VOLUME 4, 2011

ISSN 2045-3345

ISSN 2045-3345

ANALYSIS OF TECHNOLOGICAL AND NONTECHNOLOGICAL INNOVATION IN SLOVAKIA 2006 – 2008

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ABSTRACT

The Community Innovation Survey (CIS) 2008 is a survey of innovation activities of enterprises in the EU Member States. The survey collects the information about the product and process innovation as well as organisational and marketing innovation and other key variables during the three-year period from 2006 to 2008 inclusive. The aim of this paper is to analyse innovation processes in Slovakia according to various factors: region, sector, size of enterprise, productivity of labour and so on. Various statistical methods (e.g. contingency tables, logistic regression, ANOVA) are explored for this purpose. The basic results are: (1) the ratio of enterprises with technological and non-technological innovation activities were 33.6% of all enterprises, (2) productivity of labour is significantly higher in Slovak enterprises with innovation activity, (3) the rate of innovation activity varies depending on analysing factors.

JEL CLASSIFICATION & KEYWORDS

■ C10 ■ D22 ■ O31 ■ PRODUCT ■ PROCESS ■ INNOVATION ■ TECHNOLOGY ■ SLOVAKIA

INTRODUCTION

Innovation is a very broadly used term, generally referring to new ways of achieving something. The emphasis lies on applicability: any significant improvement in business practice (either in the product range or in support structures) is classified as innovation. However, the range of possible innovations is extremely broad: from introducing new rules at a company department that facilitates a business process to create a working fusion power plant.

The value of innovation for all EU countries, and for Slovakia as well, was pertinently formulated in the prologue of communication from the European Commission to the European Parliament and its committees in October 2010 (European Commission, 2010, p. 1): “At a time of public budget constraints, major demographic changes and increasing global competition, Europe's competitiveness, our capacity to create millions of new jobs to replace those lost in the crisis and, overall, our future standard of living depends on our ability to drive innovation in products, services, business and social processes and models. This is why innovation has been placed at the heart of the Europe 2020 strategy. Innovation is also our best means of successfully tackling major societal challenges, such as climate change, energy and resource scarcity, health and ageing, which are becoming more urgent by the day.”

Innovations, consequently, contribute to greater competitiveness, sustainability and job creation in the EU. The European Commission is formulating, influencing and, where appropriate, implementing policies and programmes with the aim to increase the innovativeness of EU-based enterprises. At this time of economic downturn, it is particularly necessary to keep track of strategic trends in innovation.

Literature review

The founder of modern theory of innovation was Joseph A. Schumpeter[1] (1934). He identified innovation as the critical dimension of economic change. He argued that economic change revolves around innovation, entrepreneurial activities and market power. He was the first who pointed out that the role of an innovator is vitally important in the economy.

Following Schumpeter, contributors to the scholarly literature on innovation typically distinguish between invention, an idea made manifest, and innovation, ideas applied successfully in practice (e.g. Braunerhjelm & Svensson, 2010). In economics, the change must increase value, customer value, or producer value. The goal of innovation is a positive change to make someone or something better. Innovation and the introduction of it that leads to increased productivity is a fundamental source of increasing wealth in an economy.

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Peter F. Drucker[2] (1993, p. 7) asserted in his work that: "Innovation and entrepreneurship are purposeful tasks that can and should be organized." He proposed (2003) seven sources of innovative opportunities. Four exist within a company or industry (1. unexpected events, 2. incongruities between the expected and the actual, 3. new process requirements, 4. unanticipated changes in industry or market structure) and three exist outside a company in its social and intellectual environment (5. demographic changes, 6. changes in perception, mood, or meaning, 7. new knowledge).

Eric von Hippel (1988) investigated functional sources of innovation. He proposed and tested the implication of replacing manufacturer-as-innovator assumption from the view of an innovation process as predictably distributed across users, manufacturers, suppliers, and others. He presented in series of studies that the sources of innovation vary greatly and the reasons for such differences vary from industry to industry.

[1] Joseph A. Schumpeter (1883 - 1950), Moravian-born American economist and sociologist known for his theories of capitalist development and business cycles. He wrote basic ideas about innovation in book Theorie

[2] Peter F. Drucker (1909 - 2005), Austrian-born writer, management consultant, and self-described “social ecologist”. He has had a distinguished career as a teacher - professor of management in US.

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Historically, most scholars and managers equated innovation primarily with the development of new products and new technologies. But increasingly, innovation is seen as applying to the development of new service offerings, business models, pricing plans and routes to the market as well as new management practices.

Based on the theory of innovation, the third Oslo Manual (OECD, 2005, p. 46) defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations." In addition, the innovation does not need to be something new in the world or even to have been developed by the firm. This Oslo Manual states that: "The minimum requirement for an innovation is that the product, process, marketing method or organisational method must be new (or significantly improved) to the firm. This includes products, processes and methods that firms are the first to develop and those that have been adopted from other firms or organisations."

Innovation is a complicated process of applying new ideas for gainful purposes. The types, quality and quantity of innovation in organizations depend on both its internal and external environment. Changes in the external environment give impetus to organizations to innovate. Innovative concepts and products of organizations in turn diffuse into the external environment. This interplay between the two environments has produced the body of knowledge both in economics and strategic management. The external environment can be subdivided into sectors, such as politics, economics, society, technology or nature. The internal environment is typically described by its organizational structure, resources, climate and culture (Tang, 1998).

Based on CIS data, we can identify only some of external and internal factors of innovation[3] . It is possible to analyse if the innovative activities depend on such external factors as for example: size of the enterprise, branches of economic activity, region; and also some internal factors, such as legal form or type of ownership.

Research hypotheses

Based on the innovation theory and different case studies about innovations compiled in different countries in the world and in the EU, we state several hypotheses about internal and external factors (determinants) of innovative processes in Slovakia.

H1: Enterprises with some innovation activity show significantly higher productivity of labour (factor PP08). (Note: Productivity of labour (PP08) was measured as the ratio between total turnover for given annual period and number of employees in the enterprise.)

H2: There is a higher probability that the big enterprise innovates in comparison to the other size categories (factor: size).

H3: Probability of innovation is differently depending on the branch of economic activity (factor: sector).

H4: Probability of innovation is differently depending on the geographical placement of the enterprise (factor: region).

H5: Probability of innovation is differently depending on legal form of the enterprise (factor: legal form).

H6: Probability of innovation depends on the type of enterprise ownership (factor: ownership).

H7: Probability of innovation is higher once the enterprise belongs to a certain group (factor: group).

H8: Probability of innovation depends on the type of market product realization (factor: market).

With the application of different statistical methods on CIS 2008 data, we tried to verify the hypothesis and the results are presented in this article. First, we used simple frequency and contingency tables that enabled us to compute the probabilities and conditional probabilities for innovation activities of the Slovak enterprises based on individual factors. However, such tables did not provide such evaluation of reviewed differences which would prove whether these differences are or are not of statistical significance. Therefore, we further applied the model of logistic regression that enabled us to quantify the impact of all factors (input variables) on the dependent (target) binary variable INOV2 at once. Logistic regression quantifies the impact of individual factors and tests their significance. All statistical computations were performed in the SAS Enterprise Guide 4.2 system and some also in the MS Excel 2007.

Definition of innovation in CIS 2008

Since 2008, the definition of innovation activities for CIS was extended to non-technological innovations according to the revised Oslo manual (3rd edition from 2005). An innovation is the introduction of a new or significantly improved product, process, organisational method, or marketing method by an enterprise.

This definition of innovation covered 14 variables (questions) in Slovak CIS 2008 questionnaire Inov 1-99. If the enterprise answered "yes = 1" at least once in these 14 questions, then the enterprise had innovation activity. We created a new derived binary variable for innovation, namely INOV2 (1 – event (innovation "yes"), 0 – non-event (innovation "no")). Enterprises that have had any kind of innovation activity (14 variables):

- introduced new or significantly improved products (2 variables),
- introduced a new or significantly improved process (3 variables),
- on-going or abandoned innovation activities for a product and a process (2 variables),
- implemented a new organisational method (3 variables),
- implemented a new marketing concept or strategy (4 variables).

The technological innovations (T) cover first 7 variables and the non-technological innovations (NT) cover last 7 variables.

The methodology of the statistical survey on innovation in Slovakia

The methodology of the statistical survey on innovation in Slovakia was harmonized with the Fourth Community Innovation Survey (CIS 2008 or CIS 8) of the EU member states. This innovation survey was carried out in 3 239 reporting units (Slovak enterprises). The sample accounts for 26.6% of the target population. The response rate was 70.9% from filled in questionnaires. CIS 2008 data contain 2 296 statistical units. The presented results are weighted figures, grossed up for the whole target population of 11 761 Slovak enterprises. The weighting factors were based on shares between the numbers of enterprises in the realised sample and the total number of enterprises in each stratum of the frame population.

[3] That is why the additional selective inquiries focused on other areas are carried out in the EU countries frequently (R&D investments, organizational innovations etc.).

The statistical unit was the enterprise. The set of reporting units was created from the official statistical business register by combination of an exhaustive survey and a stratified sample survey in particular branches of their economic activities. Enterprises with 10 and more employees were included into the survey. The breakdown of enterprises by size class is in the following table (Table 1).

Table 1: Size of enterprises in CIS 2008 survey

Size of enterprises	Number of employees	Frequency in sample	Percent in sample	Frequency in population	Percent in population
small enterprises	10.49	1139	49.61%	9404	79.96%
medium enterprises	50 - 249	738	32.14%	1887	16.04%
large enterprises	250 and more	419	18.25%	470	4.00%
Total		2296	100%	11761	100%

Source: Innovation activity of enterprises in the SR 2006-2008, p. 6 and own calculations

The sample was created by using a simple random selection in each stratum defined by size class according to the number of employees and economic activity. The regional allocation of units in the sample was also taken into consideration. These data are presented in the following table for four regions of NUTS 2 classification (Table 2).

Table 2: Slovak regions by NUTS 2 classification in CIS 2008 survey

Code	Slovak regions by NUTS 2	Slovak districts	Freq. in sample	Percent in sample	Freq. in population	Perc. in population
SK01	Region of Bratislava	1-Bratislava	409	17.81%	2449	20.82%
SK02	West of Slovakia	2-Trnava 3-Trenčín 4-Nitra	87	38.24%	4106	34.91%
SK03	Middle of Slovakia	5-Žilina 6-B.Bystrica	558	24.30%	2701	22.97%
SK04	East of Slovakia	7-Prešov 8-Košice	451	19.64%	2505	21.30%
	Total		2296	100%	11761	100%

Source: Innovation activity of enterprises in the SR 2006-2008, p. 7 and own calculations

According to the Eurostat methodology, the survey covered all enterprises with main economic activity in the branches of industry, construction and services by the table (Table 3 - NACE[4]).

Basic results of our statistical analysis

We present the basic results of innovation activities in Slovak enterprises in the following tables (Table 4 - Table 6) and in the tables in the annex, too (Table 9 - Table 16). The proportion of Slovak enterprises which have had their innovation activities from all enterprises was 33.58%. (949 enterprises in the sample, 3950 in the whole population). The proportion of Slovak enterprises which have not had their innovation activities was 66.42% (1347 in the sample, 7811 in the population). In comparison to the CIS 2006 results, innovation activities increased by 11 percent points (from 25.1% to 36.1%[5]).

Table 3: NACE - branches of economic activity of surveyed enterprises

Sections of NACE Rev. 2 classification	NACE Rev. 2	NACE coding	Freq. in sample	Percent in sample	Freq. in population	Perc. in population
mining and quarrying	5.9	B	47	2.05%	62	0.53%
manufacturing	10.33	C	824	35.89%	4662	39.64%
electricity, gas, steam and air conditioning supply	35	D	103	4.49%	148	1.26%
water supply; sewerage, waste management and remediation activities	36 - 39	E	78	3.40%	165	1.40%
construction	41 - 43	F	424	18.47%	2087	17.75%
wholesale trade, except of motor vehicles and motorcycles	46	G	421	18.34%	2724	23.16%
transportation and storage	49 - 53	H	150	6.53%	801	6.81%
publishing activities	58	J	98	4.27%	479	4.07%
telecommunications	61					
computer programming, consultancy and related activities	62					
information services activities	63					
financial and insurance activities	64 - 66	K	78	3.40%	164	1.39%
architectural and engineering activities; technical testing and analysis	71	M	73	3.18%	469	3.99%
scientific research and development	72					
Total			2296	100%	11761	100%

Source: Innovation activity of enterprises in the SR 2006-2008, p. 6 and own calculations

Table 4: Innovation activity in Slovak enterprises

Innovation (INOV2)	Frequency in sample	Percent in sample	Frequency in population	Percent in population
0 - no	1347	58.67%	7811	66.42%
1 - yes	949	41.33%	3950	33.58%
Total	2296	100%	11761	100%

Source: Own calculations

The proportion of enterprises, that have not innovated at all, was 66.42%. The companies that performed only one type of innovation (only technological (T) or only non-technological (NT)) amounted to 19.74% .The companies that introduced both types of innovations accounted for 13.84% (Table 5). We can see in the next contingency table (Table 6) that the enterprises, which introduced only the technological innovation, accounted for 711 (6.1%) in the whole population (in the sample: 164 enterprises, 7.1%) and those which introduced only the nontechnological innovation, accounted for 1611 (13.7%) in the whole population (in the sample: 298 enterprises, 13%).

When we look at the innovative activities considering the size of the company (Table 9 in Annex), major innovations were performed by large enterprises (67.81%), then by middle enterprises (46.6%) and least by small enterprises (29.26%). From the regional point of view (Table 10), major

[4] NACE - Nomenclature statistique des Activités économiques de la Communauté Européenne (Statistical Classification of Economic Activities in the European Community).

[5] Comparable stats by CIS 2006 data is figure 36.1% and no 33.58%, because the definition of innovation was modified for CIS 2008 (SOSR, 2010 and Eurostat,2011 .

Table 5: Technological (T) and non-technological (NT) innovations

Incidence of technological (T) and non-technological (NT) innovations	Frequency in sample	Percent in sample	Frequency in population	Percent in population
0 - (no T and no NT)	1347	58.67%	7811	66.42%
1 - (T or NT)	462	20.12%	2321	19.74%
2 - (T and NT)	487	21.21%	1628	13.84%
Total	2296	100%	11761	100%

Source: Own calculations

Table 6: Contingency table nontechnological (NT) by technological (T) innovations

Frequency percent of total	INOV_tech (T) in sample			INOV_tech (T) in population		
INOV_nontech (NT)	0	1	Total	0	1	Total
0	1347	**164**	1511	7811	**711**	8522
	58.7%	**7.1%**	65.8%	66.4%	**6.1%**	72.5%
1	**298**	487	785	**1611**	1628	3239
	13.0%	21.2%	34.2%	**13.7%**	13.8%	27.5%
Total	1645	651	2296	9422	2339	11761
	71.6%	28.4%	100%	80.1%	19.9%	100%

Source: Own calculations

innovations were performed by entities in the Middle of Slovakia (SK03 - 41.11%), namely in district 6 - Žilina (46.21% in Table 11). The least innovations were present in the West of Slovakia (SK02 - 25.57%), namely in district 3 - Trenčín (22.47% in Table 11).

By branches of economic activity (Table 12), there was the highest innovation activity in the sector J – Information and Communication, up to 54.98% and vice versa, there was the lowest activity in the sector F – Construction, only 21.84%.

By the type of ownership (Table 13), the innovations were performed mainly in those companies that were controlled by international shareholders (49.42%). Slovak enterprises with domestic Slovak ownership or with other[6] ownership have not innovated at all. By the legal form (Table 14), the innovations were followed mostly within the joint stock companies (52.85%), whereas the limited liabilities and the companies of other legal forms have not performed any innovations.

Innovating Slovak enterprises have placed their products mostly on foreign markets (59.01%), and those that were without innovations, aimed their production mainly at domestic market (75.3%, in Table 16). There have been innovations mostly within those enterprises which belonged to certain group[7] (50.46%, Table 15).

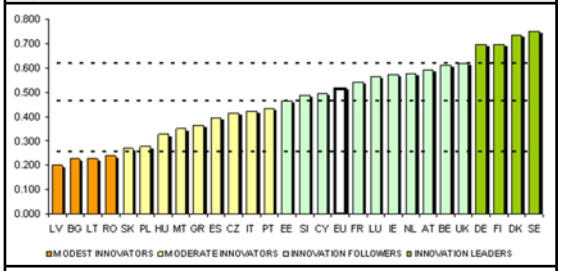
According to CIS 2008 (Eurostat, 2011), the innovation activity in industry and services was reported by 51.6% of enterprises in the EU27 countries (excluding Greece) between 2006 and 2008. Of the EU27 Member States, the highest figures were recorded in Germany (79.9%) and Luxembourg (64.7%) and the lowest rates were observed in Latvia (24.3%), Poland (27.9%) and Hungary (28.9%).

Slovakia belongs to moderate innovators by Innovation Union Scoreboard 2010 (IUS, 2010). This ranking is based on an average innovation performance across 24 indicators. The Member States fall into four performance groups: (1.) innovation leaders, (2.) innovation followers, (3.) moderate innovators and (4.) modest innovators (Figure 1).

[6] Ownership 4 - other covers cooperative, state and municipality ownership.

[7] The group of enterprises consist of two or more independent legal entities in collective ownership.

Figure 1: EU member states' innovation performance



Source: Innovation Union Scoreboard 2010, p. 4

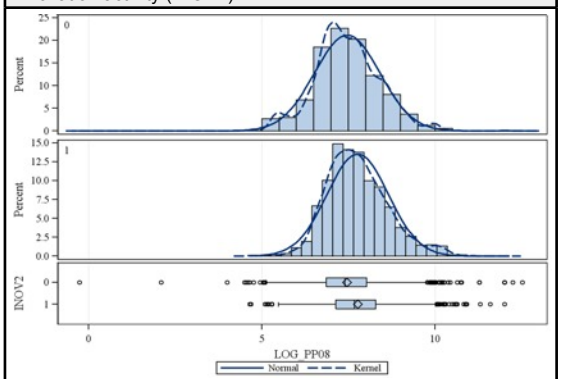
Productivity of labour by innovation activity

This theory says that entities with the innovation activity reach the higher profit (E. von Hippel, 1988) and higher productivity than entities without innovations (see for example Braunerhjelm, 2010). Our analysis has confirmed this hypothesis in Slovakia, too.

In order to use the t-test, the skewness of the analysed variable has been adjusted using the logarithmic transformation. Productivity of labour has been set as a ratio between total turnovers divided by total number of employees. As a result of this transformation, a new variable LOG_PP08 was created.

The figure shows (Figure 2), that the distribution of the variable LOG_PP08 for enterprises with innovation activity (INOV2=1) is moved to higher values. The results of t-test supported our hypothesis H1. They proved that the productivity of labour is significantly higher in enterprises with innovation activity compared to enterprises without innovations (t-statistic = -16.81, p-value <.0001). The results of our logistic regression model also support the hypothesis H1; see Figure 3.

Figure 2: Distribution of productivity of labour (LOG_PP08) by innovation activity (INOV2)



Source: Own calculation (t-test output from SAS Enterprise Guide 4.2)

Within the period being monitored, we selected only enterprises with innovation activity (INOV2 = 1) for further analysis of productivity of labour. There were 949 enterprises in the sample and 3950 in population. We derived a new categorical variable INOV_tn2 with 3 values (categories): (1) nontech – the enterprise introduced nontechnological innovation only; (2) tech – the enterprise introduced technological innovation only; (3) tn2 – the enterprise introduced both nontechnological and technological innovations.

Applying the results using the nonparametric one-way ANOVA method [8], it is evident that the highest level of labour productivity was in enterprises which introduced the nontechnological innovation only (See result in the Table 7 and p-value = 0.0014 for Kruskal-Wallis test). If this method is adopted by size of enterprises separately (3 groups of enterprises), this significant difference was in small enterprises only (10 – 50 employees).

Table 7: Nonparametric One-Way ANOVA for LOG_PP08 by INOV_ tn2

Wilcoxon Scores (Rank Sums) for Variable LOG_PP08

Classified by Variable INOV_tn2

INOV_tn2	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
nontech	1544	3029867	2911212	32863,9	1962,3
tech	679	1239264	1280254,5	25681,3	1825,1
tn2	1547	2839204	2916868,5	32873,6	1835,3

Average scores were used for ties.

Source: Own calculations

Logistic regression model: factors influencing innovation activity

The results of the logistic regression model are in the table (Table 8) and the chart (Figure 3). We modelled a binary target variable INOV2, namely the value 1 - event (innovation "yes") depending on eight explanatory variables (inputs). Only one input is numerical (LOG_PP08) and the remaining seven input variables are categorical. We use reference coding for these input categorical variables (CLASS variables). This reference category for input variables was the category with the higher conditional probability in contingency tables by factors (Table 9 - Table 16 in the Annex). The quality of this logistic model was relatively satisfying (ROC index c = 0.72).

The table (Table 8) gives the logistic regression results for the factors that influence whether a Slovak firm performs innovation activities or not. We can see that all considered determinants (factors) were significant (all p-values < 0.0001). The size of Wald chi-square statistics expresses the importance of the impact of this factor variable to target variable INOV2. The highest value was reached by the factor variable sector (labelled as SKNACE1, Wald Chi-Square = 255.02). The lowest value of Wald Chi-Square is 17.65, which was reached by the variable AQ7308 (i.e. business firm belongs to group). It means that all our basic hypotheses H1 – H8 were supported.

Table 8: Signification of variables in logistic model

Type 3 Analysis of Effects

Effect	DF	Wald Chi-Square	Pr > ChiSq
Sector - SKNACE1	9	255,02	<.0001
Region - OBLAST	3	236,86	<.0001
Productivity - LOG_PP08	1	133,88	<.0001
Size - velkost_kat_08	2	124,93	<.0001
Market - AR3053	3	111,21	<.0001
Legal form - FORMA_3kat	2	38,86	<.0001
Ownership - DRVLST_4kat	3	24,84	<.0001
Group - AQ7308	1	17,65	<.0001

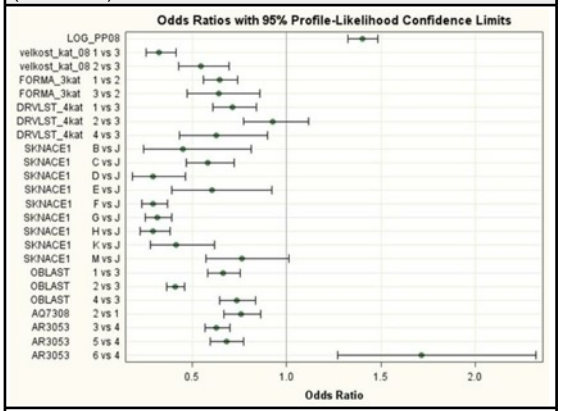
Source: Own calculation (LOGISTIC output from SAS Enterprise Guide 4.2)

[8] The logarithmic transformation didn't eliminate the skewness of the distribution of variable labour productivity (LOG_PP08) in sample 949 enterprises (INOV2 = 1), therefore we used nonparametric ANOVA.

On the following figure (Figure 3), there are 95% confidence limits of the estimated odds ratios for the explanatory variables (factors). Based on them, we can identify the significant and insignificant odds changes in innovation activities of the enterprises, which were caused by individual factors (determinants) in comparison to their referential categories (under the assumption of the stability of the other factors).

The highest probability (or odds) that the enterprise in Slovakia performs some innovation is within the J sector – Information and Communication. J sector belongs to the sector knowledge-intensive high-tech services. In other sectors, there is statistically a significantly lower probability of innovation activity. For example, if we compare the F sector – construction, then there are 3.4-times lower odds for innovation (1/0.295 = 3.39), in C sector – manufacturing, there are 1.7-times lower odds for innovation (1/0.584 = 1.71) and in D sector – electricity, gas, steam and air conditioning supply, there are up to 3.4-times lower odds for innovation (1/0.293 = 3.41). As a result, our hypothesis H3 was confirmed. This hypothesis stated that the probability of innovation activity differs from the branch activity of the enterprise (SKNACE1) and is the highest within the sector knowledge-intensive high-tech services, namely within the J sector – Information and Communication.

Figure 3: Point and interval estimation of odds ratios for factor (INOV2 = 1)



Source: Own calculation (LOGISTIC output from SAS Enterprise Guide 4.2)

Our hypothesis H2 was confirmed by the factor size of the enterprise (velkost_kat_08). It was proved that there is statistically-significant higher chance for innovations in the big enterprises in comparison to the small and medium enterprises.

When it comes to the factor region (OBLAST), then in comparison to the region Middle of Slovakia (reference category 3 - SK03), there are significantly lower chances for innovations than in all other Slovak regions, including enterprises in Bratislava (1 - SK01). The hypothesis H4 was supported.

The variables with lower influence on the modelled variable, but statistically significant, were also the other three examined factors. Those can be included into the internal determinants of the innovations because they are connected to management.

Considering the reference category for the legal form of enterprise (FORMA_3kat) was 2 = join stock company, there is a significantly lower probability for innovations in the limited liability and other legal forms than in the join-stock company (hypothesis H5).

When it comes to the type of ownership (DRVLST_4kat), then the category 3 = international ownership was considered as a referential variable. With other types of ownership, there is a significantly lower probability for innovations. With the type of ownership 2 = foreign, the difference is insignificant. The hypothesis H6 was, therefore, only partially validated.

The last significant variable was AQ7308 – whether the enterprise was a part of the group (1 = yes, 2 = no). From the graph, we can identify that the higher chance for innovations was within enterprises that belonged to some group (AQ7308 = 1), presumably those were owned by foreign investors (hypothesis H7).

The variable type of market product realisation (AR3053) was ordered at the fifth place in the table of signification (Table 8). The highest probability for innovations was within enterprises that realised their production at foreign markets (AR3053 = 6). If we compare these firms to firms which realised their production at national market (AR3053 = 4), then there are 1.7-times higher odds for innovation. Our hypothesis H8 was supported as well.

Conclusion

In Slovakia, three out of ten enterprises innovated and seven out of ten were without innovations. The ratio of the enterprises with some innovation activity (from the examined 14 types of innovation activities) in the timeframe 2006-2008 in Slovakia was 33.6%. In comparison to the average of the EU27 countries, we belong to the group of moderate innovators and it will take a long time until we reach the level of countries from the group of innovation leaders.

The analysis based on the logistic regression model confirmed that the probability of innovation activity in Slovak enterprises was significantly different depending on the examined factors. CIS 2008 data provide only some selective external and internal factors for predicting the probability of innovation activity. Those factors were used as the explanatory variables in the logistic regression model. The quality of the model was relatively satisfying (c = 0.72), but the value 1 – event (target variable INOV2) prediction was not satisfying. The sensitivity (the ability to predict an event correctly) for our model was only 32.6% and the specificity (the ability to predict a non-event correctly) was up to 89%.

Innovations belong to main power of industrial and social development. Innovation processes create positive creative changes in the society. Applied innovation processes result in higher competitive abilities of the enterprises. Higher competitiveness wins the new markets, increases employment rates and prosperity of enterprises, which triggers the increase of regional and whole-country development and prosperity. Innovations in the times of globalization and hyper competitiveness are the only solution to the survival of the enterprise.

All companies can innovate. The important thing is to define the innovation strategy. In general, large enterprises are able to access large markets and small enterprises have the opportunity to access these markets if they join a cluster. The smaller enterprises need to incorporate the innovations in the processes that are necessary for them to be on the level required for inter-company relations when a large market is being accessed. There has to be a commitment to innovation as a priority competitive element to maintain the healthy position of companies on the market and favour their growth. Companies must be aware that innovation will make them progress and fit in with the changing environment, which requires adaptation to the evolution of the markets on which they compete.

The financial crisis which started in 2007 has triggered a global economic downturn. This has resulted in at first falling economic growth rates followed by a real economic decline in many countries. The EU's most innovative firms may be relatively less affected by the economic crisis.

The present economic crisis offers to companies an opportunity for a change. The most companies rightly solve this by cutting costs in order to overcome the crisis with the least damage. But there are also companies that see the crisis as an opportunity to strengthen their competitive advantage by changing the strategy and differentiate them by product innovation. This is mirrored mainly in the field of effective organizational architecture, innovative processes and performance. Companies focus therefore on two basic approaches and their combinations; i.e. the cooperation on the outside (suppliers, partners, customers) and also inwards by the way of corporate entrepreneurship (Okruhlica, 2009, p. 1). Slovakia, and the whole region of Central and Easter Europe, shows an unflattering condition in this innovative model which is alerting for our future.

Acknowledgment

The work described in this paper was partially supported by a grant VEGA 1/0536/10 “Innovations as a strategic foundation of competitive ability of the Slovak Republic. Directions, measuring and support of innovation processes.” funded by VEGA Grant Agency.

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Annex

Table 9: Innovation activity by size of Slovak enterprises

Size of enterprises	Innovation (INOV2)		
(velkost_kat_08)	0 - no	1 - yes	Total
1 - small	70.74%	29.26%	100%
2 - middle	53.40%	46.60%	100%
3 - large	32.19%	**67.81%**	100%
Total	**66.42%**	**33.58%**	**100%**

Source: Own calculations

Table 10: Innovation activity by 4 regions

Region NUTS 2	Innovation (INOV2)		
(OBLAST)	0 - no	1 - yes	Total
SK01	59.17%	40.83%	100%
SK02	74.43%	25.57%	100%
SK03	58.89%	**41.11%**	100%
SK04	68.49%	31.51%	100%
Total	**66.42%**	**33.58%**	**100%**

Source: Own calculations

Table 11: Innovation activity by 8 districts

District	Innovation (INOV2)		
(KRAJ96)	0 - no	1 - yes	Total
1	59.17%	40.83%	100%
2	70.08%	29.92%	100%
3	77.53%	22.47%	100%
4	75.99%	24.01%	100%
5	63.41%	36.59%	100%
6	53.79%	**46.21%**	100%
7	70.36%	29.64%	100%
8	65.67%	34.33%	100%
Total	**66.42%**	**33.58%**	**100%**

Source: Own calculations

Table 12: Innovation activity by branches of economic activity NACE Rev. 2

Branch	Innovation (INOV2)		
(SKNACE1)	0 - no	1 - yes	Total
B	62.90%	37.10%	100%
C	62.75%	37.25%	100%
D	66.60%	33.40%	100%
E	65.62%	34.38%	100%
F	78.16%	21.84%	100%
G	67.69%	32.31%	100%
H	73.95%	26.05%	100%
J	45.02%	**54.98%**	100%
K	48.03%	51.97%	100%
M	59.30%	40.70%	100%
Total	**66.42%**	**33.58%**	**100%**

Source: Own calculations

Table 13: Innovation activity by ownership

Ownership	Innovation (INOV2)		
(DRVLST_4kat)	0 - no	1 - yes	Total
1-private inland	69.62%	30.38%	100%
2-foreing	56.89%	43.11%	100%
3-international	50.58%	**49.42%**	100%
4-other	71.09%	28.91%	100%
Total	**66.42%**	**33.58%**	**100%**

Source: Own calculations

Table 14: Innovation activity by legal form of enterprises

Legal form	Innovation (INOV2)		
(FORMA_3kat)	0 - no	1 - yes	Total
1-limited liability (s.r.o.)	69.08%	30.92%	100%
2-joint stock company (a.s.)	47.15%	**52.85%**	100%
3-other	70.15%	29.85%	100%
Total	**66.42%**	**33.58%**	**100%**

Source: Own calculations

Table 15: Innovation activity by group of enterprises

Group	Innovation (INOV2)		
(AQ7308)	0 - no	1 - yes	Total
1-yes	49.54%	**50.46%**	100%
2-no	70.82%	29.18%	100%
Total	**66.42%**	**33.58%**	**100%**

Source: Own calculations

Table 16: Innovation activity by realisation market of production

Market	Innovation (INOV2)		
(AR3053)	0 - no	1 - yes	Total
3-regional	75.30%	24.70%	100%
4-national	60.44%	39.56%	100%
5-EU countries	64.99%	35.01%	100%
6-others countries	40.99%	**59.01%**	100%
Total	**65.94%**	**34.06%**	**100%**

Frequency Missing = 344 (3%)

Source: Own calculations