus for the introduction time of 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 organisational and market innovation. Interestingly there is no significant effect of qualified employees on the innovation performance. The export connections rather draw back the quick technological innovation and promote the organisational one. At the end compared to processors belonging to producers or retailers increases the chance of faster innovation on the fields of organisational innovation and innovation propensity.

5. Summary

Innovation performance is identified as 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 former communist rule in which quality and innovative content of products and services was not a priority.

The study has investigated the role of openness in the innovation process and the absorptive capacity of enterprises in explanation of innovation performance. According to our results the

knowledge transfer arriving through open networks to the firms can positively influence the innovation performance just in the field of product and market innovation. Furthermore the absorptive capacity of the enterprises can positively affect the innovation progress first of all on the fields of technological- and organisational innovation, as well as on innovation propensity. Our results suggest that there exist a considerable heterogeneity both within and between the supply chain segments as well as between the different fields of innovation with regard the innovation performance. It can also indicate that we would need more targeted innovation development programs in order to solve the tight innovation bottlenecks. We also need further research in order to investigate whether the restricted use of open innovation systems in the Hungarian food enterprises how much linked to the cost and benefits of creation such systems.

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