The role of openness and absorptive capacity in explaining innovation performance: Evidence from Hungarian Agri-food Supply Chains [1]

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Abstract (max. 100 words)

This paper investigates the innovation process in the Hungarian agri-food sector using data from a 2011 survey of more than 200 agricultural producers, food processors and retailers. We determine the impact of open innovation and a company's absorptive capacity on innovation performance. A cluster analysis is used to categorise companies based on their innovation performance in technological, product, organisational and market activities. We find that firms that are part of more open networks for knowledge transfer and with more absorptive capacity, are more active innovators. However, openness and absorptive capacity are substitutes rather than complements in the Hungarian food industry.

Keywords

Open Innovation, Absorptive Capacity, SME, Agri-food, Hungary

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1. Introduction

Socialist economies faced significant problems regarding the quality and quantity of consumer goods produced. After 1989, the worst problems were eliminated, but when assessed on productivity and technical change, overall, a substantial gap between Central and Eastern Europe (CEE) and Western Europe (WE) persists (Steffen and Stephan, 2008). This gap is particularly noticeable in agriculture and the food industries. At current rates of technical change, convergence between CEE and WE will be a slow process (Gorton et al. 2006). Often what is required are step changes in technology, the type of goods produced and working practices, which calls for substantial innovation and investment efforts (Steffen and Stephan, 2008). While CEE possesses some cost advantages vis-à-vis WE, which facilitated certain types of Foreign Direct Investment (FDI), in global terms CEE possesses few absolute cost advantages and attention to quality and innovation will matter for its long-term fortunes.

In recent discussions regional differences in economic performance are linked to differences in innovation performance (Abreu et al., 2008). Policymakers are increasingly looking for effective ways to influence the 'innovation system' in an attempt to overcome disparities in regional growth rates. The focus of this approach is on local resources and local institutions that create an innovative environment where benefits from knowledge spillovers are shared between firms and local institutions (Cooke, 2001). This idea is closely linked to the concept of open innovation, which refers to the fact that companies are increasingly using resources from outside the boundaries of the firm to speed up the innovation process (Chesbrough, 2003; 2006). While there is abundant evidence of the importance of open innovation in high-tech industries, studies in the food industry are still limited (see Enzing et al. (2011) for an example). Nevertheless, Archibugi et al. (1991) indicate that a more open system of innovation is particularly interesting for food companies, which normally rely even more on external resources than other industries.

This paper investigates the innovation process in the Hungarian agri-food sector. The agri-food sector is of strategic importance to Hungary, with the food industry traditionally a substantial net exporter. Innovation is a crucial prerequisite in safeguarding the international competitive position of Hungarian agri-food exports. Improved insights in the way the innovation process works in Hungarian agri-food supply chains can be useful for policymakers and practitioners. Our focus will be on the assessment of the degree of openness of innovation at different levels of the agri-food supply chain. For this purpose, we use data from a unique 2011 survey of more than 200 Hungarian agricultural producers, food processors and retail businesses. All interviewed companies can be categorised as SMEs. This makes that insights from this research may also have broader implications as SMEs form the backbone of the European agri-food sector.

The remainder of the paper is organised as follows. Section 2 provides a brief literature review with respect to the open innovation paradigm. Special attention is given to the relation between open innovation and a company's absorptive capacity. Furthermore, we derive hypotheses about the impact of openness and absorptive capacity on innovation performance. The empirical part of the paper will start with a cluster analysis in which companies are categorised based on their innovation performance in technological, product, organisational and market activities. The next section develops an econometric model in which the determinants of innovation performance are investigated. special attention is given to the role of openness in the innovation process. Finally, we draw conclusions.

2. Open innovation and the role of absorptive capacity

The notion of open innovation was introduced by Chesbrough (2003). Increasingly, open innovation systems are advocated as superior mechanisms to organise the innovation process. The basic idea is 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 dissipated. 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 crucial in providing such an edge over competitors. Absorptive capacity refers to more intangible assets that allow firms to select the critical elements of value in shared information sources. Indicators of absorptive capacity relate, for example, to skills and access to 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 three separate hypothesis:

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

Hypothesis 3:
Open innovation has an indirect effect on innovation performance through its interaction with a firm's absorptive capacity. This effect is expected to be positive, to the extent that external knowledge inflows are complementary to internal resources.

The next section will present empirical evidence on the innovation process in the Hungarian agri-food sector. Data was collected through a company survey in 2011 at three levels in the agri-food supply chain: agricultural producers, food processors, and food retail companies. The survey was performed in the Central region of Hungary. Only SMEs have been included. Therefore, 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. Empirical analysis of the role of open innovation for innovative performance

3.1. Innovator types in the Hungarian agri-food sector

The first step in the empirical analysis is the determination of different innovator types among Hungarian food companies. We will employ cluster analysis based on four main areas of innovation: technological innovation; innovations at the product level; organisational innovation; innovation in marketing activities. Interviewed companies were asked about the timing of their most recent innovation activity in these four areas.[2] These four categorical variables are used in the cluster analysis. We have chosen to use the k-medians method to derive different innovator types in the dataset. To determine the optimal number of k (i.e. the number of clusters), we use a method based on the share of variance in the data that is explained by the clusters. Table 1 summarises the relevant information to perform this test.

INSERT TABLE 1 HERE

We find that using four clusters can explain 93% of the variance in recent innovation activities. Increasing the number of clusters does not improve the share of variance explained. The cluster analysis is therefore set-up in such a way that it will result in four groups of

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[2] The questionnaire included four questions – one related to each of the four innovation areas – that asked: 'when did you (1) start to use the technology in your major activity; (2) start to produce your newest product; (3) change your organisational structure; (4) change your marketing channels?' This resulted in four categorical variables, where the categories were defined as: (1) within the last year; (2) 1-2 years ago; (3) 2-3 years ago; (4) 3-4 years ago; (5) more than 4 years ago.

innovator types. Table 2 gives an overview of the innovator types that were identified. About 47% of the interviewed agri-food companies belongs to the "non-innovator" cluster. These companies have not made any type of innovation in the past four years. On the other hand, 29% of the sample have innovated in all four types of innovation areas (technology, product, organisation and market), we call these the "complete innovators". In the intermediate categories of "product-market" (13%) and "technology/product-market" (11%), companies have used combinations of technological types and non-technological types of innovations (Battisti and Stoneman, 2010).

INSERT TABLE 2 HERE

3.2. Determinants of innovation performance

The next step is to determine the factors that affect innovation performance – where we use the different innovator types as performance indicators. 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). 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)).

Table 3 gives an overview of the variables that affect innovation performance. Table 4 provides descriptive statistics based on these variables for each of the four innovator types identified in the cluster analysis. Reciprocity in external knowledge transfers seems to be most common among the product-market innovators. Openness vis-à-vis competitors is a less widespread phenomenon while, surprisingly, this seems to occur more often among non-innovators. Absorptive capacity is higher for all innovators as compared to the non-innovator category. As for the other determinants, our preliminary investigation tells us that complete-innovators are more likely to be younger and highly educated. Larger (and slightly younger) firms are more active innovators. Innovative companies also have a higher average share of skilled labour. Finally, innovators seem to be more focused on international markets as on average they have a higher share of foreign direct investment and are more active on export and import markets. In the next section we will extend this analysis using an econometric model.

INSERT TABLE 3 HERE

INSERT TABLE 4 HERE

3.3. Open innovation and absorptive capacity as determinants of innovation performance

To assess the impact of openness and absorptive capacity in a more quantitative way, we develop the following regression model:

$$InnovPerf = \beta_0 + \beta_1 Openness_i + \beta_2 AbsorpCap + \beta_3 (Openness * AbsorpCap)_i + \varepsilon_i \qquad (1)$$

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Where InnovPerf is a dummy equal to zero for non-innovators and one otherwise, Openness is measured by the variable Info_chain, AbsorpCap equals the variable R&D_share and Openness*AbsorpCap is a term that measures the interaction between absorptive capacity and the openness of the innovation process. The interaction term will allow us to test the hypothesis whether absorptive capacity is a necessary prerequisite or a deterrent for successful open innovation or, in other words, whether absorptive capacity and openness are complements or substitutes.

Table 5 shows the results of the probit regression analysis. We find confirmation of hypotheses 1 and 2. Firms that are part of more open networks for knowledge transfers, are more active innovators. Furthermore, a higher share of absorptive capacity also leads to a better innovation performance. However, hypothesis 3 is rejected. There seems to be a negative relationship between the use of external knowledge and own innovation capacity in creating innovations. Openness and absorptive capacity seem to be substitutes rather than complements in the Hungarian food industry. More generally speaking this would lead to a conclusion that is more in line with a closed innovation model: companies that have sufficient own resources have no need for external knowledge and innovate regardless of their external relations and networks. On the other hand, external knowledge can play an important role in stimulating the innovation process but only for those firms that have no access to internal R&D capacity.[3]

INSERT TABLE 5 HERE

4. Conclusion

Innovative performance is increasingly identified as a key determinant 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. This paper has looked specifically at the role of openness in the innovation process and a firm's absorptive capacity for explaining innovative performance. We find that having access to knowledge transfers through an open network has a positive effect on innovation performance. Furthermore, the absorptive capacity of a firm also positively affects its likelihood to innovate. However, we also find evidence of substitutability between openness and absorptive capacity. In other words, the open innovation paradigm could not be fully supported in the context of the Hungarian food industry. It seems that firms that have sufficient internal resources, are more likely to follow a closed innovation process. In other cases, where companies cannot rely on own R&D efforts, open innovation systems are used to gain access to new innovation ideas. Further research is warranted to investigate whether the limited use of the open innovation system by Hungarian agri-food companies is related to excessive costs or the lack of benefits created in the system.

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[3] We also ran some model extensions in which we tested the effect of other determinants on innovation performance. We found that agricultural producers are relatively less innovative than food companies and retailers. Furthermore, managerial quality - measured by the age of the manager and education level – plays an important role in explaining innovation performance as younger and better educated managers are more active innovators. Finally, relatively larger firms (remember that we are studying SMEs only) innovate more.

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Table 1. The optimal number of innovation clusters

# clusters	MSS / TSS[a]
k = 2	85%
k = 3	85%
k = 4	**93%**
k = 5	80%
k = 6	51%
...	-

[a] MSS/TSS = total variance explained by the model divided by the total variance in the sample; the higher the share of explained variance, the better the clusters fit the total variance in the sample.

Source: Own calculations based on survey data

Table 2. Innovator types in the Hungarian food industry

Type of innovator	%	Technological innovation	Product innovation	Organisational innovation	Market innovation
Non-innovator	47%	No	No	No	No
Product-Market	13%	No	Yes	No	Yes
Tech/Product-Market	11%	Yes	Yes	No	Yes
Complete innovator	29%	Yes	Yes	Yes	Yes

Source: Own calculations based on survey data

Table 3. Description of the explanatory variables

	Open Innovation and absorptive capacity
Info_chain	Dummy is 1 if the manager answered affirmatively to the statement: 'there is reciprocity in knowledge transfer in the supplier-buyer chain'
Info_competitors	Dummy is 1 if the manager answered affirmatively to the statement: 'there is reciprocity in knowledge transfer between competitors'
R&D_share	Dummy is 1 if R&D/total revenue is larger than zero

	Supply chain segment
Agriculture	Dummy is 1 if respondent is SME in agricultural production
Food	Dummy is 1 if respondent is SME in food processing
Retail	Dummy is 1 if respondent is SME in food retailing

	Managerial characteristics
Age	Age of the company manager in years
Experience	Experience of the company manager in years
High education	Dummy is 1 if the company manager has completed higher education

	Internal company characteristics
Size	Dummy is 1 if the gross revenue of the enterprise in 2010 was above the median gross revenue of companies in the sample
Skilled labour	Share of employees with basic computer skills
Own_fin	Dummy is 1 if the manager answered affirmatively to the statement: 'my company has satisfactory reserves'
Firmage	Age of the company in years

	External company characteristics
FDI	Dummy is 1 if the company is owned at least partly by foreign investors' capital
Export	Dummy is 1 if the company exports final products abroad
Import	Dummy is 1 if the company imports inputs from abroad

Table 4. Descriptive statistics on the type of innovator

	Non-Innovator	Product-Market	Tech/Prod-Market	Complete innov.
Open Innovation and absorptive capacity				
Info_chain	33%	54%	33%	36%
Info_competitors	15%	12%	5%	11%
R&D_share	55%	69%	71%	62%
Supply chain segment				
Agriculture	60%	5%	9%	26%
Food	40%	21%	19%	19%
Retail	42%	14%	7%	36%
Managerial characteristics				
Age (yrs)	46	45	45	40
Experience (yrs)	17	15	15	12
High education	25%	31%	33%	45%
Internal company characteristics				
Size (large)	34%	42%	52%	47%
Skilled labour	64%	70%	71%	72%
Own_fin	16%	19%	33%	16%
Firmage (yrs)	13	13	11	9
External company characteristics				
FDI	3%	12%	5%	4%
Export	14%	19%	19%	18%
Import	19%	27%	10%	24%

Source: Own calculations based on survey data

Table 5. The role of openness and absorptive capacity on innovation performance

	Coefficient	Std. Error	Significance
Openness	0.481	0.281	*
AbsorpCap	0.626	0.215	***
Openness*AbsorpCap	- 0.670	0.357	*
Constant	- 0.524	0.158	***

observations 231
Pseudo R^2 0.03

a The significance level is indicated as follows: *** 1%; ** 5%; * 10%
Source: Own calculations based on survey data