Organizational Innovation Activities in the Czech Manufacturing Sector in 2014

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Abstract

The analysis aims at organizational innovation activities of enterprises from the manufacturing sector in the Czech economy. Data comes from the Czech Community Innovation Survey of 2014. The analyzed sample consists of observation about innovators and enterprises that did not engage in innovation activities in the last three years. This paper uses a standard innovation model. The Heckman procedure is used to estimate the probability to innovate and the research and development intensity measured by the log of innovation expenditures per one employee. In the last step, the log of sales from innovated goods and services per employee is estimated. This paper explores the relationship between the enterprise's performance and organizational innovations. Results suggest that there are only a few significant differences between all innovators and organizational innovators. Organizational innovation was not a driver of enterprise's ability to capture profits of innovated goods and services. Organizational innovation was more probable in medium-tech industries.

Keywords: organizational methods; adaptation; change; human resources.

Introduction

The definition of innovation is usually based on activities or organizational processes. Martini et al. (2013) define innovation using three internal factors: exploration-exploitation, organizational ambidexterity, and paradoxical thinking. This view enables and starts innovation activities, but they have to be reasonable and based on the current market situation. According to Esmaeilpour, Dostar, and Taherparvar (2014), innovation activities depends on knowledge management and customer-value market research. Without external knowledge and market research, we observe the process of imitation, learning, and understanding of new technologies (new-to-the-firm innovations).

Organizational innovations are a new way of organizing supply-management relationships (SCM), a new way of organizing human resources (HR), and a new approach to organizing external relations (ER). This classification of organizational innovations is rather imperfect because the product and process innovation activities

are intertwined, but this division into three parts allows us to study organizational innovations in greater detail.

Current research confirms its beneficial role to all research and development (R&D) activities and a higher probability of technological innovations. The effect of internal and external R&D on the generation of complex technological innovations is higher as well (Anzola-Roman et al., 2018). The adoption of organizational innovations also enhances indirectly export performance and relates to the market orientation of enterprises (Azar and Ciabuschi, 2017; Prange and Pinho, 2017).

Organizational innovations are important drivers for SME performance. They are pushed by new information and communication technologies (ICT), supported externally by the collaboration with technology suppliers. Information sources and competitive pressures are also drivers of organizational change. The performance of organizations depends on the ability to identify goals, manage technical infrastructure, business relationships, and key individuals (Makkonen et al., 2016). Key employees are monitored by key indicators like "positions filled with talented workers" and sophisticated HR systems, competency models, and other methods like AHP, TOPSIS, and WINGS are used (Kashi, 2017).

This paper relates to the issue of Industry 4.0 and subsequent internet technologies (Internet of things), e-business activities of SMEs, modern HR practices, automatization. There are so-called transaction-based HR practices and commitment-based HR practices. The organizational innovations are the product of commitment based HR which are knowledge-intensive (statistics, data science, databases, modeling, simulations, and predictions). These activities relate to the use of big data and marketing research. In other words, ICTs are to some extent prerequisites of organizational innovation (Soto-Acosta et al., 2016).

Internal features enhance organizational performance (Kianto, 2011): individual creativity; (external and internal) knowledge implementation and commercialization, and we can also add organizational strategic flexibility (the rate of adaptability, crisis management)

Organizational "shift" towards continuous innovation (Denning 2011) depends on the viable enterprise's goal to engage customers. This can be achieved in an organization where managers enable instead of control; static coordination (hierarchy, commands, and focus on a single stakeholder) is replaced by dynamic linking (competences, by example-motivation, all stakeholders). Knowledge innovation capability (Chen, 2016) is one of three factors of continuous innovation. Cooperation and external acquisition of knowledge, as well as intra-organizational networks, are good at invoking organizational pressures like competition in the market (Karlsson and Björk, 2017).

The goal of this paper is to analyze the organizational innovations and organizational innovators. The analysis is about the probability of innovation activities and organizational innovations, R&D intensity (total R&D expenditure per one employee),

and sales of innovated goods and services. This statistical exploration can be useful for further research and contributes to the current debate about Industry 4.0 and theories of organizational innovation. Organizational activities are studied in cut-off samples (innovators vs. organizational innovators) and in innovation output analysis (contribution of organizational innovations to sales of innovated goods and services).

Material and methods

There are 3,069 observations about enterprises (Tab. 1). There are 1197 new-to-the-firm or new-to-the-market innovators and 552 out of them are organizational innovators. Some of the observations are missing and the estimation sample is slightly smaller (3017 full sample, 1159 innovators, and 546 organizational innovators). Data comes from the Community innovation survey of 2014 about innovation activities of enterprises in the Czech manufacturing industry.

Tab. 1: Summary statistics

Variable	**Obs.**	**Mean**	**Std. dev.**	**Min**	**Max**
Innovator (%)	3,069	0.39	0.49	0	1
Organizational innovator (%)	3,069	0.18	0.39	0	1
A new way of organizing SCM, supply-management rel.(%)	3,069	0.15	0.36	0	1
A new way of organizing HR, human resources (%)	3,069	0.20	0.40	0	1
A new approach to organizing ER external relations (%)	3,069	0.07	0.26	0	1
R&D expenditures (1,000 CZK)	1,503	50070.57	517376.40	0	1.51E+07
Foreign ownership (%)	3,069	0.31	0.46	0	1
Technological level of industry (4 = high-tech)	3,069	0.98	0.94	0	3
Number of employees (average)	3,069	202.46	597.43	10	24,354

Source: Authors, based on CIS 2014 survey

The most implemented organizational innovation included a new way of organizing human resources (20% of all enterprises in the sample). The average technological level of manufacturing industry is medium-to-low technology. This variable was the control variable for robustness checks. This sample has small and medium-sized enterprises

with 250 and fewer employees, but the micro enterprises are omitted because the data are not collected by the Czech Statistical Office.

The estimation method follows the concept of Crépon, Duguet, and Mairesse (1998) and Hall, Lotti, and Mairesse (2009). The logic of estimation is based on the innovation process in enterprises. The first step is about the probability to innovate (new-to-the-market and new-to-the-firm innovators) with subsequent R&D intensity analysis of the innovators. The second step analyses the ability to capture profits form innovated production.

Continuous variables like sales and number of employees are in natural logarithms. The procedure (Tab. 2) comprises the general term $Xn_{it}\beta_n$'s (with n = 1, 2, and 3) which expresses vectors of explanatory variables and control variables like number of employees, cooperation on innovation activities, barriers of innovation activities, public support etc.; The error terms are assumed to be independent of the exogenous variables, they are denoted as ε_{itn}'s (with n = 1, 2, and 3). Single parameter to be estimated is α in the last equation (innovation input-output elasticity).

There are known biases from omitted variables, endogeneity, selection issues, and due to the quality (last dependent variable is self-reported) and representativeness of the sample. The first two error terms are estimated in the Heckman procedure to control for selection bias. Control variables describing the technological level of the industry are used for robustness check analysis of estimated coefficients.

The vector of parameters of interest is denoted by β_n (with n = 1, 2, and 3). In the case of Probit probability, marginal effects at means are reported. Their interpretation at means is not elegant but the goal is to detect differences between innovators and organizational innovators. In case of ordinary least squares technique, robust standard errors are reported in brackets below the coefficients.

Tab. 2: Innovation process estimation procedure

Innovation decision (r_i^*)	$\begin{cases} r_i^* = 1 \; if \; r_i = (X_{1i}\beta_1 + \varepsilon_{i_1}) > 0 \\ r_i^* = 0 \qquad\qquad\qquad if \; r_i \leq 0 \end{cases}$
R&D function (k_i^*)	$k_i^* = \ln(k_i) \,\vert (r_i > 0) = X_{2i}\beta_2 + \varepsilon_{i_2}$
Appropriability (t_i^*)	$t_i^* = \ln(t_i) \vert (k_i > 0) = X_{3i}\beta_3 + \alpha k_i^* + \varepsilon_3$

Source: Authors, based on Crépon, Duguet, and Mairesse (1998)

The first equation (r_{it}^*) accounts for selection into R&D activities (in-house R&D, training, acquisitions of knowledge, machinery, equipment, buildings, and software for innovation purposes) but only for new-to-the-market and new-to-the-firm innovators

(self-reported variables). This is specified as a Probit model, i.e. $P(r_i^*>0) = \Phi(X_{1i}\beta_1)$, where r_i^* equals 1 if enterprise *i* is an innovator (organizational innovator respectively).

The second linear equation (k_i^*) describes the log of total R&D expenditures to the number of employees in enterprise *i*. This equation is uniquely dependent on public funding variables. The fourth equation (t_{it}^*) models the log of sales of goods and services from the new-to-the-market and new-to-the-firm innovated goods and services to the number of employees. This variable has a nature of a category, but it can be estimated as a continuous variable because there is more variation in the relative per employee form.

Results

The decision to be new-to-the-market or at least new-to-the-firm innovator (new products and/or new methods for enterprises' process) is not different from the decision to be an organizational innovator (new method of HR, SCM and managing external relations). Both groups are similarly dependent on the number of employees, being part of a group of enterprises, foreign-owned, and market orientation (Table 3).

We can observe a few percentage points differences and the highest is in the foreign ownership variable (10 pp. higher in favor of organizational innovation). But the estimated coefficients are not directly comparable given the differences in baseline enterprise. The only reasonable comparison is in large differences.

The highest difference is at the technological level which was used in the robustness check procedure. The previously estimated coefficients stayed roughly the same. Organizational innovation is more probable in medium-tech industries in comparison to low-tech, low-to-medium-tech high-tech enterprises. Innovation, in general, is more likely to happen in high-tech and medium-tech enterprises.

In the next step, R&D expenditures per one employee (ln) were estimated (Table 4). At first sight, the estimated coefficients vary more than in case of innovation-decision model. Both groups of innovators depend on more variables than those reported (Table 4) because the explained variability is only between 10 - 14% and there are a lot of statistically not significant results.

Tab. 3: Probability to innovate – all innovators and organizational innovators

Probit marginal effects	**(1)**	**(2)**	**(3)**	**(4)**
	All	**Organizational**	**All**	**Organizational**
Log of number of employees	0.298***	0.284***	0.294***	0.275***
	(0.02)	(0.02)	(0.02)	(0.03)
Being part of a group	0.294***	0.267***	0.264***	0.247***
	(0.07)	(0.08)	(0.07)	(0.08)
Foreign owned	-0.306***	-0.208***	-0.316***	-0.210***
	(0.07)	(0.07)	(0.07)	(0.07)
Market orientation	0.521***	0.388***	0.492***	0.378***
National	(0.07)	(0.09)	(0.07)	(0.09)
Market orientation	0.401***	0.321***	0.346***	0.292***
Europe	(0.08)	(0.10)	(0.08)	(0.10)
Market orientation	0.637***	0.537***	0.545***	0.500***
World	(0.11)	(0.13)	(0.11)	(0.13)
Technological level			0.011	0.104
Low-Medium Tech			(0.06)	(0.07)
Technological level			0.290***	0.230***
Medium Tech			(0.06)	(0.07)
Technological level			0.318***	0.040
High Tech			(0.11)	(0.13)
Constant	-1.965***	-2.543***	-1.998***	-2.574***
	(0.10)	(0.12)	(0.10)	(0.12)
Observations	3,017	3,017	3,017	3,017

Source: Authors, based on CIS 2014 survey

The innovation intensity is not dependent on enterprise size and being a part of a group variable. The selection bias is not should not be a problem in this step because Mill's ratio is not statistically significant. Foreign-owned companies seemed to spend on average more on R&D per one employee than the group of all innovators, but the results were not significant at 5% after the robustness check procedure.

Interesting results are in the additional effect of technological level. More enterprises engage the organizational innovation process in medium-tech industries but more R&D expenditures are on average spent in high-tech industries among organizational innovators. In the population of all innovators medium-tech and high-tech innovators spend on average more on R&D per one employee than low-tech and low-to-medium-tech enterprises.

Public central government and all EU programmes public supports of R&D are on average beneficial to the innovation intensity. Both groups vary in the structure of estimated coefficients. Organizational innovators are more consistent. All innovators benefit the most from the central government programmes.

Tab. 4: R&D intensity – all innovators and organizational innovators

R&D expenditures per employee (ln)	**(5)**	**(6)**	**(7)**	**(8)**
	All	**Organizational**	**All**	**Organizational**
Log of number of employees	-0.052	-0.696	-0.029	-0.667
	(0.31)	(0.43)	(0.31)	(0.43)
Being part of a group	0.371	-0.484	0.347	-0.506
	(0.31)	(0.43)	(0.30)	(0.42)
Foreign owned	0.255	0.867**	0.207	0.826*
	(0.31)	(0.44)	(0.31)	(0.43)
Market orientation	0.633	-0.962	0.609	-0.952
National	(0.63)	(0.93)	(0.62)	(0.91)
Market orientation	0.642	-0.784	0.568	-0.846
Europe	(0.52)	(0.78)	(0.52)	(0.78)
Market orientation	1.506**	-0.379	1.379*	-0.499
World	(0.71)	(1.05)	(0.71)	(1.04)
Technological level			0.093	-0.005
Low-Medium Tech			(0.14)	(0.20)
Technological level			0.333**	0.284

Medium Tech			(0.13)	(0.19)
Technological level			0.641***	0.805**
High Tech			(0.23)	(0.38)
Public sources	-0.043	0.144	-0.041	0.170
Local government	(0.17)	(0.18)	(0.18)	(0.19)
Public sources	0.735***	0.604***	0.667***	0.562***
Central government	(0.11)	(0.16)	(0.11)	(0.16)
Public sources	0.850***	0.560***	0.862***	0.561***
EU funds	(0.12)	(0.17)	(0.12)	(0.17)
Public sources	0.519**	0.620**	0.479**	0.623**
EU Horizon/Framework	(0.20)	(0.26)	(0.20)	(0.26)
Mill's ratio	1.046	-2.839	1.119	-2.726
	(1.59)	(2.28)	(1.58)	(2.24)
Constant	1.494	9.877**	1.237	9.569**
	(3.40)	(4.84)	(3.37)	(4.78)
Observations	1,159	546	1,159	546
Adjusted R^2	0.133	0.102	0.140	0.110

Source: Authors, based on CIS 2014 survey

The last step in the innovation process is the ability of an enterprise to capture profits from innovation activities. Again, the explained variability is quite low (10 - 12%) because there are more factors like intellectual property rights, marketing innovations, logistics innovations, design innovation, and the ability of sales-teams. A lot of variables are not statistically significant. Coefficients of public sources variables suggest there are no additional effects of public funding on innovation output. The effect of public sources is in innovation input-output elasticity (R&D expenditures per one employee variable).

In this step all innovators are estimated to capture the effects of organizational innovation activities. All the types of organizational innovation activities were statistically not significant at 5% level of alfa. Supply chain, Human resources, and External relations based organizational innovation activities did not contributed to higher sales of innovated goods and services. The results for introduction of new supply-management methods are consistent at 10% level of alfa. We can cautiously interpret them as on average beneficial to the enterprise's ability to capture profits from innovated goods and services.

Tab. 5: Innovation appropriability – all innovators and organizational innovators

Sales from innovated goods per employee (ln)	**(9)**	**(10)**
	All	**All**
Log of the number of employees	-0.005	0.192
	(0.04)	(0.26)
Being part of a group	0.346***	0.497*
	(0.11)	(0.27)
Foreign owned	0.358***	0.138
	(0.11)	(0.28)
Market orientation	0.064	0.416
National	(0.15)	(0.54)
Market orientation	0.155	0.387
Europe	(0.16)	(0.46)
Market orientation	0.315	0.659
World	(0.20)	(0.63)
Technological level		0.279***
Low-Medium Tech		(0.11)
Technological level		0.415***
Medium Tech		(0.10)
Technological level		0.441**
High Tech		(0.19)
Public sources	-0.130	-0.154
Local government	(0.16)	(0.16)
Public sources	-0.118	-0.158
Central government	(0.10)	(0.10)
Public sources	-0.191*	-0.179
EU funds	(0.11)	(0.11)
Public sources	0.206	0.162

EU Horizon/Framework	(0.20)	(0.19)
Mill's ratio		1.055
		(1.36)
R&D expenditures	0.175***	0.166***
per one employee (ln)	(0.03)	(0.03)
Organizational I.	0.191*	0.185*
Supply chain	(0.11)	(0.11)
Organizational I.	-0.089	-0.099
Human resources	(0.10)	(0.10)
Organizational I.	0.078	0.101
External relations	(0.13)	(0.13)
Constant	4.502***	2.177
	(0.20)	(2.91)
Observations	1159	1159
Adjusted R^2	0.109	0.119

Source: Authors, based on CIS 2014 survey

Conclusion

Organizational innovation activities and innovation activities, in general, are intertwined in the manufacturing sector in the Czech economy. Result suggests there are only a few differences but the two groups. Organizational innovation activities like new HR, SCM and external relation methods were not a driver of enterprise's ability to capture profits of innovated goods and services.

Organizational innovation was more probable in medium-tech industries and higher R&D intensity was in high-tech industries. This is somehow different from the general population of all innovators where there is a linear relationship between the technological level of the industry and R&D intensity.

Dataset is prepared from the Czech Community Innovation Survey of 2014. This paper uses a standard CDM innovation model. The Heckman procedure is used to estimate the probability to innovate and the research and development intensity measured by the log of innovation expenditures per one employee. In the last step, the log of sales from innovated goods and services per employee is estimated.

This paper explored the relationship between the enterprise's performance and organizational innovations. Future research should explore the last link between value-added and organizational innovations. The problem is in data availability and the problematic nature of self-reported variables.

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