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THE INNOVATION PERFORMANCE OF RUSSIAN SMEs: THE ROLE OF INTERNAL FACTORS AND THE EXTERNAL TRANSITION CONTEXT

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ABSTRACT

The **purpose** of the research is to link both internal and external factors to the innovation performance of manufacturing SMEs in a transition economy.

The **methodology** of the research is based on linear regression analysis in order to find the relationship of internal and external factors with the innovation performance of SMEs.

The **main findings** of the research are positive linkages of firm size, innovation intensity, product competitiveness, collaboration with other firms, and external funding sources with the innovation performance of SMEs. However, firm age, collaboration with industry associations and financial/organizational government support do not have a significant impact on the innovation performance of SMEs.

The research has some **limitations**, namely country and industry-specific findings. In this paper, the analysis was based on a sample from the RuFIGE database that consisted of Russian manufacturing SMEs. Moreover, the study is limited through the variables included in the linear-regression model to discussing particular internal and external factors that affect the innovation performance of SMEs. Future research may be based on diverse countries, industries and statistical variables.

The paper offers **practical implications** for managers that are willing to improve innovation performance and competitiveness of SMEs. The results also shed some light for policymakers on the main factors that influence SMEs' innovations.

The **value** of the research is to provide some insight into both internal and external factors that influence the innovation performance of Russian manufacturing SMEs in the context of transition economies.

Paper type: Research paper

Keywords: innovation performance, SMEs, linear regression analysis, RuFIGE, transition context, internal and external factors

INTRODUCTION

SMEs are one of the key sources that contribute to economic growth, total employment and innovation commercialization rates which lead to market competitiveness and are essential for a country's technological progress (OECD, 2017). How to stimulate innovations in the SME sector is a very challenging question since entrepreneurs, academics and policymakers have diverse perspectives towards SMEs' innovations, which leads to misaligned results among the key innovation stakeholders (Massa and Testa, 2008). A better understanding of the key success factors that affect the innovativeness of SMEs may be important in terms of finding possible solutions among various market players to reduce the complexity, uncertainty and dynamism of innovation activities in the SME sector (Hoffman et al., 1998; Edwards et al., 2005; Hausman, 2005).

The prime determinants of SMEs' innovation performance are usually based on findings obtained in the context of developed countries, while innovations of SMEs in transition economies are rather different for possible generalization without taking into

account the specific transition environment (Radas and Bozic, 2009; Xie et al., 2013). Due to the reorganization of key institutional bodies and the overall market system, SMEs in a transitional context face certain barriers that limit their performance and may be categorized into such factors as (1) environment; (2) the role of the state; and (3) business owner characteristics (Aidis, 2005).

One of the key challenges faced by the Russian economy is relatively low rates of innovation performance at SMEs, which affects market competitiveness and is crucially important for the sustainable development of the SME sector (OECD, 2015). In this light, the paper aims to investigate the relationships of diverse factors of manufacturing SMEs with both product and process innovation performance in the transitional context of Russia by analysing the following categories of factors:

- **Internal** (firm size, firm age, innovation intensity, product competitiveness, engineering and technically qualified staff);
- **External** (collaboration with other firms, collaboration with business associations, external funding sources, market competition and financial and organizational support from the local/regional/federal government).

The paper is structured as follows. In the second section, the theoretical background of the study is discussed in two parts: firstly, the main factors that affect the innovation performance of SMEs are highlighted and, secondly, the specifics of the transitional environment are analysed in detail. The third section presents the research model of the study and a review of empirical findings from diverse papers. Then, the RuFIGE database's characteristics, the research sample, and the main variables included in the linear regression models are presented. Furthermore, the results section briefly touches on the findings of the study. The fifth section presents a discussion of the main results obtained from the empirical research. Finally, the conclusion highlights the contribution of the paper, limitations and some implications for managers and policymakers.

THEORETICAL BACKGROUND

The sustainable development of SMEs sector is a priority in wide range of economies. One of the possible issues is to realize the innovation potential of SMEs for future economic growth. However, this could not be easily achieved due to the complexity of innovations, which makes it challenging for research, business and policy-makers. The idea of the theoretical part of this study is to give a general overview on the specifics of unstable, transitional environments in which key institutions intended to support innovation efforts of SMEs fail to do that for a number of reasons as in mature, developed market economies. Once the context is discussed, the prominent both internal and external factors that influence the innovation performance of SMEs are presented to highlight the results obtained in the major studies of the field.

Importance of the transition context

Since the 1980s, the shift from centrally-planned to market-structured economy has greatly impacted the socio-economic and political development of Central and Eastern European countries (Smallbone and Welter, 2001). The evidence shows that entrepreneurship in general is not unique in transition countries, but it has some distinctive features compared to Western market economies in terms of institutional environment, entrepreneurs' behaviour patterns and social values and conventions regarding

entrepreneurial activities (Smallbone and Welter, 2003; Smallbone and Welter, 2006). In addition, institutional changes faced in transitional economies have impacted the technological development path of the countries, which indicates the difference of National Innovation Systems from developed economies (Kitanovic, 2007).

SMEs play an important role in the transition period as sources that create and generate jobs, offer new solutions for economic diversification with particular emphasis on the restructuration of diverse sectors, and contribute to innovations that stabilize and improve the overall economic situation (Smallbone and Welter, 2009). However, a wide range of barriers hamper SMEs' development, which are categorized as follows: (1) environmental factors that refer to the reorganization of both the micro and macro-systems which resulted in a lack of key institutions required for engagement in business activities; (2) the role of the state, which is crucial for the prosperity of the private business sector, while the initiation of entirely new legislation had severe drawbacks due to the fact that policymakers had no previous experience in establishing a market economy; (3) business owner characteristics' indicating perceptions and attitudes regarding how to organize business activities in an unstable environment (Aidis, 2005).

In the case of Russia, firm managers focus more on short-term decision-making instead of long-term projects, which reflects the partner selection process that provides several important benefits for firm business activities such as access to financial capital and the complementary capability to overcome weak institutional conditions (Hitt et al., 2004). In Russia, informal network connections play a distinctive role because they consist of contacts with existing enterprises and the state administration as a result of the underdeveloped institutional environment (Aidis et al., 2007). Usually Russian entrepreneurs rely on self-financing or look for informal funding sources from their own networks to manage business activities (Aidis and Estrin, 2006). Imperfect formal institutions in terms of regulatory quality, rule of law and corruption significantly limit the innovation performance of firms in Russia (Chadee and Roxas, 2013).

FACTORS INFLUENCING THE INNOVATION PERFORMANCE OF SMES

Having analysed the prominent factors that influence SMEs' innovation performance, scholars classify them as internal variables which indicate characteristics and policies of SMEs and external variables that show the opportunities SMEs can seize from their environment (Keizer et al., 2002; Radas and Bozic, 2009). As for internal factors, the objective of the firm's origin, the objective of setting up the firm, the CEO's technical qualifications and the presence of an exclusive design office improve the innovation performance of SMEs (Subrahmanya, 2013). Highly qualified personnel seem to be an important factor that boosts the innovation performance of SMEs, as found in a number of studies (Radas and Bozic, 2009; Freel, 2005; Romijn and Albaladejo, 2002; Xie et al., 2013). Firm size positively affects the innovation performance of SMEs (Bhattacharya and Bloch, 2004). Some other internal factors are also vital for the innovation performance of SMEs, such as technology information, RandD intensity, entrepreneur orientation, business strategy and management capabilities (Xie et al., 2013).

Regarding external factors, some studies indicate that networking collaboration with diverse partners significantly increases the innovation performance of SMEs (Keizer et al., 2002; Birchall et al., 1996; Radas and Bozic, 2009; Xie et al., 2013). Government

support in terms of innovation subsidy schemes does improve SMEs' innovative efforts (Keizer et al., 2002; Romijn and Albaladejo, 2002). External funding sources (for instance, venture capital funds) positively influence the innovation performance of SMEs (Xie et al., 2013). The factor of market scope, which refers to international competitiveness, appears to be vitally important for the innovation performance of SMEs (Bhattacharya and Bloch, 2004; Radas and Bozic, 2009).

All the above results clearly indicate the complexity of SMEs innovation performance. The majority of studies in the field are based on the cases of developed economies, but recently a number of researches show that the prominent determinants of innovation performance in SMEs have some similarities as well as crucial differences, especially due to the institutional conditions and role of the government in transition countries. It is also vital to understand the specifics of the sector, which may be important to identify the key factors that boost the innovation performance of SMEs in a particular industry. Overall, the findings obtained in various firm-level empirical cases are hardly generalizable, because much depends on the internal behavioral aspects towards innovations and external environment of SMEs.

EMPIRICAL STUDIES AND HYPOTHESIS DEVELOPMENT

This section is devoted to the theoretical model of the study. The prime internal and external factors that affect the innovation performance of SMEs are briefly discussed by analysing literature sources in the field.

Research framework

Some studies have discussed various determinants that influence the innovation performance of SMEs in transition countries, namely Croatia (Radas and Bozic, 2009) and China (Xie et al., 2013). However, more detailed exploration is needed to understand the relationship of both internal and external factors with the innovation performance of manufacturing SMEs, particularly in the context of Russia.

The theoretical model of the research can be found in Figure 1. The main internal and external factors are linked with the innovation performance of SMEs based on the key findings of the empirical papers reviewed. Linear regression models were developed for the product and process innovation performance of SMEs. More details about the measurement operationalization of the variables can be found in Appendix A.

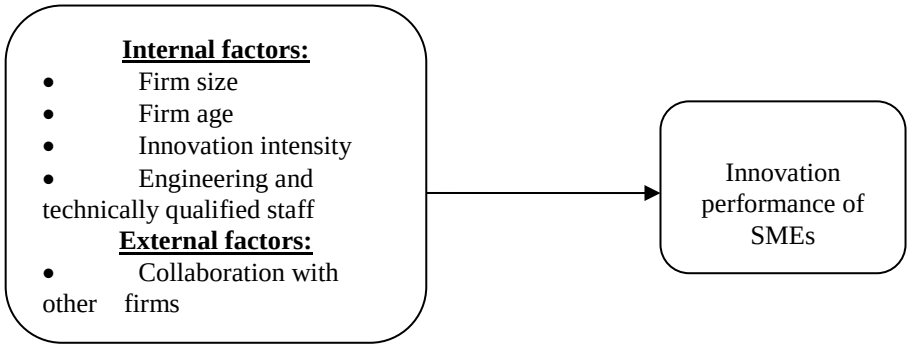

Figure 1. Innovation performance framework factors

Internal factors and the innovation performance of SMEs

Firm size

The Schumpeterian hypothesis is empirically tested to identify whether firm size increases the innovative activity of firms, but in practice such a relationship is much more complex due to the influence of other factors, namely industry level, market structure and technological characteristics of firms (Caloghirou et al., 2004; Becheikh et al., 2006). In the case of the low-technology SME sector, the findings show that innovative activity significantly increases with firm size (Bhattacharya and Bloch, 2004). Thus, the following hypothesis is advanced:

H1. Firm size is positively associated with the innovation performance of SMEs

Firm age

The key idea of a positive effect between firm age and the innovation performance of SMEs is that firms, over a certain period of time, develop expertise and practices to deal with the complexity of innovations (Becheikh et al., 2006). However, in a transition context the organizational structure of experienced firms is old-fashioned, which prevents them from establishing the required competencies to boost innovation performance (Radas and Bozic, 2009).

Taking into account these empirical results, the following hypothesis is advanced:

H2. Firm age is positively associated with the innovation performance of SMEs

Innovation intensity

The evidence of a relationship between the innovation intensity and innovation performance of SMEs is limited in the empirical studies. However, a frequency-of-innovations variable has been constructed to show how often firms carry out innovations in a certain period of time (Subrahmanya, 2013). Taking into account this study, the following hypothesis is advanced:

H3. Innovation intensity is positively associated with the innovation performance of SMEs

Engineering and technically qualified staff

Skilled workers do improve the innovativeness of SMEs since the development of new technologies is a complex process that requires unique knowledge generated from the personnel's innovation activities (Caloghirou et al., 2004; Freel, 2005). Specialized knowledge and experience, especially in the science and engineering fields, seem more important for the innovation performance of SMEs than general technical or managerial competencies (Romijn and Albaladejo, 2002).

The evidence above leads to the formulation of two separate hypotheses:

H4. Engineering staff are positively associated with the innovation performance of SMEs

H5. Technically qualified staff are positively associated with the innovation performance of SMEs

External factors and the innovation performance of SMEs

Collaboration with other firms

In a rapidly growing and dynamic market, inter-firm networking collaboration provides various benefits for firms, for instance, exclusive access to resources, creative new ideas and solutions, new market niches and opportunities, personnel competencies, and mutual sharing of project risks and costs, which leads to successful product commercialization and high innovation performance, therefore increasing the market competitiveness of the firm (Tidd et al., 2005; Powell, 1998; Powell et al., 1996).

Some empirical studies have found that inter-firm networking ties with customers, suppliers or competitors have a positive relationship with the innovation performance of SMEs (Radas and Bozic, 2009; Zeng et al., 2010; Xie et al., 2013). SMEs usually maintain networking linkages for knowledge acquisition from external sources, especially those companies that face difficulties conducting in-house RandD to improve their innovation performance (Hervas-Oliver et al., 2014).

In transition countries, external networking collaboration is vitally important because less favourable and uncertain economic conditions make firms more likely to search for external sources to access new knowledge for innovation activities (Saeed et al., 2015). However, external networks are not always beneficial for SMEs because of the complexity and risks connected with coordination and external partners' contributions to joint innovation projects (Rosenbusch et al., 2011).

Taking into consideration all the above arguments, the following hypothesis is advanced:

H6. Collaboration with other firms is positively associated with the innovation performance of SMEs

Collaboration with industry associations

Interaction with industry associations can help SMEs to engage in the learning process to gather valuable market information about technological developments and obtain access to internal competencies such as technical assistance that industry associations can provide for the innovation performance of SMEs (Romijn and Albaladejo, 2002).

In line with the above argument, the following hypothesis is formulated:

H7. Collaboration with industry associations is positively associated with the innovation performance of SMEs

External funding sources

Lack of financial funding sources may be a barrier to expanding or introducing new technologies at SMEs, but firms that seek external financing fail to improve their innovation performance (Hoffman et al., 1998). However, in the case of transition countries, external funding sources obtained from bank or partner loans positively affect the innovation performance of SMEs (Xie et al., 2013). Hence, the following hypothesis is considered:

H8. External funding sources are positively associated with the innovation performance of SMEs

Product competitiveness

In the reviewed empirical papers, the factor of product competitiveness is unexplored as a link to the innovation performance of SMEs. However, if the main technological product of a firm is competitive in the marketplace, it may result in higher engagement in SMEs' innovations. Therefore, the following hypothesis is proposed:

H9. Product competitiveness is positively associated with the innovation performance of SMEs

Market competition

The role of competition for innovation is vital when firms decide to innovate for higher investment returns and reduce the competitive pressure faced from the external environment (Caloghirou et al., 2004). If SMEs are competitive in the market, they have a unique opportunity not only to focus on the market pressure from competitors, but also to improve their innovation performance. Thus, the following hypothesis can be formulated:

H10. Market competition is positively associated with the innovation performance of SMEs

Government support (financial and organizational)

Government can provide financial support in terms of subsidies, grants, awards or loans to encourage firms' innovation activities, but government can also organize various meetings to establish collaboration with diverse market players for the exchange of ideas and experience in innovation activities (Becheikh et al., 2006).

In a transition context, firms should take into account the influential role of governmental policies towards innovations that may significantly impact the market competition environment by supporting priority organizations and sectors, while neglecting other areas (Yang et al., 2012).

The relationship between government bodies and the innovation performance of SMEs seems controversial due to insignificant (Zeng et al., 2010) and negative (Xie et al., 2013) findings. In the case of Russia, the innovation support system is poorly integrated into the institutional environment, which results in government agencies failing to incorporate SMEs into the existing value chains for mutual innovation development with other market players (Sokolov and Rudnik, 2014). Thus, weak governmental bodies fail to support and improve the innovation performance of SMEs (Volchek et al., 2013).

The above arguments lead to the following hypothesis:

H11a. Government financial support is negatively associated with the innovation performance of SMEs

H11b. Government organizational support is negatively associated with the innovation performance of SMEs

METHODOLOGY

Data source

In the present paper, internal and external factors that affect the *innovation performance* of Russian SMEs are analysed on the basis of the Russian database RuFIGE[1].

[1] *Russian firms in the global economy, more details at: https://iims.hse.ru/en/rfge/about (accessed 27 March 2017)*

The survey consists of 2092 manufacturing firms (including large enterprises) based on the stratified random sampling method. The sample is representative of manufacturing firm sectors and firm employment, but is not representative of regions. RuFIGE was developed to analyse diverse features of firms, such as competitiveness and performance.

The data was obtained by the Russian professional marketing company GFK-Rus in 60 regions (sub-federal units of Russia) from May to October 2014. Face-to-face interviews were used to examine the following top managers of manufacturing firms: chief executive officer (CEO), executive director, vice director of economics and finance, director of economics, financial director (not the chief accountant), commercial director.

Characteristics of SMEs

Firms are usually measured by number of employees (Oslo Manual, 2005). In the present paper, "small enterprise" will be defined as having 10 to 100 employees and "medium enterprise" will be defined as having 101 to 499 employees. Other size categories are not analysed.

Once large enterprises with 499+ employees were excluded from the research, the sample of the paper consists of 1677 manufacturing SMEs from the database RuFIGE. Table 1 indicates the characteristics of the sample according to manufacturing sector. It shows that the majority of manufacturing enterprises are from the food production sector (22.7%). In addition, sectors such as timber and paper products (12.8%), machinery and equipment (12.6%) and metal products (12.0%) are at the golden mean. The least represented sector is transport equipment (4%). Table 2 reveals that there are 1181 (70%) small enterprises (10-100 employees) and 496 (30%) medium enterprises (101-499 employees).

Table 1

Sample of manufacturing sectors

Manufacturing sectors	Number of enterprises	Percentage (%)
1. Food production	380	22.7
2. Textile industry, garments and other fibre products	161	9.6
3. Timber processing and production, cellulose and paper products	215	12.8
4. Raw chemical materials and chemical products, plastic and rubber products, petroleum processing and coking	180	10.7
5. Non-metal mineral products	141	8.4
6. Metal products	202	12.0
7. Machinery and equipment	212	12.6
8. Electric equipment and machinery	119	7.1
9. Transport equipment	67	4.0
Total	1677	100.0

Table 2

Sample of SMEs by firm size

Number of employees	Number of enterprises	Percentage (%)
10-19	344	20.5
20-49	503	30.0
50-100	334	19.9
101-249	325	19.4
250-499	171	10.2
Total	1677	100.0

Dependent variables

There is no exact measurement of innovation performance due to the complexity of interaction between diverse components (Becheikh et al., 2006). In this study, the innovation performance of SMEs is measured as *innovative product* and *innovative process* for two separate linear regression models.

Independent variables

The independent variables as internal factors are firm size, firm age, innovation intensity, product competitiveness, engineering and technically qualified staff. Firm size is measured by number of employees 0 (small enterprise with 10-100 employees) and 1 (medium enterprise with 101-499 employees). Firm age is represented by a natural logarithm. Innovation intensity is a dummy variable (0 – no, 1 – yes). Product competitiveness indicates the level of the main technological product (0 – medium-quality; 1 – high-quality). Lack of engineering and technically qualified staff are viewed as a barrier for the company (0 – yes, it is a barrier; 1 – no, it is not a barrier).

As for the external factors, collaboration with other firms, collaboration with industry associations, external funding sources, market competition, and financial and organizational support from the federal/regional/local government are all dummy variables (0 – no, 1 – yes).

Appendix A presents the measurement operationalization of the variables from the RuFIGE database questionnaire included in the regression model.

RESULTS

Linear regression analysis is used to test the relationship between diverse independent variables with the innovation performance of SMEs. This method can be used when the dependent variable is dichotomous (Hair et al., 2010). In this case, it ideally fits the research objectives of the study.

Results were obtained separately for product (Table 3, 4) and process innovation performance (Table 5, 6). The model summary for product innovation performance (Table 3) reveals the amount of unexplained variability of the basic model (intercept) and the final model of regression analysis. Likelihood ratio tests, in particular, chi-square (x^2=147.932), show that there is a significant effect for the combined predictors in the dependent variable and the results are statistically significant ($p<0.000$). The Hosmer-Lemeshow test (goodness of fit test) indicates that the final model is suitable for analysis (x^2=10.903). In

this case, poor significance (p=0.207) means that the predicted values included in the analysis are not significantly different from the observed ones.

Table 3

Model summary for product innovation performance

	Model fitting criteria	Likelihood ratio tests			Hosmer-Lemeshow test		
Model	-2 Log likelihood	Chi-square	df	Sig.	Chi-square	df	Sig.
Base	1458.817						
Final	1310.886	147.932	16	.000	10.903	8	.207

The prominent estimates of the regression analysis for innovative product performance are presented in Table 4. The predictors *collaboration with other firms* ($p<0.001$), *innovation intensity* ($p<0.001$), *engineering staff* ($p<0.05$), *market competition* ($p<0.01$), *product competitiveness* ($p<0.01$), *external funding sources* ($p<0.05$) and *firm size* ($p<0.01$) are significant. All other variables show insignificant results.

In Table 4, the logistic coefficient (B) means expected amount of change in the logit (the natural logarithm of the odds of the outcome variable occurring). The value of the odds ratio Exp (B) is more crucial for interpretation because it does not require logarithmic transformation. Exp (B) indicates the change in odds resulting from the unit change of the predictor. For instance, the predictor *collaboration with other firms* demonstrates Exp (B)>1 (Exp (B) =1.706). When it increases, the odds of developing an innovative product are 1.706 times higher than when it does not increase.

Table 4

Parameter estimates for product innovation performance

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Collaboration with other firms	.534	.137	15.100	1	.000***	1.706
Innovation intensity	.902	.177	25.946	1	.000***	2.464
Engineering staff	-.398	.192	4.280	1	.039*	.672
Technically qualified staff	-.111	.199	.310	1	.578	.895
Collaboration with industry associations	.096	.204	.222	1	.637	1.101
Financial support from the federal government	-.039	.440	.008	1	.929	.962
Financial support from the regional government	.332	.330	1.012	1	.314	1.394
Financial support from the local government	.025	.363	.005	1	.945	1.025
Organizational support from the federal government	.520	.494	1.108	1	.293	1.682
Organizational support from the regional government	.087	.367	.056	1	.813	1.091
Organizational support from the local government	-.121	.328	.137	1	.711	.886
Market competition	.361	.138	6.786	1	.009**	1.434

Product competitiveness	.408	.136	9.049	1	.003**	1.503
External funding sources	.290	.139	4.360	1	.037*	1.337
Firm size	.408	.163	6.288	1	.012*	1.505
Firm age	-.039	.079	.248	1	.619	.961
Intercept	-.642	.247	7.095	1	.008	.526
*p<0.05, **p<0.01, ***p<0.001						

Table 5 shows the model summary for process innovation performance. The difference between the base and final model (x^2=153.669) and the significance (p<0.000) determines that the final model is better than the basic one and the results are statistically significant. The Hosmer-Lemeshow test shows that the model is quite good (x^2=1.240; p=0.996).

Table 5

Model summary for process innovation performance

	Model fitting criteria	Likelihood ratio tests			Hosmer-Lemeshow test		
Model	-2 Log likelihood	Chi-square	df	Sig.	Chi-square	Df	Sig.
Base	1388.777						
Final	1235.108	153.669	16	.000	1.240	8	.996

The crucial estimates of the regression analysis for process innovation performance are presented in Table 6. The significant predictors are *collaboration with other firms* (p<0.01), *innovation intensity* (p<0.001), *engineering staff* (p<0.05), *technically qualified staff* (p<0.05), *product competitiveness* (p<0.01), *external funding sources* (p<0.05) and *firm size* (p<0.001). All other variables are insignificant.

Table 6

Parameter estimates for process innovation performance

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Collaboration with other firms	.451	.144	9.830	1	.002**	1.570
Innovation intensity	1.126	.168	44.940	1	.000***	3.082
Engineering staff	-.496	.202	6.004	1	.014*	.609
Technically qualified staff	.498	.209	5.668	1	.017*	1.645
Collaboration with industry associations	.316	.202	2.449	1	.118	1.371
Financial support from the federal government	.554	.440	1.586	1	.208	1.740
Financial support from the regional government	.281	.320	.770	1	.380	1.324
Financial support from the local government	-.176	.350	.252	1	.616	.839
Organizational support from the federal government	.179	.446	.160	1	.689	1.196
Organizational support from the regional government	-.470	.354	1.759	1	.185	.625

Organizational support from the local government	.123	.322	.146	1	.703	1.131
Market competition	.162	.147	1.220	1	.269	1.176
Product competitiveness	.380	.141	7.208	1	.007**	1.462
External funding sources	.333	.143	5.437	1	.020*	1.395
Firm size	.597	.162	13.587	1	.000***	1.816
Firm age	-.006	.082	.005	1	.946	.994
Intercept	-1.623	.259	39.212	1	.000	.197
*p<0.05, **p<0.01, ***p<0.001						

DISCUSSION

In the present paper, the aim of the study was to link diverse internal and external factors to the innovation performance of SMEs in the transitional context of Russia. The empirical evidence indicates the importance of firm size, innovation intensity, product competitiveness, collaboration with other firms, and external funding sources, which increase both product and process innovation performance in the SME manufacturing sector of Russia. Market competition only positively affects the product innovation performance of SMEs, while technically qualified staff have a positive influence only on the process innovation performance of SMEs. Engineering staff negatively affect both the product and process innovation performance of SMEs. Other results such as firm age, collaboration with industry associations and both financial and organizational support on the federal/regional/local level do not exhibit a significant relationship with the product and process innovation performance of SMEs. In general, the results obtained from the two linear regression models can be interpreted in line with the stated hypotheses.

Hypothesis 1 was proposed to explore the relationship between the firm size factor and the innovation performance of SMEs. The findings show that firm size positively influences the product (0.408; $p<0.05$) and process (0.597; $p<0.001$) innovation performance of SMEs. Thus, the release of innovative products and engagement in innovative processes increases with firm size. The result is in line with the evidence obtained in the context of low technology industries (Bhattacharya and Bloch, 2004).

Hypothesis 2 was formulated to test the link between the firm age factor and the innovation performance of SMEs. The result indicates that there is no significant correlation between firm age and the product and process innovation performance of SMEs. Hence, H2 is not supported in the present study. Surprisingly, this finding is consistent with the case of transition countries, which confirms the insignificant relationship between firm age and the innovation performance of SMEs (Radas and Bozic, 2009).

Hypothesis 3 was developed to test the interconnection between the innovation intensity factor and the innovation performance of SMEs. The findings indicate that innovation intensity is positively linked to the product (0.902; $p<0.001$) and process (1.126; $p<0.001$) innovation performance of SMEs. In this case, engagement in innovations significantly boosts both the product and process innovation performance of Russian manufacturing SMEs. In practice, the RandD intensity of Russian manufacturing SMEs is quite low (OECD, 2015). However, if SMEs focus on innovations, they have an opportunity to release both product and process innovation outputs.

Hypotheses 4 and 5 were designed to reveal the relationship between RandD personnel such as engineering and technically qualified staff with the innovation performance of SMEs. Engineering and technically qualified staff exhibit diverse relationships with the product (-0.398; $p<0.05$ and insignificant) and process (-0.496; $p<0.05$ and 0.498; $p<0.05$) innovation performance of SMEs. It should be mentioned that in the database of the study, the variables are designed to reveal if the firm faces a lack of engineering or technically qualified staff. Thus, SMEs have enough engineering staff to improve both product and process innovation performance, while technically qualified personnel seem to be a severe barrier, especially for process innovation performance at SMEs. An empirical study found that technically qualified staff negatively affect the innovation performance of SMEs due to the complexity of an innovation project, which results in insufficient competency levels of personnel; this is in line with the results of the present research (Subrahmanya, 2013). The lack of skilled labour in the Russian market is accounted for by the fact that the educational system is designed to offer a theoretical background, while practical aspects are less taught at higher education institutions (OECD, 2015). In this light, it is crucially important to establish systematic practically-oriented training programmes at educational institutions of Russia that would develop the creativity and knowledge required of potential staff during the innovation process for future sustainable development of the SME sector in Russia (Sokolov and Rudnik, 2014).

Hypothesis 6 was proposed to determine the positive relationship between collaboration with other firms and the innovation performance of SMEs. As the results indicate, collaboration with other firms positively affects both the product (0.534; $p<0.001$) and process (0.451; $p<0.01$) innovation performance of SMEs. The finding shows that the collaboration process with other firms may improve the release of product and process innovations of Russian manufacturing SMEs. This finding is interesting but not surprising since the transition period greatly impacted the way collaboration for entrepreneurship is organized in the context of Russian SMEs. As a result, formal institutions became underdeveloped, which made the legal framework ineffective for the further development of the SME sector in Russia; thus, companies maintained informal networking partnerships to rapidly access valuable resources and survive in the marketplace. To improve the current situation, the role of the government is to maintain partnerships and integrate SMEs into the established supply chains, especially with large companies and institutional bodies that will enhance innovation performance, which leads to the overall competitiveness of the manufacturing SME sector in Russia (Sokolov and Rudnik, 2014).

Hypothesis 7 was developed to reveal the interrelation between the factor of collaboration with industry associations and the innovation performance of SMEs. The empirical evidence shows an insignificant result for collaboration with industry associations and both the product and process innovation performance of SMEs. Therefore, H8 did not receive support in this paper. However, this finding is in line with an empirical study that found a similar, insignificant correlation of collaboration with industry associations and the innovation performance of SMEs (Romijn and Albaladejo, 2002).

Hypothesis 8 was tested to find out the relationship between external funding sources and the innovation performance of SMEs. External funding sources have a positive significant relationship with the product (0.290; $p<0.05$) and process (0.333; $p<0.05$) innovation performance of SMEs. In the context of Russia, SMEs usually fund their businesses through partner or bank loans as well as borrowing from family and friends,

especially in the early stages of business, which indicates the importance of such linkages for better innovation performance and competitive advantage in the marketplace of Russian SMEs (European Investment Bank, 2013).

Hypothesis 9 was stated to analyse the interconnection between the product competitiveness factor and the innovation performance of SMEs. Product competitiveness has a positive linkage to the product (0.408; $p<0.01$) and process (0.380; $p<0.01$) innovation performance of SMEs. This result means that a "competitive" technological product in the local or global marketplace significantly increases the innovation performance of manufacturing SMEs in Russia. Due to the lack of financial and managerial resources, it is quite hard for SMEs to develop such high-level technology, especially to overcome the competitive pressure in the global-scale market, but additional revenues from technological product commercialization would be beneficial for future innovation performance and market competitiveness in the SME sector of Russia.

Hypothesis 10 was proposed to link the market competition factor with the innovation performance of SMEs. Market competition has diverse results with regard to the product (0.361; $p<0.01$) and process (insignificant) innovation performance of SMEs. That is, firms meet the challenge of competition by introducing innovative products on the market, whereas the innovation process is more an in-house development of the firm that usually does not directly influence SMEs' competitiveness.

Hypothesis 11 was developed to test the relationship between both financial and organizational government support and the innovation performance of SMEs. Interestingly, all six variables included in the regression model that indicate financial and organizational support from local, regional and federal governmental authorities did not significantly impact the product and process innovation performance of Russian SMEs. As a matter of fact, the Russian government provides diverse benefits such as money lending, simplified taxation regimes, property lending and state orders of goods and services to improve the sustainable development of the SME sector in Russia. However, the application procedure for obtaining state support is not quite clear, which causes SMEs to search for both short-term and long-term funding from other market players (European Investment Bank, 2013).

CONCLUSIONS

Based on a sample of 1677 Russian manufacturing SMEs, the relationship of internal and external factors that affect innovation performance was tested by linear regression analysis. The findings indicate that firm size, innovation intensity, product competitiveness, collaboration with other firms and external funding sources are positively related to the innovation performance of Russian SMEs. Interestingly, the results reveal that firm age, collaboration with industry associations and financial/organizational government support do not have a significant impact on the innovation performance of SMEs.

However, it should be mentioned that the study has some limitations. The sample consists only of Russian manufacturing SMEs; thus, the findings may be context-dependent with regard to country and industry. Future studies could be based within the context of other countries and diverse industries to generalize the results. The present study focuses on a particular group of factors, but there may be many more internal and external factors that affect the innovation performance of SMEs. Finally, the results were achieved

by using RuFIGE database variables. It is possible to use a different measurement for internal and external factors.

Despite the limitations, the study offers some contributions to research. Firstly, the paper contributes to the literature that focuses on determining the prominent factors that affect the innovation performance of SMEs in a transitional context (Radas and Bozic, 2009; Xie et al., 2013). Secondly, it contributes to the institutional-based literature in which the strategic partner selection process exhibits some differences in the poor institutional settings of transition (emerging) economies (Hitt et al., 2004; Hoskisson et al., 2000; Peng, 2003). Thirdly, the findings can be applied to the strategic management literature, where collaboration alliances and personal networks greatly minimize transaction costs, provide access to valuable resources and create value for all the network members in the marketplace (Dyer, 1997; Gulati, 1999).

Managerial implications

Based on the results obtained, managers should form networking linkages with strategic partners, engage in innovation activities and improve the level of technological products to increase the innovation performance of SMEs. An important finding of this research is linked to external funding sources that affect the innovation performance of SMEs. In the database, external funding sources cover all financial support from external partners, which makes the specification of SMEs' external funding sources impossible. However, the main idea is to collaborate with stakeholders in the marketplace (e.g. customers, suppliers or even other firms) that can provide financial support for the product and process the innovation performance of SMEs. Managers should take into consideration that organizing as many network linkages as possible is not a good idea since the competence level of external partners may differ significantly in innovation activities, and it is better to look for strong strategic partners that can truly influence the innovation performance of SMEs (Brunswicker and van de Vrande, 2014).

Policy recommendations

The research findings offer some insights for policymakers. It should be mentioned that government support on local, regional and federal levels does not impact the innovation performance of SMEs. In the case of Russia, the priority of the government is to support the innovation activities of SMEs, which is clearly stated in federal-level policy programmes, but the governmental agencies that are required to implement the policy fail to do so due to poor coordination and allocation efforts (Sokolov and Rudnik, 2014).

In this context, government officials should organize network linkages and support the prominent market players to increase the innovation performance of SMEs. Exchange of viewpoints and experience among diverse stakeholders can give rise to fruitful information for further targeted policymaking and reduce risks and uncertainty during SMEs' innovation efforts in the manufacturing sector. Industry associations seem to be a good intermediary platform with unique practical insights on the market challenges for SMEs. However, the study's findings show that industry associations do not significantly affect the innovation performance of SMEs. Therefore, policymakers need to evaluate the performance of institutional bodies such as industry associations to create a better ecosystem for SME innovations that contributes to the sustainable development of the manufacturing sector in Russia.

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APPENDIX A

Measurement Operationalization

Variables	Factors	Variable labels	Measurement item	Values
Dependent variables	Innovation performance of SMEs	B55_SME_1	Did the firm introduce a new or significantly improved innovative product on the market	0-No 1-Yes
		B55_SME_2	Did the firm introduce new or significantly improved innovative technology on the market	0-No 1-Yes
Independent variables	Firm size	F14_SME	Number of employees	0-Small enterprise (10-100 employees) 1-Medium enterprise (101-499 employees)
	Firm age	B1_SME	Year of the firm's establishment	Natural logarithm
	Innovation intensity	B58_SME	Did the firm engage in innovation activities	0-No 1-Yes
	Product competitiveness	B54_SME	Does the main technological product meet the quality requirements	0-Meets the requirements of medium-quality versions 1-Meets the requirements of high-quality versions
	Engineering staff	B48_SME_2	Is it a barrier for the firm to lack engineering staff	0-Yes, it is a barrier 1-No, it is not a barrier
	Technically qualified staff	B48_SME_3	Is it a barrier for the firm to lack technically qualified staff	0-Yes, it is a barrier 1-No, it is not a barrier
	Collaboration with other firms	B36_SME	Did the firm collaborate with other firms	0-No 1-Yes

Variables	Factors	Variable labels	Measurement item	Values
	Collaboration with industry associations	B102_SME	Did the firm collaborate with industry associations	0-No 1-Yes
	External funding sources	B89_SME	Did the firm receive funding from external sources (e.g. banks or partners)	0-No 1-Yes
	Market competition	B15_SME	Is the firm's market share enough to gain a competitive advantage	0-No 1-Yes
	Government financial support	B104_SME_1	Did the firm receive financial support from the federal government	0-No 1-Yes
		B104_SME_2	Did the firm receive financial support from the regional government	0-No 1-Yes
		B104_SME_3	Did the firm receive financial support from the local government	0-No 1-Yes
	Government organizational support	B105_SME_1	Did the firm receive organizational support from the federal government	0-No 1-Yes
		B105_SME_2	Did the firm receive organizational support from the regional government	0-No 1-Yes
		B105_SME_3	Did the firm receive organizational support from the local government	0-No 1-Yes