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*International Food and Agribusiness Management Review*  
Volume 17 Issue 1, 2014

## **Keeping Your Secrets Public? Open Versus Closed Innovation Processes in the Hungarian Wine Sector**

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### **Abstract**

An effective innovation system is crucial for food companies to cope with competitive pressure. An important issue is whether to innovate by cooperating and sharing ideas or to innovate in-house. Thus the question is how to arrange external ties without compromising unique knowledge and assets. This is particularly controversial in the wine sector, where innovative marketing strategies have to be combined with “exclusive” and “secret” recipes. We use primary data on the Hungarian wine industry to study factors affecting the adoption of an open innovation approach. We find that both regional and company-specific factors affect the openness of innovation processes.

**Keywords:** open innovation, dynamic capabilities, Hungary, wine

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## **Introduction**

Assuring safe, affordable and healthy food under conditions of a rapidly growing global population, shifting dietary patterns, increased competition for land use and environmental concerns is one of the major challenge of the EU agri-food sector (Baregheh et al. 2012a). The European Union tackles these challenges by investing in research and innovation and by facilitating the integration of scientific knowledge and innovation into food chain operations. Research and Development (R&D) are among the main engines of innovation, productivity growth and structural change and hence are essential to guarantee continued competitiveness of the food industry (Boehlje et al. 2011; Capitanio et al. 2009; Capitanio et al. 2010; Garcia Martinez 2013). Nevertheless, compared to other leading industry branches, the agro-food processing industry is generally not considered as being very innovative (Pascucci et al. 2012; Baregheh et al. 2012b).

Recent surveys show that the European food industry is targeting 50% less of its investment in R&D than the non-food industry (European Commission 2009). Furthermore, the return on investment and margins of profit are generally low and can contribute to a lack of incentives to commit to R&D projects. Barriers to R&D initiatives include the costliness and inappropriateness of patenting in the case of food products or new food processing techniques. Moreover, the European agro-food industry is dominated by small and medium enterprises (SMEs) that often lack resources and qualified personnel to invest in research and innovation (European Commission 2009).

In this context a more open and collaborative interaction among food companies could be used to overcome those barriers and lead to higher rate of innovation. In fact, an open innovation approach emphasizes the use of inflows and outflows of knowledge to speed up the internal innovation process of a company, eventually enabling this company to expand its markets (Chesbrough 2006). Therefore, increasing innovation through collaborative and open innovation networks in the agri-food sector is becoming a major focus in the EU policy framework in recent years. Particularly sustaining cooperation among SMEs, and creating a favorable climate for sharing knowledge and developing capabilities is one of the main targets at EU level (Baregheh et al. 2012b; Garcia Martinez 2013).

How to best implement cooperation among companies for sharing knowledge, developing capabilities and fostering open innovation are generally well-accepted concepts but are still highly debated in the agri-food industry (Dries et al. 2013). SMEs operating in this industry have a core business that is often related to production and marketing of traditional food products which rely on locally and family grounded recipes and procedures. Therefore, for many food SMEs cooperation and open innovation create risks for appropriability of valuable resources for the companies even though cooperation and open innovation can be seen as an approach for overcoming organizational and financial limitations. Moreover, whether cooperation is established in the idea creation or in the commercialization phase of the innovation process may lead to entirely different issues in terms of appropriability risks.

This paper contributes to the existing literature by addressing the issue of open innovation in the different phases of the innovation process in SMEs operating in the agri-food sector. The issue is

particularly controversial in the wine sector, where innovative marketing strategies have to be combined with sometimes “exclusive” and “secret” recipes, which make the quality of the products unique. The Hungarian wine industry presents an interesting case for research on the issue of open innovation. Wine contributes significantly to the total turnover in the Hungarian agri-food industry. Wine typically offers opportunities for strong value creation and can be marketed as a premium processed agri-food product. However, in recent years the Hungarian wine industry has been left behind in worldwide trends on premium and super-premium wine markets (Wittwer 2007). The uniqueness of the empirical investigation is twofold: (i) our survey is one of the first particularly designed to investigate innovation and competitiveness of the Hungarian agri-food sector; (ii) the survey is one of the few in Hungary specifically focusing on open innovation issues in the agri-food sector. The research has been motivated by an increasing interest of Hungarian authorities for the wine sector due to its economic potentials. In many developing countries, especially in the so-called “New World of Wine countries” like Chile and South Africa, the wine sector has proved to be able to generate sustained economic wealth during the last 20 years (Anderson 2004).

Besides this increased interest, still one of the most critical questions to be answered by wine companies is how to arrange external ties (i.e. networks of collaboration) with other companies and research organizations - potentially leading to a successful innovation system - without compromising unique and highly specific assets. Therefore, understanding the main factors that lead wine companies to adopt an open, rather than a closed, innovation system is the main research question of this paper. We aim at “unbundling” the open innovation process and analyse whether the degree of openness of wine companies varies in the different stages of innovation and whether patterns of openness and common factors that can predict these patterns exist. More specifically, we analyze the relationship between dynamic capabilities, namely the adaptive and absorptive capabilities<sup>1</sup> of the firm, and open innovation in three important stages of the innovation process: idea creation, development and commercialization. We also control for company characteristics.

The literature on open innovation predicts a low degree of openness in low-tech companies (Dahlander and Gann 2010), including SMEs operating in the agri-food sector (Sarkar and Costa 2008). However, we find that open innovation is quite extensive in the Hungarian wine industry: 25-30% of companies generate, develop and commercialize the majority of new ideas in cooperation with other partners. As a second result, we find that the degree of openness decreases as a company moves through the consecutive stages of innovation. In other words, Hungarian wine companies are significantly more likely to use outside ideas in the idea generation and development stages than in the commercialization stage. This contradicts findings in the literature (Lee et al. 2010). However, conclusions from this earlier research focused on the importance of outbound activities in the later innovation stages, while our data only allow us to

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<sup>1</sup> In the context of this paper *dynamic capabilities* are defined as “the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments” (Teece et al. 1997, 516). *Absorptive capacity* is defined as the ability [of the company] for sense-making of external developments depending on the existing set of [internal] competences (Cohen and Levinthal 1990). Organizations have *adaptive capacity* “when learning takes place at a rate faster than the rate of change in the conditions that require dismantling old routines and creating new ones” (Staber and Sydow 2002, 410-411; Verona and Ravasi 2003).

look at the inbound open innovation processes (i.e. the ‘buy’ decision with respect to knowledge and technology transfer). This may explain our outcomes.

In our econometric approach we use a multivariate probit model to determine the factors that drive the degree of openness at different innovation stages. As dependent variable we use an indicator of the presence of openness at the three main stages in the innovation process, more specifically presence of idea generation, idea development and idea commercialization realized with outsiders (i.e. suppliers, buyers, etc.). The independent variables are derived from the literature and include indicators of (1) companies’ dynamic capabilities, such as absorptive and adaptive capabilities, which are hypothesized to be a precondition to benefit from open innovation; (2) control variables such as companies’ age, size and legal form.

Results show that there is a high, positive correlation between the degree of openness in different stages of the innovation process. This result leads us to conclude that companies are inclined to be open (or closed) throughout the whole innovation process. Drivers that stimulate openness in idea creation in a company may therefore also contribute to a positive attitude towards openness in idea development and commercialization and vice versa. Furthermore, the estimation provides evidence that larger wine companies have more open innovation processes. Other significant results are the positive impact of access to specialized regional suppliers and the negative impact of a company’s age. The former seems to indicate that supplier-buyer relationships are crucial in stimulating knowledge and technology transfer. The latter shows that older wine companies rely more on in-house innovation processes.

The remainder of this article will focus on the role of external partners in stimulating innovations in the EU food sector. After introducing the concept of open innovation, in general and in food SMEs more specifically, we use a case-study of the Hungarian wine sector to explore the concept in more depth. In the last section policy and the managerial implications are thoroughly discussed.

## Literature Review

### *The Open Innovation Paradigm*

Adopting an open innovation process is the new mantra of the agri-food sector. To illustrate, Heinz, one of the largest multinational corporations (MNC) operating in the sector, recently re-focused its R&D and innovation strategy on an open innovation platform, including all relevant phases of food production, thus from agriculture to health science<sup>2</sup>. This has led the company to introduce “consumer-inspired” innovations such as sugar-free ketchup and salt-free soups. Unilever, another agri-food giant, re-shaped its Corporate Social Responsibility policy (Unilever Sustainable Living Plan) with a renewed innovation platform fully re-focused on an open innovation approach<sup>3</sup>. Unilever operates by continuously interacting with established as well potential stakeholders by posting a “wish list” of main challenges and calling for technical

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<sup>2</sup> <http://www.heinz.com/our-food/innovation/research-development.aspx> [accessed November 27, 2013]

<sup>3</sup> <http://www.unilever.com/innovation/collaborating-with-unilever/open-innovation/> [accessed November 13, 2013]

solutions for outsiders. This approach is extended to non-technical issues related to marketing, packaging and product development, including ideas from consumers. Another example is provided by Barilla group, one of the largest pasta-makers in Europe, which funded a branch-company, Academia Barilla, as an open (web-based) platform to collect traditional recipes from the Italian cuisine and to use them to produce world-class food products<sup>4</sup>. SMEs are also increasingly joining the club of open-innovators, especially through industrial and knowledge-based clusters<sup>5</sup>.

This trend can be seen as a reaction of food companies to their exposure to severe (and increasing) competitive pressures worldwide (Boehlje et al. 2011). Adopting an effective innovation process to successfully introduce and develop new products to the market has become one of the most important strategies for food companies (Garcia Martinez 2013; Karantininis et al. 2010). However, whether it is more effective to speed up the innovation process by sharing ideas and resources with other companies or to innovate in-house in a more closed system is still under debate in the academic domain (Sarkar and Costa 2008).

Chesbrough (2003) has been the first to introduce the concept of 'open innovation'. The idea of open innovation indicates that a company is increasingly using inflows and outflows of knowledge to speed up the internal innovation process, and expand the markets for external use of innovation (Chesbrough 2006; Gassmann et al. 2010). From a theoretical perspective, the open innovation literature has focused on different topics such as (i) the degree and type of openness (i.e. outbound or inbound), (ii) effectiveness, (iii) context and (iv) process (Huizingh 2011). In this respect a gap in the literature is an understanding of open innovation in the different stages of the innovation process, from the idea generation to the commercialization phase.

Moreover, if we look at the empirical studies on open innovation, most of them draw on evidence from high-tech industries such as equipment, computers, Information Communication Technology (ICT) or pharmaceuticals (e.g. Christensen et al. 2005; Dittrich and Duysters 2007; Fetterhoff and Voelkel 2006) and have a prevalent focus on large companies and multinational corporations (Chesbrough 2003; Chesbrough 2006). Empirical investigations on open innovation in SMEs operating in the agri-food sector are relatively scarce in literature (Dries et al. 2013; Enzing et al. 2011; Garcia Martinez 2013; Huston and Sakkab 2006; Sarkar and Costa 2008; Vanhaverbeke and Cloudt 2006). 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 (see also Enzing et al. 2011). Moreover, some specific features of the innovation pattern in food companies make that looking at only internal, closed innovation processes (i.e. the effort in R&D) is a misleading indicator of food companies' innovation capacity (Avermaete et al. 2004; Capitanio et al. 2010; Galizzi and Venturini 2008). On the other hand, a strong R&D department and access to well-trained and expert human resources is a necessary condition to adopt a more open innovation system (Wang and Ahmed 2007).

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<sup>4</sup> <http://www.academiabarilla.it/italian-food-academy/sede/default.aspx> [accessed November 11, 2013]

<sup>5</sup> An example is FoodValley operating in the Netherlands (<http://www.youtube.com/watch?v=hEg0a2xCePo>)

### *Defining Open Innovation in the Agri-food Sector*

What makes food companies substantially different from other manufacturing companies is their higher dependency on natural resources - not limited to e.g. fossil fuels – and their need for specific (often tacit and local) know-how in their production processes. Transforming an often heterogeneous and discontinuous flow of raw materials into standardized and marketable products is at the core of a food business. Therefore, more than being involved in ground-breaking and radically innovative projects, food companies (including multinational corporations) are more likely to be active in a very targeted process of stakeholder and technology adaptation (Enzing et al. 2011; Rama 2008). As a result, when scholars look at R&D activities in the agri-food sector they are often inclined to see food companies as conservative, slow-growing and mature businesses, where innovative activities are less likely to occur (Capitanio et al. 2010; Sakar and Costa 2008). On top of that it is rather difficult to assess the degree of openness of the innovation system adopted by a food company. To illustrate, if a wine-maker is producing a world-class wine using and adapting a “local recipe” (which is often the case), this is not regarded as an open innovation approach, though it is fitting in the concept of “increasingly using inflows and outflows of knowledge to accelerate the internal innovation process, and expand the markets for external use of innovation” (Chesbrough 2006).

A review of the literature on open innovation in the agri-food sector performed by Sarkar and Costa (2008) clearly indicates two main shortcomings in this domain: on the one hand, little empirical evidence is available to thoroughly assess whether food companies are approaching open innovation in a different way than other manufacturing companies; on the other hand, most of the contributions in the literature use proxies to measure the presence and degree of open innovation, for example through the presence and number of external ties (see also Enzing et al. 2011). The literature also indicates potential differences of open innovation features in the different stages of innovation (i.e. idea generation, development and commercialization) (Sarkar and Costa 2008). The question is how to measure and assess open innovation in food companies.

Van de Vrande et al. (2009) measure open innovation by identifying technology exploration and exploitation practices. As pointed out by Huizingh (2011) using external ties as a proxy of openness is potentially misleading because it only captures one of the components of the concept, such as the inbound/outbound dynamics. Thus being engaged in a partnership with someone (i.e. a research organization) does not necessarily mean that you are internally making use of your partner’s knowledge (*inbound innovation*), nor that you are using internal knowledge to exploit resources provided by your partner (*outbound innovation*). In effect it merely highlights the underpinning mechanisms and trends leading to an open innovation process (Gassman et al. 2010; Huizingh 2011). Parida et al. (2012) point out that inbound open innovation refers more to exploring and integrating external knowledge to develop and exploit technology. Outbound open innovation is the practice of exploiting technological capabilities, combining internal with also external paths of commercialization (Chesbrough 2003; Chesbrough and Crowther 2006).

In line with this literature review, we conceptualize open innovation as “the proportion of innovations generated in co-operation/collaboration with universities, research organizations, regional customers and/or suppliers, other agri-food companies, venture capitalists and

industry/cluster associations or business assistance centers (open innovation) as opposed to innovations entirely generated within the company (closed innovation)”. We apply this definition to the different stages of innovation, namely the *idea generation* phase (discovering market opportunities or problems to be solved, envisioning areas for technical breakthrough, developing initial insights, basic and applied research), *idea development* phase (developing a deeper conception of products or services, building a model of a product or service, product or process testing) and *commercialization* phase (production, promotion, distribution, and sales of a product/service/technique). In line with Parida et al. (2012) this conceptualization emphasizes more an inbound than an outbound open innovation process. This is particularly relevant in the agri-food sector since inbound open innovation is prevailing in low-tech industries (Chesbrough and Crowther 2006). In low-tech industries, in fact, the exploration and exploitation of external knowledge is more likely to occur through networks of collaboration than through new ventures, spin-offs, or licensing-out (Parida et al. 2012). However, what is more difficult to understand is whether significant differences occur in the different stages of the open innovation process in low-tech industries. Lee et al. (2010) argue that high-tech companies can be more prone to use an open innovation process in the commercialization phase. While high-tech companies show superior capabilities in the phases of creation and development of new technologies, they might suffer from a lack of marketing capabilities when it comes to the phase of commercialization (Lee et al. 2010). Enzing et al. (2011) show that agri-food companies need to implement open innovation processes from idea creation to commercialization. In fact, while they are more likely to engage in large networks of collaboration with upstream partners to use and adapt technologies to innovate their processes (Capitanio et al. 2010), they engage with downstream partners (i.e. retailers) to overcome challenges in introducing new products to the market (Enzing et al. 2011). Based on this literature we formulate the following hypothesis:

*Hypothesis 1: The degree of openness in the innovation process does not differ between the three different stages of the innovation process.*

### *The Role of Company Dynamic Capabilities*

Factors that contribute to a company’s openness, such as dynamic capabilities, must be seen as the main explanatory variables when analyzing open innovation (Dahlander and Gann 2010, Huizingh 2011). As mentioned earlier, the role of openness and connected capabilities is even more important in agri-food companies because they have even more intense interactions with both upstream and downstream partners than other types of companies (Enzing et al. 2011). Agri-food companies may develop some specific capabilities due to the peculiarities characterizing their innovation pattern. On the one hand, agri-food companies are mainly “market-pulled” businesses, therefore involved in incremental rather than radical food product innovations (Enzing et al. 2011; Galizzi and Venturini 2008; Grunert et al. 1997). In this respect, they benefit the most from the interaction with downstream partners, such as retailers and distributors, in order to make the introduction onto the market of new products successful. On the other hand, agri-food companies are “technology-pushed” (Capitanio et al. 2010). Therefore, they are mainly process-innovation oriented through adaptation of equipment and the use of new technologies developed by upstream (high-tech) industries to create new food products (Archibugi et al. 1991; Capitanio et al. 2010; Garcia Martinez and Burns 1999). In line with these statements, we use dynamic capabilities to explain differences in degree and patterns of



open innovation in agri-food companies. Teece et al. (1997) extensively discusses the relationship between dynamic capabilities and innovation-based competition in different industries. In this framework dynamic capabilities are seen as a subset of competences and resources which allow the firm to create new products and processes, and respond to market changes (Teece et al. 1997). Wang and Ahmed (2007) highlight the presence of two main types of dynamic capabilities, namely the *absorptive capabilities*, as a way in which companies create and absorb, integrate and re-configure external knowledge from other organizations (Cohen and Levinthal 1990); and *adaptive capabilities*, as a way in which companies are able to explore and exploit external opportunities in the market (or the geographical context) (Staber and Sydow 2002). Based on these concepts we develop the following research hypotheses:

*Hypothesis 2: Open innovation in the idea creation and development phase is more likely to occur in the presence of dynamic capabilities developed with upstream partners*

*Hypothesis 3: Open innovation in the commercialization phase is more likely to occur in the presence of dynamic capabilities developed with downstream partners*

## Data and Empirical Strategy

### *Study Area and Data Gathering*

Wine production in Hungary has a long history which dates back to the Ancient Greeks.<sup>6</sup> In the Middle Ages the region that corresponds to Hungary had been recognized as an area of special wine-making interest and Tokaji, the most internationally-known Hungarian wine, was first mentioned as early as the 15th Century. During the “Communist era” wine production was oriented towards high yields and reliability, while quality and diversity were sacrificed in order to achieve more homogenized wines (including Tokaji). Moreover the overall production was under public control, including vineyards ownership. Today Hungary is particularly known for producing fiery white wines, as well as their sweeter counterparts. The Hungarian wine sector has experienced important structural changes in the last two decades, due to major changes in the institutional and economic domain. Particularly the sector has moved from more centralized and state-owned companies, to highly fragmented small farm businesses<sup>7</sup> (Sidlovits and Kator 2007). Since the fall of Communism wine-makers are recovering traditional recipes and are experimenting with new techniques that existed before collectivization. The Hungarian Wine Society describes the sector as characterized by “a time of innovation, rivalries and rediscovery – attempts to define the Hungarian version of “international” grape varieties, and to recreate and rehabilitate their indigenous grapes”. Vineyards are experimenting with new blends, new grape varieties in unfamiliar regions, and rediscovering lost varietals. A small number of large wine farms have received interest from Foreign Direct Investment but the majority of the sector is still constituted by domestically owned, micro and small businesses. To illustrate, before transition about 30 large state societies and 50 cooperatives controlled the Hungarian wine production. By

<sup>6</sup> See <http://www.hungarianwinesociety.co.uk/about-hungarian-wines/> for further information.

<sup>7</sup> Average size of vine-growing exploitations is 0.3 ha

the late 2000s about 13,000 enterprises and 29 cooperatives were involved with wine-making activities (i.e. processing and marketing) (Sidlovits and Kator 2007).

The survey was carried out in 2006 in the 22 Hungarian wine regions (Török and Tóth 2013). Altogether 119 questionnaires were sent to managers of wine-making companies and 115 questionnaires<sup>8</sup> were completed, representing an average of five questionnaires for each wine region. During the examined time period (2004-2006), the EU faced aggressive market penetration of new wine producing countries (Australia, Chile and South Africa) and implemented new wine reforms. The new EU framework is more market oriented and competitive, therefore for the Hungarian wine sector – with almost only SME companies – fostering, adapting and spreading innovation is more crucial than ever.

Table 1 reports the main variables. Panel A describes the open innovation variables. We identify open innovation in the Hungarian wine companies when at least 25% of the new ideas have been created / developed / commercialized together with partners outside the boundaries of the firm. Therefore the dependent variable assumes value 1 (presence of open innovation) when managers indicated that more than 25% of the new ideas have been created, developed and/or commercialized with outsiders<sup>9</sup>. All three measures are based on self-assessment of top-managers.

Panel B refers to variables related to dynamic capabilities. We proxy absorptive capacities through the presence of highly-educated workers<sup>10</sup>, the percentage of workers who are able to use English for business relations and the percentage of workers that have a familiarity with ICT. Furthermore, we include variables that are based on the assessment of top-managers about the firm's dependence on specific knowledge and the level of know-how specificity that is present in the company.

To proxy adaptive capabilities we use the intensity of information exchanges the company has with both upstream (suppliers) and downstream parties (buyers) and the reciprocity in sharing know-how with competitors. In the context of this research upstream parties include raw material suppliers (i.e. grapes) as well as service and technology suppliers.

As controls we use firm size, age and legal status (whether a wine company is a private partnership instead of a cooperative or other legal forms).

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<sup>8</sup> 119 questionnaires were filled in by the associates of the Council, which means an average of 5 per wine region. The wineries were questioned about their knowledge and information acquisition-, development- and marketing practice and opinion. A 7 point Lickert-scale evaluation scheme has been used.

<sup>9</sup> The survey included a specific question on openness of idea generation, development and commercialization by means of 4 categories and namely ranging from 0% to 25%, 25% to 50%, 50% to 75% and from 75% to 100%. Therefore we interpreted as “non-open” all companies falling within the first quartile, while considering the companies as “open” otherwise. This is in line with previous empirical evidence on rate of openness in food companies (see Enzing et al. 2011, Garcia Martinez 2013).

<sup>10</sup> Defined as dummy variable that is 1 if at least one employee has finished higher or university education and zero otherwise.

**Table 1.** Descriptive Statistics

Variables			Obs.	Mean	S.D.	Min.	Max
<i>Panel A: Open innovation variables</i>							
	Presence of open innovation at idea generation phase (>25% ideas created with outsiders)	OIgeneration	115	0.635	-	0	1
	Presence of open innovation at idea development phase (>25% ideas developed with outsiders)	OIdevelopmt	115	0.548	-	0	1
	Presence of open innovation at commercialization phase (>25% ideas coming from outside)	OIcommerce	115	0.426	-	0	1
<i>Panel B: Dynamic capabilities variables</i>							
Absorptive capabilities	Presence of high-skilled workers	educ_skill	92	0.304	0.280	0	1
	Percentage of English-speaking workers	eng_skill	115	20.643	25.380	0	100
	Percentage of workers familiar with ICT	ICT_skill	115	44.757	37.235	0	100
	The firm is dependent on specific knowledge	spec_know_depend	114	5.518	1.465	1	7
	The firm owns specific know-how	own_spec_know	114	5.105	1.319	2	7
Adaptive capabilities	The firm has intensive info exchanges with buyers	buy_info	114	5.193	1.211	1	7
	The firm has intensive info exchanges with suppliers	supl_info	114	4.307	1.446	1	7
	Reciprocity in sharing know-how with competitors	rec_info	114	3.500	1.581	1	7
<i>Panel C: Control variables</i>							
	Number of workers	size	115	11.296	19.916	0	130
	Age of the firm	age	105	11.095	6.631	1	47
	Legal status (1 if private partnership)	legalform	115	0.574	0.497	0	1

We now describe our empirical strategy. We consider correlations between the measures of open innovation and dynamic capabilities of agri-food companies:

$$(1) O_j = \alpha + \beta_1 D_j + \beta_2 C_j + \varepsilon_j,$$

where  $O_j$  refers to our open innovation variables, such as the proportion of ideas entirely generated, developed or commercialized in collaboration with other partners of company  $j$ , with  $j=1, \dots, 92$ .  $D_j$  refers to a vector of company dynamic capabilities, and  $C_j$  refers to a vector of company control variables.

We use a multivariate probit model to determine the factors that drive the degree of openness at different innovation stages. The multivariate probit allows the binary dependent variables to be correlated. Since the cross-sectional nature of our data does not allow us to completely avoid issues of endogeneity, reverse causality and omitted variables problems, the results of the econometric estimations should be interpreted as correlations and not as causal relationships.

## Results

As a first result we can see from table 1 that the degree of openness decreases as we move through the different stages of the innovation process. While open innovation occurs in 63% of the surveyed companies in the idea generation phase, this share has decreased to 55% and 43% in the development and commercialization phase respectively.

To test hypothesis 1 we perform Pearson's chi-squared test to determine independence of the variables  $OI_{\text{generation}}$ ,  $OI_{\text{development}}$  and  $OI_{\text{commerce}}$ . The test strongly rejects independence and hence confirms that the degree of openness is strongly correlated in the three different stages of the innovation process in Hungarian wine companies. In other words, we fail to reject hypothesis 1. Moreover, the positive correlation between the degree of openness in different stages of the innovation process also justifies the use of the multivariate probit model. We can conclude that companies are inclined to be open throughout the whole innovation process. Drivers that stimulate openness in idea creation in a company may therefore also contribute to a positive attitude towards openness in idea development and commercialization and vice versa.

In Table 2 we present our results on correlations between open innovation variables and dynamic capabilities in Hungarian wine companies. As a first general observation we point out that only a limited number of coefficients are significantly different from zero. A reason for this may be the small sample size – only 92 observations were retained in the regression model – combined with an extensive list of explanatory variables. Results should therefore be interpreted with caution.

The results in Table 2 are in line with hypothesis 2: open innovation in the idea generation phase is more likely to occur in the presence of intensive information exchanges with suppliers (upstream partners). Furthermore, we find evidence in line with hypothesis 3, namely that open innovation in the commercialization phase is stimulated by information flows between the wine companies and downstream buyers (i.e. retailers). This points to the relevance of other value chain actors in the innovation process in the wine industry but with an important distinction between the players that affect the first stages of the innovation process (idea generation) as compared to the later stages (commercialization).

**Table 2.** Multivariate Probit Results

Variable	OIgeneration			OIdevelopment		OIcommerce	
	Coef.		Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Presence of high-skilled workers	0.1596		0.6401	0.0430	0.5624	0.7054	0.60613
Percentage of English-speaking workers	0.0189	*	0.0099	0.0029	0.0071	0.0068	0.00802
Percentage of workers familiar with ICT	0.0015		0.0065	0.0040	0.0052	-0.0059	0.00525
The firm is dependent on specific knowledge	-0.1465		0.1301	- 0.1208	0.1104	-0.0673	0.10143
The firm owns specific know-how	-0.2466	*	0.1432	- 0.0224	0.1245	-0.1256	0.12784
The firm has intense info exchanges with buyers	0.0322		0.1506	- 0.0536	0.1279	0.2499 4 *	0.14356
The firm has intense info exchanges with suppliers	0.3106	**	0.1231	0.0868	0.1055	0.1055 5	0.11103
Reciprocity in sharing know-how with competitors	-0.1224		0.1429	- 0.1077	0.1141	-0.1741 *	0.10474
Size	0.0184		0.0151	0.0211 *	0.0124	0.0103	0.008
Age	-0.0494	*	0.0287	- 0.0181	0.0236	-0.0519 **	0.02536
Legal form	-0.2764		0.3579	- 0.5377 *	0.3030	-0.4972	0.31389
Constant	1.3445		1.0627	1.0813	0.8964	0.205	0.94027
Corr_gener_dev	0.83902	** *	0.08653				
Corr_com_gener	0.66411	** *	0.12792				
Corr_dev_com	0.84704	** *	0.07919				

N. sample = 92 valid observations

\* significant at 10% level, \*\* significant at 5% level, \*\*\* significant at 1% level

Other dynamic capabilities that play a role in explaining the degree of openness include the skill level of the labor force and the degree of in-house specific knowledge. In line with the literature, companies that adopt an open innovation process have access to a well-educated workforce. Furthermore, access to own specific know-how in the company is negatively correlated with the openness of the innovation process in the idea generation phase. This may point to a trade-off

between openness and own innovation capacity. As expected, reciprocity in information exchange with competitors is negatively correlated with open innovation in the commercialization phase.

Finally, the control variables show a significant effect of firm size (positive), firm age (negative) and legal form. The former indicate that larger and younger firms are more likely to have an open innovation process. Companies established as private partnerships, on the other hand, are less likely to engage in open innovation.

## **Discussion and Conclusions**

Food companies, policy-makers and practitioners are increasingly looking at open innovation as a promising approach to support the competitiveness of the agri-food sector. However the transition to an open innovation system is not straightforward and requires specific resources and capabilities, as well as a supportive institutional environment. The current study shows that agri-food SMEs in the Hungarian wine industry are actively using “open sources” in their innovation processes, even more than commonly acknowledged in the literature and the policy debate. For example, even in a relatively closed sector, such as the wine sector in Hungary, the degree of openness of companies in all the different stages of the innovation process has been surprisingly high. Looking at the determinants of the openness of the innovation process, we find that the phases of “idea generation” and “commercialization” are more influenced by specific company’s capabilities than the development phase. Openness in the idea generating phase occurs more in companies that have higher shares of English-speaking employees and that have more intense relationships with suppliers. This may point to the importance of the flows of new ideas that come from global trends and from dealing with foreign companies and stakeholders. This result gives support to internationalization strategies at both company and sector level. Furthermore, interactions with suppliers seem important at the idea generation stage. In agribusiness, suppliers form a key component to assure quality and effective sourcing for agri-food companies that want to develop new products and services. This finding supports managerial and policy strategies oriented towards the creation of business parks and rural clusters, where farmers, processors and tech-companies can establish joint ventures and networks to create new products and/or processing technologies. Commercializing new ideas is also affected by the companies’ capabilities, specifically when it comes to the creation of productive interactions with buyers.

Unfortunately, our approach was also affected by some limitations. The dataset didn’t allow us to incorporate differences in regional conditions that can support or constrain the opportunities that companies have to participate in open innovation networks. This is a component of great relevance for shaping policy interventions at national and regional level. Moreover, we know that innovative interactions are deeply affected by proximity and cooperation. This is indeed a challenging issue since it creates the need for change not only in business practices and strategies, but also in the type of policy support provided to agri-food stakeholders and namely a shift from company-based to network/cluster based types of policy support.

## **Acknowledgements**

Data were collected as part of the OTKA K 84327 research project with the assistance of the National Council of Wine Regions, and the analysis was undertaken as part of COMPETE, a research project supported by the EU’s Seventh Framework Programme (Contract No 312029).

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