INNOVATION ACROSS THE FOOD CHAIN – THE HUNGARIAN CASE*

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ABSTRACT

The small and medium sized enterprises (SMEs) in the Hungarian agri-food sector play determining role. The innovation capacity (efforts, activities and results) however of the individual SMEs is very limited. Food production (including SMEs) has to fulfil food safety requirements in a rapidly increasing extent, which implies a continuous innovation and development process from all market players. In Hungary the agri-food chain had to face a suddenly increased competition especially after the EU enlargement. Based on survey data this paper examines the efforts, activities and results in knowledge acquisition, utilisation, coordination and transfer in the Central Hungarian food SMEs. We have found (using ordered logistic regression) that R&D expenditures, achieved innovations, export/import orientation as well as the networking activity of the SMEs play significant role in market development.

 Keywords: Hungarian agri-food chain, SMEs, innovation capacity, knowledge management, ordered logistic model

INTRODUCTION

The innovation capacity (efforts, activities and results) of the individual small and medium sized enterprises (SMEs) is very limited. They have to restrict themselves due to their resource constrains. On the other side food production (including SMEs) has to fulfil food safety requirements in a rapidly increasing extent, which implies a continuous innovation and development process from all market players who are involved in the food chain (Ziggers, Tjemkes, 2010, Kühne, Gellync, 2010b). It is widely recognised that knowledge accumulation and coordination as base of innovative solutions for the production and technological processes can play decisive role in keeping the firms in competitive position (Alston, 2010).

During the last two decades the Hungarian agri-food sector had to face dramatic changes in its competitive environment. In addition the shock of transition process, retail revolution has evolved much faster than in Western European countries. Structural change in retailing, processing and farming, together with growing market saturation and increasing consumers' concerns regarding product and process quality, have had strong influence not only on the organization and structures, but also on the generation of profits along the food chain. Moreover, the agri-food sector had to face a suddenly increased competition especially after the EU enlargement in 2004 (Csáki, 2005, 2007). As a results of these pressures, agri-food chain, which is generally assumed as mature and relatively low technology sector has been forced to introduce changes affecting all aspects of operation. The only chance for them to overcome the stress of the recent economic crisis is if they explore their innovation capacities through their improved networking activities (Gellynck, Vermeire, Viane and Molnár, 2007, Kühne, Gellync, 2010b).

This paper examines the efforts, activities and results in knowledge acquisition, utilisation, coordination and transfer in the Hungarian food SMEs. The aim of the paper is to determine the pattern of innovation along the food chain focusing on the relationships between the inclination to innovate and a set of firm characteristics. The novelties and contributions of the paper to the literature are twofold. First, although there is increasing literature on the innovation in food industry, but similar research is very limited in the Central and Eastern European countries. Second, contrary to previous studies which concentrated mainly on processors' innovation activity we investigate three stages of food chain: producers, processors, and retailers. This approach allows us to get more insights to better understanding of food chain.

Although innovation is a key concept in economics and widely investigated, there is no unified approach of measuring innovation. Following Lundwall (1992) definition of innovation we focus on four aspects of innovation: product innovation, process innovation, organisational innovation and market innovation. Previous research identified a wide range of determinants of innovation including internal and external factors. We focus on factors which may explain the market success of the firms. These factors are directly linked to innovation (product-, process-, etc.) as well as indirectly influence the sales (like market and export orientation, participation in network activities, etc.)

Our sample is based on a stratified survey (231 SMSs from the agri-food chain: agricultural producers, processors and traders) carried out in the Region of Central Hungary.

We present our results in steps. The first step in the empirical work was an exploratory analysis (principal component analysis) aimed at identifying factors that can help understand food firms' differentiations and which can be used to get an overview of the relationship between firm characters and innovativeness. These relationships were first verified by testing for differences among means. As the next step we then carried out a quantitative analysis to regress characteristics from PCA, to express the propensity to innovate. The third step tests whether the innovation capacity of the firms play significant role in formulating the market development. We regress the firms' R&D expenditures, innovation activity variables, export/import orientation and networking activity against the sales.

Both the exploratory and quantitative analyses revealed the importance of the presence of internal R&D as well as readiness to react on market signal variables to explain the propensity to innovate. The empirical analysis shows that, in the Hungarian agri-food sector, innovation adoption follows different patterns when different level of food chain is considered. Our results highlight the need to provide for diversified intervention strategies to stimulate and enforce innovation in the Hungarian agri-food sector.

LITERATURE OVERVIEW

At the end of the 20th century the role of the knowledge has appraised in every field of the economies, the decreasing importance of the knowledge and capital intensive industries accompanied the appraise of the knowledge intensive organizations and their services (Dobrai, Farkas, 2009). Not only theoretical assumptions but also empirical researches prove

that the knowledge intensive services are the keys for the success in every field of the modern business. The small and medium sized enterprises use these services usually as external resources.

The capacity of SMEs for innovation is very limited. The development and the maintenance of such capacities are usually facing the limit of these companies. On the other hand, there are some industries (e.g. winery) where the high level of competition requires having an innovative management attitude. The limited internal resources and the unused economics of scale force the enterprises to use external resources for the extension of the organizational knowledge and for the effective use of the results of the innovation (Kühne, Gellynck, 2010a).

The agricultural SMEs producing traditional products use vertical and horizontal integration to overcome their deficiency in the field of knowledge and information. The research of Kühne and Gellynck (2010b) focusing on Belgium, Hungary and Italy showed that though some examples exist of both vertical and horizontal integration, the cooperation usually fails because of the lack of trust, the inefficient capital and other resources and the skepticism of cooperation.

The success of the agricultural SMEs requires many preconditions. Because of the size-limits these companies – operating usually as family run businesses – have to be very flexible. In North-Carolina – where the number and proportion of family run businesses is over the average of the USA – the success of local farmers depends mainly on six factors (Yeboah et al, 2010). In addition to important management skills (clear goals, management experiences, financial expertise) and the efforts of product differentiation (special products, diversified activities) the authors state that the access to knowledge is the most important key of success. The smaller organizations can only turn their flexibility to advantages if they are in possession of the required knowledge.

Mihailovic et al (2009) made a research for the former socialist countries and found that the knowledge gained from researches and education could lead the agricultural SMEs towards innovation and technological development. On the other hand, the inherited knowledge in the former Eastern Block is hardly could be transform to innovative advantage, as far the centralized researches were not carried out according to the needs of the market. Therefore the first step should be the establishment of such cooperation where the public research capacities are working together with the private sector.

Based on the Czech experiences of the project called „Best European Practices" the knowledge share of the universities and the research institutes have an important role to increase the level of competitiveness (Tichá, Havlícek 2008) Therefore these institutions are under a growing pressure in order to fulfil such needs.

It is a general concept that the SMEs use their innovative capacities in order to gain and maintain competitive advantages. (Alston, 2010).

DATA AND METHODOLOGY

Data was drawn from a survey carried out in Central Hungary and aiming at the research of cooperation and knowledge management within the SMEs of the food economy. The questionnaires were filled out by trained BSc students and professional interviewers. 231 interviews have been collected.

However the literature of innovation and knowledge management is rapidly increasing in the recent years, we hardly can find predecessor ones around the Hungarian agricultural- and food sector. Therefore we have started with the exploration of the field in question. Exploratory data analysis (EDA) helps us to maximize insight into a data set and discover underlying structure, which is vital viewpoint in our case. However, we did not use the total arsenal of EDA, but only a single element, the Principal Component Analysis (PCA). PCA is especially useful if the underlying structure is not properly discovered (Patterson N, Price AL, Reich D, 2006). Before we carried out PCA we have tested our original survey data for factor simplicity, using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy. For determining the number of components we applied the Kaiser criterion. Regarding the relative great number of original variables we put the criterion for 2.

According to the previous knowledge (c.f. Alston, 2010), we assumed that the differences between the marketing position (the total turnover) of the firms can be significantly explained by the variation of their innovation's principal components. In the questionnaire we asked not for exact turnover, but turnover categories, because the firms are very cautious of providing sensitive information from themselves. In order to check this assumption we have used ologit regression on the revealed principal components. Ordinary logistic regression was applied, because the distance between the adjacent turnover categories is not equivalent and at the same time the categories are ranked from low to high.

The SMEs of the food chain in Central Hungary doesn't compose a homogenous society. Therefore it is also a part of the exploration to point out these differences among them. Basically two dimensions of differentiation can be of interest: along the chain and according to size. The identification along the chain was simple: it was based on their main activity. For the size dimension we could have used the EU standard (micro-, small- and medium employee- and turnover categories), but in this case just a few (not more than 10) firms would have belonged to the "small" category and 2 to the "medium" one. For this reason we applied different categorization, but which is in accordance with the Hungarian standards: a firm is "Micro" in our investigation, if its yearly total turnover is less than 10 million HUF (roughly 40.000 €), "Small" if the turnover is between 10 million and 500 million HUF (between 40.000 and 2 million €) and "Medium" above this amount.

For testing the difference among the principal components along the chain and according to size we used oneway ANOVA as well as Bonferroni, Scheffe, and Sidak multiple comparison tests. These tests examine the differences between each pair of means.

In order to reveal the importance of innovation capacity in formulating the market success we have applied ordered logistic regression for these variables against the market sales. We have tested the first results for the violation of parallel regression assumption with Brant test and after that we used generalized ordered logit model in order to recover the appropriate and significant odds ratios.

EMPIRICAL FINDINGS

Table 1: The survey structure: number of firms answered

	Micro	Small	Medium	**Total**
Producer	20	38	4	**62**
Processor	15	33	4	**52**
Retailer	20	71	7	**98**
Other	2	3	0	**5**
Total	**57**	**145**	**15**	**217**

Source: Authors' own calculations

HYPOTHESES

The examined literature as well as our a priori knowledge has suggested that the innovation characteristics of the firms play significant role in explaining the differences between the performance and behaviour of the organization. We put three hypotheses which have been tested during the empirical analysis.

H1: There exist factors which explain the differences between the firms' innovation capacities

The limited innovation capacity (efforts, activities and results) of the individual small and medium sized enterprises (SMEs) means limited resource for the companies. The firms are necessarily different from each other in the sense that they put different emphasis on the different components of this resource. However, the complex effect of these effort, managerial routines and activities result in heterogeneous innovation capacity.

H2: These factors play significant role in formulating the firms' market positions

If the innovation capacity of a firm is a real economic resource, the extent of efficient use of this resource contribute in positive or negative way to the market realization of the firms' product and services. We assume that the more intensive use of this source comes together with better market position.

H3: The factors differ from each other along the food chain and according to the size

The non-homogeneity nature of the inquired firms incorporates the variance in many aspects. From our point of view the most important dimensions are the position which is occupied by the firm along the food chain, and the size of the firm. According to the previous studies (Gellynck, Kühne1 and Weaver, 2009) the differences are bridged by the quality of relationship between the companies and continuously change during the time.

H4: The innovation capacity of the firms play significant role in determining the market success

The innovation capacity (efforts, activities and results) of the individual small and medium sized enterprises (SMEs) is very limited. They have to restrict themselves due to their resource constrains. The current hypothesis checks whether these activities and efforts lead to business success in terms of market sales. We assume that R&D expenditures, innovation activity and results, export/import orientation as well as participation in social cohesion (networking with other SMEs) positively influence the development of sales.

RESULTS

The analysis was made in steps outlined above and the results are arranged according the hypotheses. We are aware that the scope of scientific problems and questions is much broader than is treated below, but during the exploration of the topic these were the very first questions which were due to start with.

Result 1

Table 2. summarizes the result of the principal component analysis. The eigenvalue of the seventh principal component was less than 2, so this one and all the other components afterward have been dropped from the analysis. The names of the components were given according to the highest component weights.

Table 2: Principal components of the surveyed data

		Proportion
pc1	Knowledge accumulation	19,5%
pc2	Product innovation	12,4%
pc 3	Anticipated innovation advantages	9,3%
pc 4	Technological innovation	5,9%
pc 5	Organizational innovation	5,4%
pc 6	Innovation environment	4,6%
	Total	57,1%

Note: Kaiser-Meyer-Olkin Measure of Sampling Adequacy, KMO = 0.701

Source: Authors' own calculations

Result 2

Table 3 shows the output of the Stata computation. The analyses have resulted in three significant components out of six ones.

Table 3: Comprehensive statistics of the ordered logistic regression

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------------------------------------------------------------------
. ologit Turnover pc1 pc2 pc3 pc4 pc5 pc6

Iteration 0:   log likelihood = -216.68869
Iteration 1:   log likelihood = -210.46211
Iteration 2:   log likelihood = -210.39266
Iteration 3:   log likelihood = -210.39259
Iteration 4:   log likelihood = -210.39259

Ordered logistic regression               Number of obs   =        126
                                           LR chi2(6)      =      12.59
                                           Prob > chi2     =     0.0500
Log likelihood = -210.39259               Pseudo R2       =     0.0291


------------------------------------------------------------------
    Turnover |    Coef.   Std. Err.     z     P>|z|    [95% Conf. Interval]
-------------+----------------------------------------------------
         pc1 |  .0953689   .0534975    1.78   0.075   -.0094843    .2002221
         pc2 |  .0425345   .0702079    0.61   0.545   -.0950705    .1801395
         pc3 |  .1601305   .0797549    2.01   0.045    .0038138    .3164473
         pc4 | -.0648899   .1042558   -0.62   0.534   -.2692274    .1394477
         pc5 | -.1361994   .1073976   -1.27   0.205   -.3466948    .0742961
         pc6 |   .229926   .1165287    1.97   0.048    .001534     .4583179
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Source: Authors' own calculations

Result 3

The third hypothesis assumes that there are significant differences among the means of the principal components. Table 4 comprises the results of the mean comparisons.

Table 4: Mean differences along the chain and according to size

	Producer-Processor	Producer-Trader	Processor-Trader	Micro -Small	Micro -Medium	Small -Medium
pc1						
pc2		**	***	*		**
pc3	**	***				
pc4	***	***		**		
pc5	***	**				
pc6				**		

Source: own estimation based on survey data
Note: * p<0.1; ** p<0.05; *** p<0.01

Source: Authors' own calculations

Result 4

Table 5 shows the significant factors on the level of sales derived from the sample. According to the calculations the age of the organizational structure, the source of new ideas and the

activity in the external trade plays a significant (p<0,05) role on the level of the sales. On the other hand it is important to mention that that the Brant test shows that the parallel regression assumption has been violated therefore we cannot generalize the results.

Table 5: Significant factors on the level of sales

```
Ordered logistic regression                    Number of obs   =        137
                                               Wald chi2(11)   =      42.96
                                               Prob > chi2     =     0.0000
Log pseudolikelihood = -102.36115              Pseudo R2       =     0.1984


--------------------------------------------------------------------------
             |               Robust
       sales | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+------------------------------------------------------------
   #  K5_511 |   .7127048    .1195101    -2.02   0.043     .5130689    .9900193
      K5_201 |   2.094005    .6663552     2.32   0.020     1.122298    3.907036
      K4_301 |   4.546942    2.624096     2.62   0.009     1.467171    14.09153
      K4_302 |   3.553339    2.026937     2.22   0.026     1.161674    10.86899
-------------+------------------------------------------------------------
       /cut1 |  -1.953071    1.541453                     -4.974264    1.068122
       /cut2 |   1.835016    1.549589                     -1.202122    4.872154
--------------------------------------------------------------------------
(#)    K5_511: The age of the organizational structure
       K5_201: The source of new ideas
       K4_301: Export orientation
       K4_302: Import orientation
```

Source: Authors' own calculations

Finally we distributed the sample to three different groups according to the level of the companies' revenue. After the gologit calculations we compared the results of the permeability between the different groups. We could find significant results rather only in the group of the companies with higher level of sales. Table 6 shows the significant results of these the groups.

Table 6: Significant factor of the companies

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Generalized Ordered Logit Estimates            Number of obs   =        137
                                               Wald chi2(22)   =      43.03
                                               Prob > chi2     =     0.0047
Log pseudolikelihood = -96.808585              Pseudo R2       =     0.2419


--------------------------------------------------------------------------
             |               Robust
       sales | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+------------------------------------------------------------
1            |
#     K5_201 |   1.902883    .6593368     1.86   0.063     .9648868    3.752736
-------------+------------------------------------------------------------
2            |
#     K5_511 |    .649442    .1231775    -2.28   0.023     .4478121     .941857
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  K5_512 |      .615727    .1312348    -2.28   0.023     .4054757    .9349999
  K5_201 |     2.534936    1.307739     1.80   0.071     .9222395    6.967716
  K5_301 |     .3580049    .2034525    -1.81   0.071     .1175317    1.090493
  K4_301 |     6.385361    3.770682     3.14   0.002     2.006938    20.31594
  K4_302 |     4.562839    2.726777     2.54   0.011     1.414336    14.72034
  K4_206 |     7.468038    6.028978     2.49   0.013     1.534716    36.34001
-------------------------------------------------------------------------
(#)   K5_201: The source of new ideas
      K5_511: The age of the organizational structure
      K5_512: The age of the marketing channels
      K5_301: Share of the new ideas coming from inside of the company
      K4_301: Export orientation
      K4_302: Import orientation
      K4_206: Cooperation in purchase
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Source: Authors' own calculations

DISCUSSION & CONCLUSIONS

Discussion

The main purpose of this survey is to show up successful patterns for the food and agricultural SMEs in Central Hungary. Our scientific conviction is that the proper treatment of innovation issues within the management of the SMEs can help in successful surviving of the current economic and financial crisis. Only the innovation capacity as economic resource of a firm will not get amortized if it is treated in proper manner. From the other side, the appropriate use of organizational knowledge is a key factor in achieving better market positions.

The SMEs are surrounded by an extremely challenging business environment, where they are pressed both by the suppliers and consumers to innovate. Regarding that their innovation capacity is very much limited; they can utilize this specific economic resource in an efficient way only if they cooperate with other business players.

The scope of this paper partly includes this latter point. As the main target, we were focusing on the main characteristics of innovative behaviour of the agri-food SMEs in Central Hungary, because there is almost no research activity in this field.

Our analysis was made in four steps. **First** we have identified the innovation factors which might explain the differences among the firms. We have found six components which were to be tied to specific innovation areas. The ranking of them shows that the most important factor is the knowledge accumulation: it comprises almost 20% of the original variables' explanation power. It seems to be a bit surprising that the second one of ranking is the product innovation. In the agri-food industry the product innovation plays usually a rather limited role

(Kühne, Gellynck, 2010b). We need to treat this result with care and also need to come back to this point in our next survey.

As a **second** step we carried out an ordered logistic regression so that we could determine the contribution of the principal components (innovation capacity) to the improvement of market position of the firms. Our expectation was that all of them play significant positive role in formulating the turnover. However we experienced that the half of them (**pc1** – Knowledge accumulation, **pc3** – Anticipated innovation advantages and **pc6** – Innovation environment) are significant and positively influence the revenue. The interpretation of these results need some care because coefficient has got other meaning than in the ordinary regressions. Regarding that we applied turnover categories, the pc6 coefficient (0,229926) for example means that if the value of pc6 increased by 1%, the odds of getting into one turnover category higher would be 1,26 (= $e^{0,229926}$).

Within the **third** step we have verified that the companies show up different profiles with respect to their innovation capacity. We have tested the equivalence of means of principal components along the chain and according to size. We made pair comparisons. Due to that procedure we could have made mistakes deriving from the order of subgroups. But the number of the subgroups was just 3 and we carried out three tests which could have revealed if we had made any mistake in the evaluation.

Finally we've found that we cannot generalize our assumptions for all the subgroups, the Brant test shows that there are significant differences. Our findings underline that the higher the level of the sales of the selected firm the more significant factors exist those have a great influence on the revenue. Therefore we can say that among the firms with high level of sales the activity in external trade and the cooperation in purchase have a positive effect on the revenue. This later one underlines that the role of cooperation and the networks play an important role in this field. Regarding the innovation the results say that the more new idea is coming from inside of the companies, the more successful the firm is. The negative correlation of the sales with the age of organizational structure and marketing channels refer to the fact that among the selected company the quick reaction on external and internal change of conditions results t success. The more up to date the firm is in these fields the higher level of sales could be expected.

Conclusions

The results unambiguously show the existence of knowledge-related factors which may explain the differences in the innovation capacity of the food SMEs in Central Hungary.

A large share of these factors positively contribute to increasing the firms' turnover.

The mean differences are more pronounced along the chain than according to size.

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