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FIRMS' PERSPECTIVES ON INNOVATION POLICY MEASURES

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The article explores the effectiveness of public policies to encourage innovation by industry, and in particular to develop industry-science interactions. The demand and impact of innovation policy measures on enterprises' behaviour is investigated based on the results from a specialized survey of high-tech and medium high-tech manufacturing enterprises in Russia, conducted in 2018. The empirical approach is based on the concept of additionality allowing to determine the net effects of policy interventions. Particular attention is paid to the comparison of changes in the behaviour of enterprises (behavioral additionality) depending on their innovation strategies, including the decision to cooperate with universities and R&D organizations. The results indicate that while there is a strong demand for policy instruments used to promote innovation, they do not provide significant additional impacts to the business' innovation activity. State efforts to promote industry-science cooperation seem to be ineffective. Public support contributes to reinforcing already established links, but does not lead to the emergence of new research partnerships.

Keywords: Industry-science interactions; Innovation policy; Public support; Public policy evaluation; Additionality concept; Innovation strategy; Manufacturing; Empirical study.

JEL Codes: D22, L2, 031, 038

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1 Introduction

From business perspective, innovation is central for driving sustainable competitive advantages and effective value creation (Dosi, 1997; Porter, 1990). Innovation processes emerge on the boundary of intra-firm and external environments and involve a range of players distributed up and down the supply chain (Dahlander, Gann, 2010; Powell, Grodal, 2005). In the context of expanding the number of channels through which firms acquire knowledge and technologies (Laursen and Salter, 2006), interactions between industry and institutional research and development (R&D) performers remain critical (Bercovitz, Feldmann, 2006; Kaufmann, Tödtling, 2001). The ability of firms to incorporate the new knowledge, acquire and adopt R&D results (Cohen, Levinthal, 1989) facilitates the creation of radical and impactful innovation (Cohen et al., 2002).

Promoting close and intensive interactions of enterprises with universities and R&D organisations is one of the strategic goals of the national innovation policy, aimed at fostering the use of R&D to produce new and competitive products and processes (Georghiou et al., 2014; Martin, Scott, 2000). In recent years, new approaches and initiatives to promote research partnerships have been actively initiated. The key issue, however, is the effectiveness of the efforts undertaken by the state: what is the impact of innovation policy on business innovation activity? And do existing support measures promote industry-science cooperation successfully?

The assessment of innovation policy effectiveness and its impact on enterprises' behaviour is a complex task that requires consideration of firm specificities, institutional and economic conditions in the country and other factors (Edler et al., 2012; Edler et al., 2016). It should be also considered that there is a delay between a policy intervention and a consequence, especially at the macro level (Kline and Rosenberg, 2010). One of the main approaches to policy evaluation is the concept of additionality aimed at identifying the effects of regulatory interventions that would not occur in the absence of public support (Buisseret et al., 1995; Georghiou, 2002; Gök, Edler, 2012).

The objective of this study is to assess the effectiveness of innovation policy in Russia on the basis of the additionality concept. Using firm-level data on innovation activity of high- and medium-high-tech enterprises in Russia, the demand for state support measures, and their effect on innovation performance of enterprises are investigated. The focus is on the impact on the expansion of interaction with universities and R&D organisations.

The empirical approach allows, firstly, measuring the "net" effects of public support on firms' innovation activities, and secondly, finding out how the existing cooperation links with institutional R&D performers affect the demand for and effectiveness of various state support

measures. Under 'institutional R&D performers' this paper understands universities and R&D organisations.

The rest of the paper is structured as follows. The paper begins with a review of innovation policy measures aimed at promoting industry-science cooperation, and of the existing approaches to evaluate them. The next section contains a detailed description of the empirical data and methodology applied to measure additional effects of state support measures. In the conclusion the main results of the research are presented and discussed.

2. Literature review, and hypotheses of the study

Public support for innovation: focus on industry-science cooperation

Promoting interaction between industry and institutional R&D performers is one of the objectives of the innovation policy where the choice of support measures is determined by both the state's current resource capabilities, and the vision of the role of innovation in the development of the country's economy (Borrás, Edquist, 2013).

There is a wide range of instruments to support and promote interactions between industry and science, including financial (direct and indirect) incentives, regulatory, and the co-called "soft" measures (Bozeman, 2000; Kochenkova et al., 2016; Meissner, Carayannis, 2017; OECD, 2019). The former include various formats of making public funding available to enterprises, universities, and R&D organisations, on condition of jointly implementing R&D projects. Regulatory instruments are aimed at providing additional incentives for cooperation by improving legislation on intellectual property (IP), promoting researchers' careers, providing funding to universities, etc. "Soft" instruments include various mechanisms for providing information and consulting support; they are focused on simplifying partners' interaction, and building trust.

The government promotes industry-science cooperation (and innovation in general) by both supporting supply, and promoting demand (Edler, Georghiou, 2007; Aschhoff, Sofka, 2009). Supply-side policies are focused on creating an environment favourable for generating new knowledge which can be subsequently transformed into new technologies and products. On the other hand, demand-side policies are designed to stimulate interest in the scientific and technological (S&T) results from the real sector of the economy, the state, and the public.

State support measures aimed at developing networking in innovation are traditionally included in the supply-side policies category (Edler, Fagerberg, 2017). However, in recent years more countries have focused their policies on stimulating businesses' demand for S&T results (Guerzoni, Raiteri, 2015). Therefore, the popularity of demand-support measures began to grow: public procurement of innovative products and services (Edquist et al., 2015; Georghiou et al., 2014), various types of innovation vouchers (Dezhina, Ponomarev, 2014), supporting development

of innovation infrastructure to promote transfer of knowledge and technologies into the real sector of the economy (De Silva et al., 2018). A transition from implementing a set of selective instruments to a balanced, complementary policy mix to create positive synergies is under way (Cunningham et al., 2016).

Approaches for innovation policy effectiveness evaluation

Policy evaluation is an important step in the policy process aimed at establishing whether existing instruments are effective in achieving the objectives of their beneficiaries. The lack of monitoring and evaluation (both ex-ante and ex-post) could lead to the development of new instruments, while the existing ones remain uncorrected. There is both a need for an integrated policy evaluation (Borrás, Laatsit, 2019), and isolation and impact assessment of individual policy instruments (Smits, Kuhlmann, 2004).

There are different approaches to the innovation policy evaluation varying in terms of stages, objects, subjects, and methodologies (Edler et al., 2016; Link, Vonortas, 2013). A universal approach cannot be developed for many reasons, for example country specificities of policy design and implementation, causality and interrelation of policy instruments and their delayed impact, especially at the macro level (Kline, Rosenberg, 2010; OECD, Eurostat, 2018). The interpretation of the evaluation results should take account of socio-economic conditions and political context in the country and also specific features of beneficiary firms as they influence the demand for and impact of policy instruments.

One of the main data source for assessing the effectiveness of policy instruments are specialized surveys as they collect information on both the use of state support measures and the effect on firm activities (Aerts, Schmidt, 2008; Marino et al., 2016). At the firm level, such surveys typically look at potential determinants of firms' propensity to use public support including the industry the enterprise operates in, its size, age, ownership, economic performance, market structure, technological opportunities, etc. (see, e.g., Simachev et al., 2017). Such factors also significantly affect the likelihood and success of cooperation with R&D organisations and universities (Eom, Lee, 2010; Roud, Vlasova, 2018). Particular attention is also paid to innovation strategies which determine enterprises' behaviour (Roud, 2018). The goals of innovation activities, and the choice of mechanisms and resources to accomplish them, including interactions with other economic actors, define enterprises' innovation strategies.

Promoting industry-science cooperation in Russia

In Russia, innovation policy has been actively developing since the early 2000s. Against the background of business low interest in innovation, and the modest scale of industry-science cooperation (Gokhberg, Kuznetsova, 2009), the state has initiated a wide range of initiatives to

promote interactions between a variety of actors – enterprises, academia, public authorities and society – each fulfilling special roles at different stages of innovation process. Most attention has been paid to the industry-science interactions.

A distinctive feature of the policy aimed at promoting industry-science cooperation is the dominant role of direct financial instruments that usually set clear targets and rigidly regulate the use of funds (Dezhina, 2017; Gershman, 2013). The evolution of the role of the state in developing industry-science interactions and relevant support measures are described in detail in Gershman et al. (2018) and Simachev and Kuzyk (2017).

Despite the significant effort the government makes to trigger industry-science cooperation, strong and sustainable links between R&D performers and industry have yet to be established. A variety of issues related to the external conditions hinders the development of industry-science interactions. They include low level of competition on the domestic market; low business interest in innovation; strong state participation in the economy; inefficient regulation; industrial and regional disproportions; unbalanced institutional structure of the R&D network, etc. (Gokhberg, Kuznetsova, 2015; Polischuk, 2013; Roud, Vlasova, 2019; Yakovlev, 2014).

The influence of these factors is reflected in the indicators of innovation at the macro level. The analysis of statistical data confirms the low innovation propensity of Russian manufacturing enterprises. The share of manufacturing enterprises engaged in technological innovation as a percentage of all enterprises has not changed much in recent years and does not exceed 10% (HSE, 2019b). High- and medium-tech industrial companies have the highest level of innovation activity, but their share in the total number of organisations engaged in technological innovation in 2017 was 31.8% and 19.9%, respectively (HSE, 2019b). The state continues to act as a catalyst of innovation, while the federal budget remains its main funding source. Businesses' share in gross domestic expenditures on R&D is just 30%, while in developed countries it's over 50% (HSE, 2019a). In terms of innovation cost intensity Russia is comparable with leading countries (in 2017 the share in total sales was 2.4%), but productivity remains low: the share of innovative products in the total volume of shipped products is 7.2%; and in the industrial sector only 6.7% (HSE, 2019b). The scale of cooperation in innovation activities is limited. Only 3.3% of all manufacturing enterprises are engaged in joint R&D projects (HSE, 2019b).

In order to understand the effects of state support on the innovation activity of manufacturing enterprises in Russia, this study three hypothesis are tested. The first hypothesis focuses on what initially affects the decision of enterprises to take advantage of state support, specifically characteristics of their innovation strategy. This study assumes two possible innovation strategies based on the degree of novelty of innovation: new-to-market and new-to-firm. This

grouping is in line with internationally accepted definitions of R&D (OECD, Eurostat, 2018). This allows also assessing the effectiveness of technology transfer (Kaufmann, Tödtling, 2001).

The decision on interaction with external partners in the innovation process is a part of the innovation strategy of the enterprise (Hagedoorn et al., 2000). This study considers the role of the existing partnerships with institutional R&D performers as a determinant in the decision to use state support. Two types of cooperation partners are investigated: universities and R&D organisations, Russian and international ones separately, considering their different focus of research (basic and applied), different conditions for, and approaches to conducting it (Tether, Tajar, 2008).

Hypothesis H1: Specifics of innovation strategies significantly affect the demand of manufacturing enterprises for public support.

Drawing on the main goal of the innovation policy to increase the innovation activity in enterprises, the second hypothesis concerns the relationship between the use of state support and the results achieved in innovation activities. The lack of significant results at the macro level suggests a limited positive effect of state support on the innovation activities of enterprises.

Hypothesis H2: Existing measures of state support contribute to the improvement of innovation performance of enterprises, but the strength of this positive impact remains small.

The third hypothesis focuses on the effect that innovation policy has on the development of interactions between industry and institutional R&D performers. The impact is assessed against the backdrop of all the results achieved in innovation activities, as well as the existence of partnerships with R&D organisations and universities.

Hypothesis H3: State support does not have a significant impact on the emergence of novel industry-science links, but may contribute to strengthening the existing partnerships.

3. Source data and methodology

The data behind the study originates from the specialized survey 'Monitoring of Innovation behaviour of Enterprises' conducted in the framework of the project "Design of theoretical and methodological approaches to analyse innovation activity of innovation process actors"[2] implemented by the HSE ISSEK[3] as a part of HSE Basic Research Programme. The survey toolkit takes into account the recommendations of the European Manufacturing Survey (EMS) consortium, and the OECD and Eurostat guidance on innovation statistics (OECD, Eurostat, 2018). The survey was conducted in late 2018; the respondents were managers of high- and medium-high-technology manufacturing enterprises (Eurostat/OECD classification)[4]. In Rosstat's

[2] https://www.hse.ru/monitoring/innproc/
[3] https://issek.hse.ru/
[4] https://ec.europa.eu/eurostat/statistics-explained/pdfscache/6384.pdf

methodology[5], high- and medium-high-technology industries are included in the high-technology group and not subdivided for analytical purposes.

The questionnaire comprises five groups of questions: general characteristics of the enterprise; innovation activities; cooperation in innovation; public support for innovation; the use of advanced technologies and organisational concepts. The section "Public support for innovation" is key for this study and includes two questions: Did your firm use any of the following measures of state support for innovation activities in 2016-2018? What are the effects of state support for the enterprise's innovation performance? The choice of policy instruments for the analysis is conditioned by their relevance and scale of application by the high-tech enterprises participating in the survey. Possible impact of receiving public support includes changes in the conditions ensuring: competitiveness of the enterprise, expansion of market influence, stronger cooperation links, improved innovation processes, and better innovation activity results.

The selection criteria for including an enterprise to the sample are it carries out the types of economic activities commensurate with OKVED codes[6], and the number of staff is more than 15 employees. The survey covers more than 40 regions (out of 85) in all eight federal districts. The final sample comprised 545 enterprises. See Table A1 in the Appendix for a more detailed sample description.

To test the hypotheses two sub-samples are used: 422 innovation-active enterprises that had innovation activities during the period under review, including those with ongoing and abandoned activities, out of which 203 interacted with universities and/or R&D organizations in innovation activities during 2016-2018 (Table 1).

Table 1. Frequencies of cooperation of innovation-active high-tech enterprises with institutional R&D performers in innovation activities in 2016-2018

Cooperation strategy	Number of firms	Share (%)
No cooperation with R&D performers	219	51.9%
Cooperation with institutional R&D performers, among which:	203	48.1%
Russian R&D organisations	160	37.9%
Russian universities	128	30.3%
International R&D organisations and/or universities	29	6.9%
Total	422	100.0%

The analysis is implemented in two stages. Using the propensity score matching (PSM) technique (Khandker et al., 2009; Rosenbaum, Rubin, 1983), the enterprise decision to receive public support is first modelled, and then the impact of policy intervention on innovation activity is

[5] http://www.gks.ru/metod/metodika_832.pdf

[6] OKVED – National classification of activities by Russian Classification of Economic Activities, which is compatible with the Statistical Classification of Economic Activities in the European Communities (NACE Rev. 1.1).

assessed. By comparing how effects differ for enterprises receiving public support (i.e. treated) relative to observationally similar enterprises that do not receive public support (i.e. non-treated), it is possible to estimate the 'net' effects (i.e. relative additionality) of the state support.

This non-parametric analysis of measuring impact is based on two assumptions: conditional independence and common support (Heckman et al., 1999). They imply that all variables that can influence the probability of treatment and potential outcomes are observed and that firms with the same characteristics have a positive probability of being both treated and untreated.

Table 2. Control variables used to calculate the propensity to receive public support

General characteristics	Value	Variable	Innovation-active enterprises	
			Total	Cooperation with R&D performers
			Average (standard deviation)	
Size (number of employees)	Up to 50	Order	0.365 (0.482)	0.356 (0.480)
	50-249		0.310 (0.463)	0.261 (0.440)
	More than 250		0.325 (0.469)	0.384 (0.488)
Age (years)	Less than 5	Order	0.047 (0.213)	0.049 (0.217)
	5 – 10		0.235 (0.424)	0.187 (0.391)
	10 – 20		0.229 (0.421)	0.227 (0.419)
	More than 20		0.488 (0.501)	0.537 (0.500)
Ownership	State-owned	Dummy	0.310 (0.463)	0.320 (0.467)
Competition (market)	International markets	Dummy	0.441 (0.497)	0.488 (0.501)
Financial position (profits)	Positive	Dummy	0.874 (0.332)	0.887 (0.318)
R&D performance	Internal (in-house) R&D	Dummy	0.900 (0.306)	0.911 (0.285)
	External (contract) R&D	Dummy	0.310 (0.461)	0.460 (0.500)
Innovation strategy (degree of novelty)	New-to-firm innovation	Dummy	0.664 (0.473)	0.650 (0.478)
	New-to-market innovation	Dummy	0.528 (0.499)	0.571 (0.496)
Cooperation strategy	R&D organisations	Dummy	0.379 (0.486)	-
	Universities	Dummy	0.303 (0.460)	-
	International R&D organisations, universities	Dummy	0.069 (0.253)	-

To model the decision of receiving public support a bivariate probit model is estimated. Different characteristics of enterprises are included in the model as explanatory variables (Table 2), except the industry, since only high-tech enterprises are included in the sample. Dimensionality

problem of explanatory variables is solved by introducing a single measure which is the propensity score that determines the probability of being treated (Dehejia and Wahba, 1999). The treated and non-treated observations are matched on the estimated probability of being treated (i.e. propensity score) using the k-nearest neighbor matching (k = 3). The hypotheses about the significance of differences in explanatory variables between those who received and those who did not receive support are tested using t-tests. Finally, the means of outcomes across state support recipients and their matched pairs (i.e. average treatment effect on the treated (ATT)) are estimated and compared.

The PSM is chosen because it allows eliminating the effect of self-selection, which prevents the 'net' impact of the state support estimation. This due to the fact that being a beneficiary of state support may indicate a higher initial level of innovation performance of enterprises (e.g., "picking-the-winner" strategy (Cerulli, 2010)). As a result, even without the use of state support measures, enterprises may achieve a higher level of innovation activity than those receiving support (i.e. treatment group).

4. Results and discussion

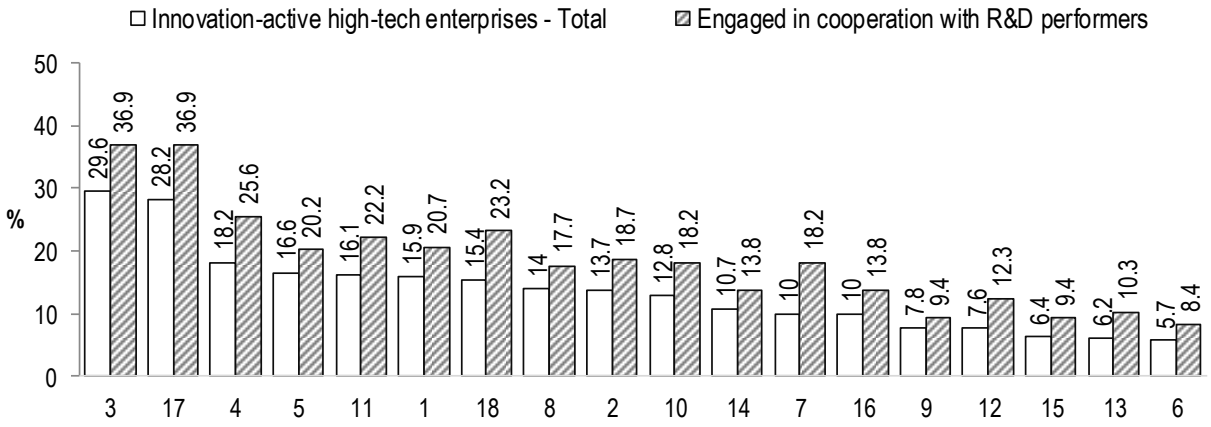
Industry demand for public support and effects on innovation activity: descriptive analysis

The analysis of the demand for state support measures for innovation revealed that enterprises interacting with universities and/or R&D organisations in innovation activities more often receive public support (Fig. 1) and are interested in the use of several policy instruments simultaneously (Fig. 2).

More than a half of innovation-active enterprises in high-tech industries (57% of the sample) received support from the state in the last three years; among the enterprises that cooperate with R&D performers – more than 68%. The intensity of the use of all policy instruments is higher among enterprises engaged in cooperation with universities and/or R&D organisations, by an average of 5 percentage points (Fig. 1).

Traditionally, financial instruments turned out to be the most popular ones: targeted subsidies within the framework of state and federal target programs (36.9%), support from development institutions (25.6%), soft loans from the Industrial Development Fund (22.2%), as well as tax benefits (18.7%). The 'cooperation component' is not a necessary condition for using them, so they promote industry-science cooperation only indirectly. Russian manufacturing enterprises also show high demand for information and consulting support from public authorities (approximately 30% of the respondents used it).

Figure 1. Industry demand for public support



1. VAT exemption for R&D
2. Profit tax incentives for R&D
3. Subsidies/ state purchases within the innovation-oriented state and federal special-purpose programmes
4. Support from development institutions
5. State export support: loans, guarantees, insurance, non-financial support (Russian Export Centre)
6. Participation in the National Technology Initiative projects
7. Support for complex high-tech projects performed together with universities (Government Resolution No 218, 2010)
8. Subsidised credit interest rates for complex investment projects in priority areas of civilian industry (Government Resolution No 3, 2014)
9. State guarantees for investment projects
10. Subsidies to compensate part of R&D expenditures (Government Resolution No 1312, 2013)
11. Soft loans from the Industrial Development Fund
12. Use of R&D, innovation and industrial infrastructure built at the expense pf public funds (e.g. shared-access equipment centres)
13. Acquisition of rights for budget-sponsored R&D results
14. Support for innovative territorial and industrial clusters
15. Participation in Innovation development programmes of state-owned enterprises (SOEs)
16. Support for intellectual property rights protection
17. Information and consulting support from public authorities
18. Regional R&D and innovation support initiatives

Note: The share of innovation-active high-tech enterprises that tried to use (successfully and unsuccessfully) a particular policy instrument in 2016-2018 in the total number of innovation-active high-tech enterprises.

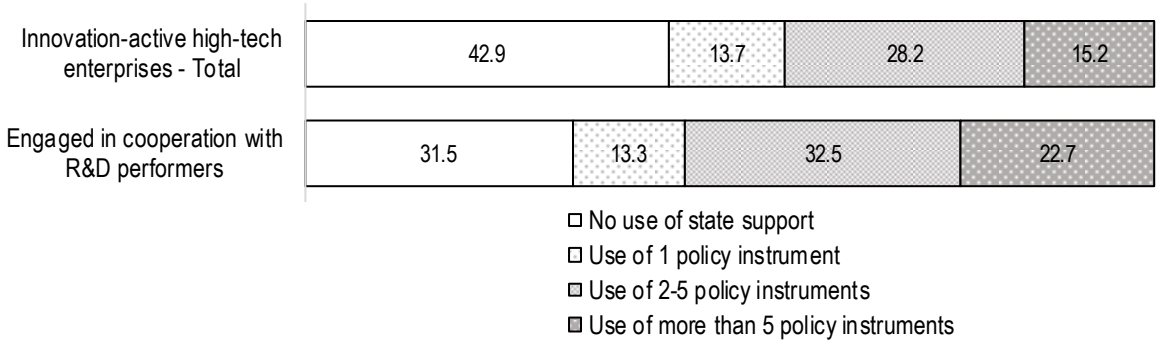
Though promotion of industry-science cooperation is one of the main strategic objectives of the national innovation policy, the number of targeted instruments remains rather limited. Out of the state support measures examined in the survey, only three measures (i.e. subsidies provided within the framework of implementing the Decree of the Government of the Russian Federation No 218[7], programmes to support innovative territorial and industrial clusters, and innovation development programmes of state-owned enterprises) are targeted at the development of

[7] The Decree of the Government of the Russian Federation of April 9, 2010 No. 218 "On measures of state support for the development of cooperation between Russian higher education institutions and organizations implementing comprehensive projects on creation of high–tech production"

interactions between enterprises and institutional R&D performers. Less than 20% of the respondents engaged in cooperation with R&D performers took advantage of them.

The analysis of the number of policy instruments used by innovation-active high-tech enterprises during the last three years revealed that enterprises engaged in cooperation with R&D performers in general have higher demand for "packaged support" (the use of several policy instruments simultaneously). About a third of the respondents used more than two different policy instruments, and approximately 20% used more than five (Fig. 2).

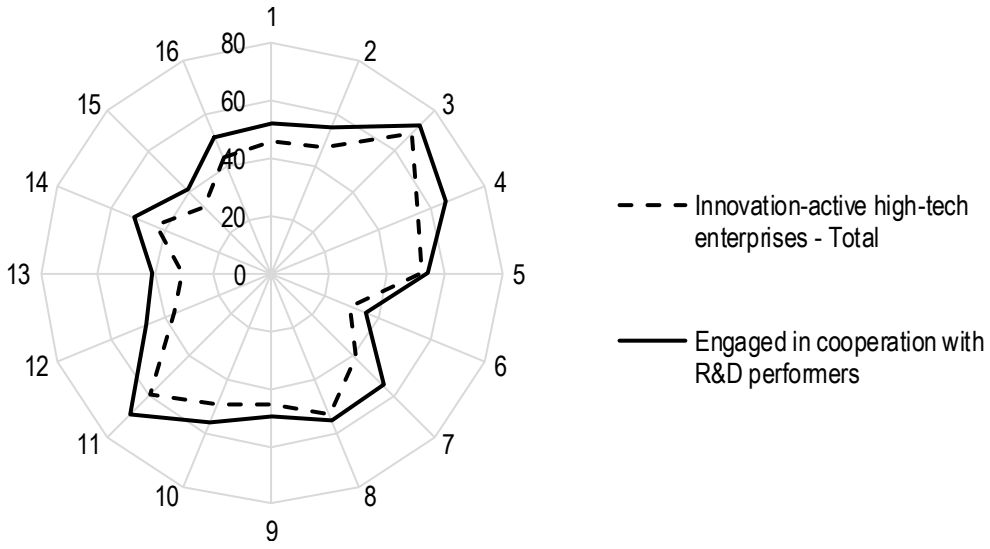
Figure 2. Public support in 2016-2018 by number of policy instruments used: demand structure (%)



From the perspective of the beneficiaries, existing innovation policy instruments contribute to the improvement of their innovation performance: about a half of the respondents noted a significant improvement of various innovation activity indicators (Fig. 3). State support has the strongest effect on enterprise competitive performance, in particular by improving financial and economic indicators and upgrading facilities and equipment. Another significant effect is the possibility of reducing the risks of innovation activities associated with conducting R&D, acquiring S&T results, and promoting products to the market. Every second enterprise noted that the state support facilitated market expansion.

Notably, enterprises engaged in industry-science cooperation not only more often become recipients of state support, but are more optimistic about the policy impact on their innovation activity. They note a significant effect on such aspects of innovation activity as expansion of the range of innovative products, launch of new innovation projects, increasing internal innovation expenditures and commercialization of R&D results.

Figure 3. Self-reported effects of public support for innovation on innovation performance of enterprises



Competitiveness:

1 – Strengthening competitive positions

2 – Attracting additional funding sources

3 – Improving financial and economic performance

4 – Upgrading facilities and equipment

5 – Applying new production technologies

6 – Implementing new management and organizational solutions for manufacturing

Markets:

7 – Extending product range

8 – Entering new markets

Cooperation:

9 – Expansion of cooperation links with other firms

10 – Expansion of cooperation links with universities and/or R&D organisations

Innovation:

11 – Reducing risks associated with innovation

12 – Launching new innovation projects

13 – Intensifying internal innovation expenditures

14 – Stepping up in-house R&D

15 – Commercialisation of R&D results

16 – Participation in the complex innovation projects

Note: The share of enterprises that noted the relevant effect in the total number of innovation-active high-tech enterprises that used at least one state support measure in 2016-2018.

Net effects of public support on innovation activity of high-tech enterprises

However, the key question here is to what extent the results achieved are conditioned by the receiving of state support. Perhaps even without it, an enterprise could achieve similar results? In order to answer this question, the additional impact of public support for innovation on firm outcomes is assessed using the PSM design.

The outcomes of the bivariate probit model estimation allow considering the reliability of the policy propensity predictors and determining features particular to enterprises using state support (Table 3). The results show that in Russia the state supports mainly large and sustainable business. The tendency to support "successful" firms and projects is also apparent in other countries (see, e.g., Lach, 2012; Wallsten, 2000). This can be argued to be a rational bureaucratic

strategy in an environment where "failure" is punishable at the level of the program decision maker.

Confirming the results of Almus, Czarnitzki (2003) and González, Pazó (2008), the results show that in-house R&D activity, R&D outsourcing, and innovation strategy influence the decision of receiving state support for innovation. State support is more often provided to large enterprises carrying out both in-house and external R&D (e.g., purchasing machinery and equipment, outsourcing of engineering, design, marketing, personnel training). Among those that cooperate with universities and R&D organisations, enterprises operating in international markets and creating new-to-market innovations are more likely to act as beneficiaries of state support.

It is important to note that for innovation-active high-tech enterprises, existing partnerships with national universities plays a key role in deciding to use state support. This may be due to both the requirements for obtaining support and the historically established concentration of scientific and technological capacity in universities.

Table 3. Determinant factors that influence on the propensity to use public support measures

Variable	Innovation-active enterprises — Total	Engaged in cooperation with universities and/or R&D organisations
Size	**0.268***** (0.095)	**0.359***** (0.136)
Age	0.008 (0.079)	-0.045 (0.121)
State ownership	-0.231 (0.142)	-0.315 (0.214)
Sales in international markets	0.180 (0.135)	**0.411**** (0.208)
Positive economic profit	-0.317 (0.207)	**-1.050**** (0.414)
Internal (in-house) R&D	**0.413*** (0.215)	**0.675*** (0.349)
External (contract) R&D	**0.359**** (0.154)	**0.451**** (0.210)
New-to-firm innovation	**0.387***** (0.140)	0.102 (0.220)
New-to- market innovation	**0.396***** (0.147)	**0.469****(0.224)
Cooperation with R&D performers:		
with Russian R&D organisations	-0.045 (0.159)	-
with Russian universities	**0.825***** (0.173)	-
with international R&D organisations and/or universities	-0.313 (0.286)	-
Constant	**-1.227***** (0.380)	-0.352 (0.611)
Number of observations	422	203
LogL	-243.201	-103.438
Likelihood-ratio test	90.06	46.16
Prob > chi2	0.000	0.000
Pseudo R^2	0.156	0.183

Note: Bivariate probit model estimation of propensity score. Regression coefficients show the effect of various characteristics of enterprises on the probability of using state support; and are used to estimate the

propensity scores. Standard errors in parentheses. Bold values indicate statistically significant coefficients. *— Significant at 10%; **— significant at 5%; ***— significant at 1%.

The estimated 'net' effects of the policy intervention on the innovation performance of Russian high-tech manufacturing enterprises show that receiving public support contributes to achieving better results in innovation, but positive effects are small and mostly statistically insignificant (Table 4). State support for innovation improves financial and economic performance indicators and reduces innovation risks. In terms of boosting competitiveness, the increased frequency of new production technologies introduction and growth of opportunities for updating their facilities and equipment are also significant effects for innovation-active enterprises.

Table 4. Average treatment effects of public support on innovation performance of enterprises

Effects	Innovation-active enterprises — Total	Engaged in cooperation with universities and/or R&D organisations
Competitiveness:		
1 – Strengthening competitive positions	0.079	0.104
2 – Attracting additional funding sources	0.079	0.123
3 – Improving financial and economic performance	**0.240*** **	**0.226** **
4 – Upgrading facilities and equipment	**0.134** **	0.173
5 – Applying new production technologies	**0.172*** **	0.130
6 – Implementing new management and organizational solutions for manufacturing	-0.061	-0.081
Markets:		
7 – Extending product range	0.052	0.097
8 – Entering new markets	**0.130** **	0.104
Cooperation:		
9 – Expansion of cooperation links with other firms	0.025	-0.004
10 – Expansion of cooperation links with universities and/or R&D organisations	0.093	0.122
Innovation:		
11 – Reducing risks associated with innovation	**0.179*** **	**0.210***
12 – Launching new innovation projects	-0.002	0.017
13 – Intensifying internal innovation expenditures	-0.081	-0.070
14 – Stepping up in-house R&D	0.071	0.071
15 – Commercialisation of R&D results	-0.018	-0.039
16 – Participation in the complex innovation projects	0.035	0.031

Note: The average treatment effect on the treated (ATT) estimators based on the Propensity Score Matching (PSM) approach. The values of the coefficients range between -1 and 1. A zero value means that the probability of achieving a corresponding effect for firms that received public support and firms that did not is the same. Bold values indicate statistically significant coefficients. *— Significant at 10%; **— significant at 5%; ***— significant at 1%.

The lowest (and statistically insignificant) values of behaviour additionality are for the direct changes in innovation activities, including launching and participating in new innovation projects, developing in-house R&D activity and R&D results commercialization. These results indicate the limited impact of innovation policy on the firm- level intensification of innovative activity. Moreover, receiving public support may contribute to the substitution of enterprises' own funds with public ones, thereby reducing the intensity of internal innovation expenditures.

The estimates show that there are no significant effects of state support on industry-science interactions development. This result is consistent with the finding of Simachev et al. (2017), analysing the impact of financial and tax support instruments on promoting industry-science cooperation in Russia. Given the fact that partnerships with institutional R&D performers is a determinant of firms' propensity to use public support, it can be assumed that although the innovation policy does not appear to induce new linkages with universities and/or R&D organisations, it may contribute to the sustainability of already established links. This is also reflected in other foreign studies (Carboni, 2013; Georghiou, 2002; Teirlinck, Spithoven, 2012).

On the basis of the analysis, conclusions can be drawn regarding the hypotheses put forward in the study. The hypothesis that *innovation and cooperation strategies have a significant impact on the propensity of enterprises to receive state support* (***H1***) is partially confirmed. For firms developing products and services that embody higher degrees of novelty (i.e. new-to-market innovation) and having research partnerships with Russian universities state support is in greater demand. The results indicate a *positive, but limited impact of innovation policy measures on firms' innovation performance,* confirming the hypothesis ***H2***. Respondents note that the use of state support measures improves various aspects of their innovation performance, however, the assessed 'net' effects are negligible. The hypothesis that the *state support does not lead to the emergence of new research partnerships, but may contribute to strengthening the already existing cooperation* (***H3***) cannot be rejected. There are no significant effects of state support on industry-science interactions development. However, the intensity of using state support measures is higher for innovation-active enterprises engaged in cooperation with universities and/or R&D organisations, and subsequently they achieve better performance.

5. Conclusion

This paper has investigated the determinants of receiving public support for innovation and the extent to which such public support enhances firm innovation activity and promotes cooperation with R&D performers. The analysis was performed using data from a specialized survey of high-tech manufacturing enterprises in Russia, conducted in 2018.

The results indicate that high-tech innovation-active enterprises are highly interested in public support for innovation, but the existing support measures do not provide a significant additional impact on the innovation activities of enterprises. Receiving public funding contributes only marginally to the increase of competitiveness of enterprises (i.e. upgrading technical facilities, intensifying new technologies acquisition and application, increasing financial performance) and reduction of innovation risks. However, the impact on innovation activities is insignificant.

The observed improvement in innovation performance is explained to a greater extent by the characteristics of enterprises – their size, engagement in R&D activities, and innovation and cooperative strategies. The state supports mainly large and sustainable business, offsetting the risks of low efficiency of the implemented measures. Enterprises introducing innovations with a higher degree of novelty and interacting with universities are more likely to use public support.

Another essential highlight – public support for innovation seems to be ineffective for promoting industry-science interactions. Being already engaged in cooperation with universities and/or R&D organisations, enterprises are more likely to receive government support. The use of policy measures, meanwhile, does not encourage them to create new research partnerships only strengthening the existing links.

The study is subject to certain limitations. The first one is due to the relatively small and low-coverage sample – only innovation-active enterprises in high-tech manufacturing. The second limitation is the impossibility to model the impact of institutional and economic conditions, typically strong determinants of the propensity of enterprises to innovate and of the demand for state support. A third limitation is related to lack of longer time series which does not allow to determine the effects of public support on firm innovation outcomes. The analysis is insufficient for comprehensive evaluation of government policies.

The present analysis indicates the interrelation between the effects of policy intervention and the characteristics of enterprises-beneficiaries, especially their innovation strategies. Taking this into account in the designing of new policy instruments, as well as ensuring their continuity and coherence, can help to achieve qualitative changes in the innovation activities of enterprises. Subsequently, the effects of government efforts will be also visible at the macro level.

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Appendix 1

Table A1. Dataset – industry structure

Industry	OKVED	Manufacturing sector	Number of firms (frequency, %)
High-tech	21	Manufacture of pharmaceuticals, medicinal chemical (pharmaceutical substances, medicines, chemicals and materials used for medical purposes)	42 (10.0%)
	26	Manufacture (maintenance, repair) of computers, communication equipment, optical devices, consumer electronics, instrumentation and navigation devices	86 (20.4%)
High medium-tech	20	Manufacture of chemicals and chemical product (except pharmaceutical products)	65 (15.4%)
	27	Manufacture (maintenance, repair) of electrical equipment, including household appliances	100 (23.7%)
	29	Manufacture (maintenance, repair) of motor transport, full-trailers and semi-trailers, their components	34 (8.1%)
	30	Manufacture (maintenance, repair) of aircraft, locomotives and rolling stock, their components	22 (5.2%)
	28	Manufacture (maintenance, repair) of general-purpose and special-purpose machinery, except the above	73 (17.3%)
Total			422 (100%)

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