Title of manuscript: Patterns of innovation in the SMEs of the Hungarian agri-food industry

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Problem Statement

The food and beverage industry is the leading manufacturing industry in the European Union in terms of turnover (16%), value added (13,8%) and employment (14,6). Food and drink industry is less innovative compared to other manufacturing sectors (EU, 2011). Food industry has been regarded as a sector where the R&D spending is very low. A low level of R&D and innovation represents a significant structural weakness for the EU member states compared with the USA (2,6%) and Japan (3,4%). In the food industry R&D spending at 0.5% indicates a lower level of innovation (Arundel and Geuna, 2004).

In Hungary, the food sector plays an important role with high level of export share and positive trade balance. On the contrary, since 1990 the domestic sales of the Hungarian food companies decreased by 40 % (EFOSZ, 2016). Although its share in the output of Hungarian food industry has decreased over the past decade, the food processing industry still remains one of the most important sub-sectors of the country's economy. The industry employed 124.000 workers in 2011 and generated about 6% of the country's exports (EUGO, 2016). Furthermore, about 96% of food companies are micro, small and medium-sized enterprises. On the other hand, the innovation activities of the Hungarian food industry are far below the level needed for boosting the competitiveness (EFOSZ, 2016).

Many types of definition exist for innovation in scientific literature. Two major competing approach of innovation can be highlighted in the management domain: the schumpeterian technological push innovation (linear model of innovation) and the alternative Schmookler's demand pull innovation approach, that refers to innovation stimulated by market demand rather than by scientific discoveries.

According to Schumpeter (1934) innovation can be defined as launch of a new product, application of new methods, opening new markets, acquiring of new resources etc. All these types of innovations allow companies to realize a competitive advantage and economic benefits. Research brings inventions that should be developed and marketed. The inventions that are successfully introduced to the market result in revenues that exceed investments costs. To this approach the search for new technologies is more important than the adaptation to the existing patterns of demand. Consequently, the technological innovation is a driver of competition and profitability (Schumpeter, 1934).

On the other side, Schmookler (1966) emphasized the role of economic factors in innovation, as opposed to scientific discoveries. In his famous book "Invention and Economic Growth" Schmookler has stressed the influence of economic conditions in decisions about science and their effects on the demand for inventions. Therefore he underlines that knowledge and requests are necessary since without demand or need no problems would exist and could not be solved. Schmookler also framed the debate between technology-push (knowledge-induced) and demand-pull (demand-induced) innovation (Schmookler, 1966:12).

According to Walsh, Schmookler was certainly the major contributor to the demand-pull theories of innovation (Walsh, 1984:212). Freeman confirms that Schmookler was the most influential among economists who has given credibility to the demand hypothesis of innovation (Freeman, 1979:208; Freeman et al., 1982:82)

To date, the demand-pull model is rarely employed in the literature and it disappeared from researchers' agendas (Godin, 2013).

Our paper focuses on Schmookler's approach of demand-pull innovation model. The main reason why we have chosen this method is that our analysis was originated in the Scumpeterian model up till now. The results were very in line with other studies' results, but we could not achieve breakthrough novelties. The purpose of our current study – according

to the Smookler's model – is to explore how external demand signals and internal readiness and knowledge resources influence the innovation production/development in Hungarian food industry. We assume that innovation, like other goods or assets can be produced based on the existing set of knowledge, the absorptive and adaptive capacities of companies as well as the availability of new ideas. Therefore, the paper tries to discover, what factors are behind the innovative ideas maintained and developed within the enterprise and realised on the market in the Hungarian food industry?

The paper analysis the relationships between innovation production and its determinants among the agro-food SME companies in Hungary. More specifically, we investigate what factors influence the innovation ideas, which get realised on the market (idea marketing).

Objectives

The food industry is seen less innovative compared to other branches of the economy, especially in the European Union. Innovation is interpreted as a schumpeterian type technological push innovation or as Schmookler's type demand pull innovation. Our paper focuses on the Schmookler's model. The purpose is to explore how external impetuses and internal assets and knowledge sources influence the innovation development in the Hungarian food industry. Results show that tacit knowledge is more important than the explicit one. Accumulation of external explicit knowledge doesn't influence the innovation production of Hungarian SMEs. The use of internal tacit knowledge is significant and relevant in innovation process. We applied OLS and hurdle regression models. The hurdle approach proved to be more in line with our hypotheses.

Methodology

The link between innovative inputs and outputs was introduced by Griliches (1979 and 1990) and developed by Crépon et al. (1998), Lööf and Hesmati (2001) is called the knowledge production function.

The theoretical framework for innovation production model derived from a Cobb-Douglas production function (Lööf, 2004):

$$Q=A\,X^{\alpha}\,K^{\beta}\,e^{\lambda\,t+u} \qquad (1)$$

where Q is the productivity, X is a vector of conventional input variables such as labour, capital, K is a measure of technical knowledge, A is a constant and u represents all other unobserved determinants of productivity. α, β and λ are the estimated parameters.

According to the previous empirical models, our estimated knowledge production functions established consist of four main factors/categories:

- tacit knowledge: specific knowledge of the enterprise, in-house developments, foreign language spoken
- absorptive capacity, access to external resources, demand pull innovation: the reciprocity in knowledge sharing between suppliers and buyers.
- cooperation, R&D spill-overs: new ideas stimulated by universities and research institutes
- R&D spending: R&D ratio compared to turnover.

More precisely our empirical variables show the following descriptive statistics (Table 1).

In accordant with the empirical innovation literature in the food industry the following five hypotheses are tested here:

- The first hypothesis referring to the positive role of the human components of innovation and test effect of the knowledge capital. This gives a good estimation about the innovation related quality of the companies, testing the role of tacit knowledge.
  H1: A firm's own knowledge and idea development have a positive effect on innovation performance of SMEs.
- The second hypothesis highlight that customers' needs would be provided by the suppliers and buyers of the company that can be interpreted as a demand pull innovation process which refers to the Schmookler's type demand pull innovation.
  H2: The knowledge sharing between the food SMEs and their suppliers or buyers can enhance innovation development (demand pull innovation).
- The third hypothesis tests the effect of R&D spending on innovation performance for SMEs. This hypothesis is in line with the Schumpeterian approach and investigates the role of explicit knowledge.
  H3: A firm's R&D spending has a positive or negative effect on innovation performance.
- As fourth hypothesis, the absorptive capacity of companies is captured by the number of foreign language speaking employees. The questionnaire's related question about the foreign language skills of the employees in the selected companies is a good proxy variable and helps to measure the absorptive capacity of them The fourth hypothesis – in line with the third one – investigates the explicit knowledge in general.
  H4: Higher number of foreign language speaking employees may stimulate innovation.
- Finally, the fifth hypothesis investigates the role of academic institutions and universities in firm's innovation development process. Here the spill-over effect is tested, whether there is any relevant connection between the selected companies' innovation process and the universities, research institutions (R&D spill-overs).
  H5: Cooperation between food companies and research institutions, universities has a positive or negative effect on innovation ideas.

To investigate the innovation of SMEs and to test the determinants of innovation production function, the dataset was collected by a Hungarian survey in 2014. The SME is defined here as a firm with less than 250 employees (CIAA, 2005). Our sample covers three stages of the food chain companies: producers, processors and retailers. The survey includes information on "Knowledge accumulation and use in the food industry" as well as on "Cooperation and clustering as the keys of intense and effective business".

The sample was drawn on the database of Hungarian Central Statistical Office and the surveyed 302 firms include 100 producers, 101 processors and 101 retailers.

Results

Our results suggest that interestingly the explicit knowledge (R&D) influences negatively the innovation of SMEs in Hungarian food sector. R&D variable is insignificant and has negative effect on innovation marketing. Consequently, majority of the new ideas of Hungarian food industry do not arise from universities, research institutes.

The firm's inner idea development (IDDEV) has more deterministic positive effect on realising innovative business ideas in food SME sector. Furthermore, the business ideas from buyers or downstream partners (NID2) and specific tacit knowledge (KNL) had a positive effect on innovation performance (Table 1).

As concerns the reciprocity in knowledge sharing, our estimation indicates that innovative business ideas are rather also provided by suppliers and buyers that suggesting demand pull

innovation. REC variable is only significant if we censoring the values representing not existing knowledge sharing among the players of the food chain (REC - selection ll(1).

Absorptive capacity (LANG) has negative significant effect of knowledge production function inducing that foreign language knowledge of employees is not necessarily fostering innovation development.

Table 1: Results of the regression

Variables	OLS model	Hurdle model
NID1	-0.216***	-0.275***
NID2	0.243***	0.202***
IDDEV	0.548***	0.368***
KNL	0.112**	0.079**
REC	0.066	0.030
R&D	-0.062	-0.058
LANG	-0.086	-0.140***
constant	0.663**	1.923***
selection_ll(1)		
REC		1.041***
R&D		-0.282
constant		0.151
F	0,0000	
χ^2		0,0000
Adjusted R^2	0,7629	
Pseudo R^2		0,5512
Number of observations	103	103

Legend: * p<0.1; ** p<0.05; *** p<0.01

Note: selection_ll(1) denotes selection for value 1 in REC and R&D variables. These values were excluded for REC and R&D variables because in that case the knowledge sharing was missing.

Source: Own composition

IN101 NEW IDEAS: how often you get them from universities, research institutes
IN102 NEW IDEAS: how often you get them from buyers, downstream partners
IN207 How many % of IDEA DEVELOPMENT is carried out within the enterprise?
IN401 The enterprise owes exclusive and specific knowledge - KNL
IN602 Reciprocity in knowledge sharing: SUPPLIERS and BUYERS - REC
IN003 How many % of employees speak at least one foreign language? - LANG
IN001 R&D ratio compared to turnover

The high R-square confirms a good model fit (0,7629) for OLS estimation. The relative high value of pseudo R2 (0,55) also validates a good explanation power of Hurdle regression model. Our estimations are mostly robust for OLS and Hurdle models.

Conclusions

In the European Union and in Hungary, the food and beverage industry is the leading manufacturing industry. However, in the food sector, the level of the R&D spending is very low in these regions of the world. Therefore, our study aimed to explore how external impetuses, internal assets and knowledge sources influence the innovation development in the Hungarian food industry in line with Schmookler's model of demand-pull innovation model.

To investigate the innovation of SMEs and to test the determinants of innovation production function, the dataset was collected by a Hungarian survey in 2014. The sample covered three stages of the food chain companies: producers, processors and retailers. Several different indicators have been in order to measure innovation production end its determinants. We were focusing on the indicators of absorptive capacity, demand pull innovation, role of academic cooperation and R&D spending.

We run OLS and censored Hurdle regression model to include the knowledge transfers among the players of food supply chain and simulating ideas carried out within the enterprise.

Results show that in the Hungarian food industry the tacit knowledge is more important and more significant than explicit knowledge. The explicit knowledge (R&D) was insignificant and had negative effect on innovation marketing. It should be noted that in the Hungarian food sector the R&D spending does not foster innovation performance. The firm's inner idea development (IDDEV) had stimulated the realisation of innovative business ideas in food SME sector. Acquiring external knowledge (collaboration with universities and academic institutions) did not influence the innovation production of Hungarian SMEs. In contrast, using internal resources were more relevant in innovation process. Moreover, the business ideas from buyers or downstream partners have encouraged innovation performance. Our estimation indicates that innovative business ideas are rather also provided by suppliers and buyers that suggesting demand pull innovation (reciprocity in knowledge sharing).

Absorptive capacity had negative significant effect of knowledge production function inducing that foreign language knowledge of employees is not necessarily fostering innovation development.

As conclusion the outcome of the paper was threefold. First, it analysed the demand pull innovation in Hungarian food sector. It revealed that tacit knowledge is more important is more significant than explicit knowledge in food sector. Second, it suggests negative role of R&D. Finally, our survey and research was conducted on large and representative sample of Hungarian food SME's.

References

Arundel, A., Geuna, A. (2004): Proximity and the use of public science by innovative European firms. Economics of Innovation and New Technology, 13(6): 559-580.

CIAA (2005), Data & Trends of the European Food and Drink Industry, Brussels, p. 6, Available at: http://www.fooddrinkeurope.eu/documents/brochures/Data_&_Trends_2005.pdf Accessed: 8/12/2016

Crepon, B., Duguet, E. and Mairesse, J. (1998): Research innovation and productivity: An econometric analysis at the firm level. NBER Working Paper No. 6696

EFOSZ (2016): Hungarian National Association of food processors. Available at http://www.efosz.hu/prioritasok/versenykepesseg/ Accessed: 8/12/2016

EU (2011): European Union. Trends and innovation needs in the European Food and Drink Industry Available at http://www.innofoodsee.eu/downloads/trends_and_innovation.pdf

EUGO (2016): Hungarian homepage of EUGO, Hungary's Point of Single Contact (PSC) for enterprises http://eugo.gov.hu/key-facts-about-hungary/main-industries Accessed: 8/12/2016

Freeman, C. (1979): The Determinants of Innovation: Market Demand, Technology, and the Response to Social Problems, Futures, June: 206-15.

Freeman, C. (1982): The Economics of Industrial Innovation, Second edition, Cambridge (Mass.): MIT Press.

Godin, B. (2013): Pushes and Pulls: The Hi(story) of the Demand Pull Model of Innovation. Project on the Intellectual History of Innovation Working Paper No. 13 2013 Available at: www.csiic.ca/PDF/Demand-pull.pdf

Lööf (2004) A Comparative Perspective on Innovation and in Manufacturing and Services CESIS Electronic Working Paper Series Paper No. 01

Lööf, H., Heshmati, A., Asplund, R. and Nåås, S-O. (2001): Innovation performance in Manufacturing Industry: A comparison of Nordic countries. SSE/EFI Working Paper Series in Economics and Finance No. 457 August 6, 2001 Available at: http://swopec.hhs.se/hastef/papers/hastef0457.pdf

Schmookler, J. (1966): Invention and Economic Growth, Cambridge (Mass.): Harvard University Press.

Schumpeter, J. A. (1934): The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle, Harvard Economic Studies, Vol. 46, Harvard College, Cambridge, MA.

Walsh, V. (1984), Invention and Innovation in the Chemical Industry: Demand-Pull and Discovery-Push? Research Policy, 13 (4): 211-34.