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TRAINING EFFECTS OF EXPORTS IN RUSSIAN SOFTWARE INDUSTRY

ABSTRACT

The existence of educational effects of export is conditioned by nature of creation, accumulation, transfer of knowledge as well as absorption capacity of companies to accumulate and adapt the best experience, competencies borrowed from abroad. The length and direction of exports have a significant impact on innovation activity of organizations, and innovations do not always encourage IT companies to initiate export activities.

In the course of empirical research, we found following patterns in relation to Russian IT companies:

1) New IT exporters do not have a visible link between introduction of new products, technologies and beginning of exports. Investments in research and development, which may have been initiated after entering foreign markets or at the same time, have not yet yielded results.
2) Stable export activities stimulate IT companies to apply new technological, process and marketing innovations that were not a part of company's plans previously, much more often than companies on local market.
3) The influence of external knowledge effects on performance of IT companies depends on geographical direction of exports: markets of the near foreign (CIS countries) and Russia itself; markets of the far foreign.
4) Investments in research and development, marketing and production of new products are more typical for capital companies. The relationship between availability of an international office and introduction of innovations, on contrary, has not been proven. The size of companies affected only production of new technologies: if company is an average enterprise or larger, the probability of inventing an innovation is increased by 22%.
5) The smaller the company, the lower is its desire to take part in extensive innovative networks, increase number and variety of external relations. The size of company predetermines the level of influence of cooperation with other market participants on its internal innovation process.

The article deals with classification of spillover effects of knowledge, methodology of their research, analyzes economic effect of the "cross flow" process as a result of entering foreign markets. The emphasis is made on assessing ability of recipients to accumulate new knowledge in conduct of export activities to gain advantages in terms of future development: increase innovation activity and, accordingly, attractiveness, resulting in increased production efficiency.

KEYWORDS KNOWLEDGE CROSS FLOW, SPILLOVER EFFECTS OF KNOWLEDGE, RESEARCH AND DEVELOPMENT, INNOVATION, CHANNELS AND FORMS OF CROSS FLOW, KNOWLEDGE TRANSFER, EXPORT SALES.

INTRODUCTION

Knowledge is a resource, a specific asset capable of generating vast external effects, expressed in accumulation of knowledge and continuous production of new knowledge based on acquired competencies, skills, experience. In scientific literature, external effects are generally considered as a negative result of activity of industrial enterprises, expressed in deterioration of ecological situation. "Learning" effects, as a rule, are evaluated positively, as they contribute to expansion of companies' activities.

The concept of "knowledge transfer" (the spillover effect) arose in early 1990s.

Transfer as a process within which one organizational unit (for example, a group, department or division) depends on experience, performance, knowledge of another structural unit [Argote L.; Ingram P., 2000; Kuryatnikov A. B., Linder N. V., 2015]. The national innovation system (NIS), which consists of state (different institutes), science (scientific communities), enterprises (forming demand for innovation), innovative infrastructure (investors, business incubators, technoparks) plays a huge role in the process of technological progress development through creation and dissemination of scientific knowledge [Trachuk A. V., 2012]. The speed of spread of knowledge between research organizations predetermines one or another vector of economic development [The knowledge-based economy, 1996, p. 24]. The effective cross flow of knowledge depends on investing in skills and abilities in finding and adapting necessary, useful knowledge for further effective use and overcoming backwardness of developing business units, i. e. to solve accumulated problems [Trachuk A. V., Linder N. V., 2017a].

Narrowly, the cross flow of knowledge means exchange of ideas among individuals [Carlino G.A., 2001]. At the company level, the cross flow is described as follows:

- companies can obtain information created by other companies "free of charge";
- creators (or current owners) of information do not have an effective mechanism to prevent use of this information by other economic agents under current legislation [Grossman G. M., Helpman E., 1992].

Broadly, the cross flow is defined as a process that generates extensive spillover effects (externalities), or "the impact of market transactions onto third parties not mediated by market" [Externality, [n/y]], uncompensated impacts of one party on another. We will understand spillover effects as "changes in innovative behavior of companies" [Trachuk A. V., Linder N. V., 2016c]. expressed in the transformation of a business model, a corporate culture, employee behavior and other intra-company changes.

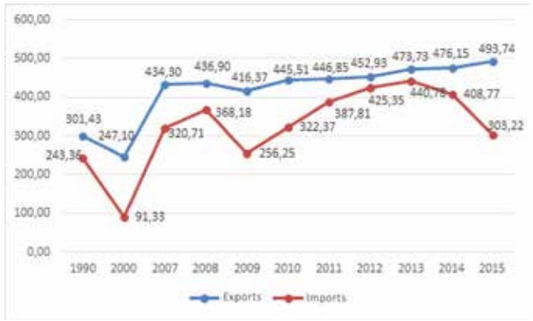
In scientific communities of economists, disputes of economic agents do not stop whether there really spillover effects of knowledge exist or not that to a large extent affect efficiency of activities, or it is a pattern caused by influence of many other factors [Trachuk A., Linder N., 2018b]. Due to contentiousness of the issue, we decided to analyze database of Russian high-tech companies in order to prove existence of effects considering cross flow of knowledge as a factor of innovation in the process of entering companies into foreign markets.

To begin with, we give a brief overview of the current state of structure of Russia's exports. The increase rate of export volumes is small: in 1990-2000, averagely 0.8% per year, in 2001-2015 – 4.4% [World Development, [s.a.]], but there is a slight improvement in export potential of the Russian Federation (Fig. 1). For comparison: in 2000-2015, import increase rate was averagely 10.3% per year, in 1990-2000 – 6.1%.

In one way or another, there is a positive balance of trade relations throughout the whole period, which means that Russia is relatively independent from other states. At same time, there is an opinion that Russia has not yet got off the over-reliance on oil and the only chance to stop being dependent on outside world is to develop and modernize industry, to start exporting high-tech products instead of trade with raw materials, matters and semi-finished products without increase of the value added. To analyze development of industries in Russia, it is necessary to conduct a detailed analysis of structure of exports. We set ourselves an objective of analyzing impact of spillover effects of exports on innovative performance of high-tech companies engaged in development of software (SW), IT technologies.

Most Russian IT companies are engaged in creating solutions for most promising segments of IT (large data, machine learning, digital intelligence, augmented and virtual reality, neural-like structures, mobility, cognitive, biometric technologies, security of cyberphysical systems, etc.). In these segments, competition for global markets unfolds, foundations of leadership are laid for

Fig. 1. Export and import of goods and services, billion dollars (in prices as of 2010), according to data of the World Bank



the period when the world economy acquires a new way of life. The IT industry is not self-contained, it is completely open to the world: companies are actively using opportunities for cooperation with global technology vendors, they are not afraid to enter previously unfamiliar markets and enter into fierce competition with successful global producers.

According to experts of the "Russoft" association, following main trends took place in 2016-2017:

- Since 2014, there has been a steady increase in revenues of domestic software developers from exports (averagely by 11-13%), only in 2016, domestic sales, as calculated in dollars, began to provide a significant increase in income of many enterprises in the industry;
- sales of software in 2016 grew by about 21% compared with results of 2015 (in 2016, revenue was not less than 4.4 billion dollars).

It is necessary to distinguish between terms "export" and "overseas sales" of software: it's not always so when sales in foreign markets lead to a direct inflow of currency into the Russian Federation (if we consider the term from position of legal entities), the part of money remains in foreign subsidiary companies established by Russian companies according to world practice of conducting foreign business. Money, as a rule, is directed to development of foreign development centers, sales offices, marketing (foreign currency proceeds are not received on accounts in Russia) and up to May 7, 2006, for partial mandatory sale of foreign currency earnings in Russia [Federal Law, 2003].

Thus, there are three indicators that characterize foreign economic activities of software developers:

- total foreign sales by end of 2016 made 7.6 billion dollars. (calculated by the Russoft);
- the inflow of currency to Russia from foreign sales in 2016 made $ 4.8-5.0 billion. (expert estimation of the Russoft);
- export of IT services – 2.7 billion dollars. [Statistics [n/y]].

This article sets following objectives:

- to analyze the efficiency of modern Russian and foreign companies in terms of impact of "training" spillover effects of exports on their activities;
- to prove existence of a causal relationship between effects of export of knowledge and innovation of Russian IT companies.

Scientific novelty lies in the fact that objects of research were enterprises of high technology sector and not of industri-

Main economic indicators of software developers in the Russian Federation, 2013-2017, according to data of the Russoft at end of 2016 [2]

Parameter	2013*	2014	2015	2016	2017**
Aggregate turnover of software developers: abs. Billion dollars rel. increase, %	More than 11 —	12 —	10,34 –10	12 +16	13,6 +13
Volume of foreign sales abs. Billion dollars rel. increase, %	5,4 +17	6,0 +11	6,7 +12	7,6 13	8,6 13
Share of foreign sales in total turnover,%	49	50	65	63	63
Volume of domestic sales: abs. Billion dollars rel. increase, %	5,0 —	6,0 +7	3,64 –39	4,4 +21	5,0 +14

** Until 2013, the "Russoft" company did not determine the size of total turnover, so there is no data on increase in turnover compared to 2012.*
*** Prediction for year 2017*

al production, new approaches to understanding the concept of "training spillovers" were formed. A comparative analysis of experience of foreign and Russian companies in measuring cross flow and adaptation of knowledge through participation in foreign trade activities is used to propose and justify its own toolkit for assessing spillover effects of exports. Recommendations have also been prepared on how to encourage IT companies to enter foreign markets in order to expand their activities and increase their turnover, how to assess activity in the field of innovations before and after the start of export activities.

THE CONCEPT OF SPILLOVER EFFECTS OF KNOWLEDGE: LITERATURE ANALYSIS

If knowledge creates one economic entity (be it an individual or an entire organization), then it will be available to other entities with time. Such a phenomenon can be described as a transfer of knowledge. For backward market participants with an undeveloped technological, intellectual base, the process of knowledge transfer serves as a "fresh gulp of air," allowing at least a little further development [Trachuk A. V., 2013].

In theory, external effects can be classified as follows:

- internal ones: the result of exchange of information, experience, of knowledge between employees of one organization or technology, equipment, staff within divisions of one company;
- external ones: the result of company's interaction with external environment;
- positive one: improvement of product, process, technology as a result of imitation, borrowing;
- negative one: theft of confidential information, secrets of production, causing damage to another enterprise;
- horizontal ones: the result of interaction between companies located at adjacent stages of the production chain;
- vertical ones: the result of interaction between companies in supplier/seller – consumer relationship (strong diversification of knowledge concentrated in complementary sectors):
  - direct ones (direct foreign ones): the result of foreign investments: When national companies gain access to less expensive or new intermediate resources;
  - invert ones: the effects of spread of new technologies through supply chain from companies with foreign capital to local, domestic suppliers;
  - direct ones: knowledge is not mediated by market transactions, trade, leads to an improvement in structural elements of production (material output);
  - indirect ones (monetary ones): the result of dependence on strategies, pricing policies;
  - temporary ones: the impact on next generations, for example as a result of scientific and technological progress, development of alternative energy sources (models by P. David, D. Rosegger, P. Stoneman);
  - spatial ones: impact on agents located in the same economic space (the theory of diffusion of innovations by T. Hagerstrand, D. Audretch's theory of entrepreneurship, P. Krugman's new economic geography);
  - o spillover effects of knowledge, innovative spillover effects, technological spillover effects – types of spillover effects accompanying diffusion of innovations, or process of spreading innovations through various communication channels;
  - o spillover effects (of knowledge): transfer of knowledge beyond intended boundaries, a certain range of individuals, organizations (as opposed to knowledge sharing);
  - o innovative effects: derivatives from external knowledge arising from unintended use of exchange of knowledge;
  - o technological effects arise in diffusion of technologies with only difference that spreading occurs uncontrollably and without any payment for technology; knowledge is transformed into one of factors of production; application of technologies in various sectors of economy;
- spillover effects of Marshall-Arrow-Romer, Porter, Jacobs are classified according to geographical branch concentration:
  - o spillover-effects of Marshall-Arrow-Romer arise among companies of one geographically close located industry. Knowledge accumulated by one company helps the development of technologically related companies one way or another [Jaffe A. B., 1986];
  - o Porter's spillover effects arise in companies that are geographThe theories of dynamic spillover effects mentioned above give reasons for proposing a kind of hypothesis about nature of branch base, diversified and concentrated, and also which of them is more likely to be subject to process of knowledge transfer and fastest growth.

Table 2.
Classification of spillover effects of knowledge on basis of sectoral geographical concentration

	Competitive environment	Monopolistic environment
Technological cluster	Porter effects	Marshall-Arrow-Romer effects
Variety of industries	Jacobs effects	—

The role of exports as a factor that provokes growth in general and productivity in particular has been empirically proven using aggregated intercountry and interindustry data-in-time for quite some time (macrolevel). Only recently, researchers decided to do the same at the inter-company level (micro- and mesolevel) in order to determine how effective are exporters and companies operating only in the domestic market.

One of most famous, cited works devoted to study of this phenomenon at micro level is the synopsis by Professor J. Wagner, "Export and Productivity", written in 2007. The research work at microlevel [Wagner J., 2007] was based on 45 small econometric models based on data from companies from 33 countries and published in 1995-2004. Then following conclusions were drawn:

- exporting companies proved to be more effective, innovative compared to non-exporters;
- as a result of self-selection effect, more productive companies tend to enter foreign markets, while export activities do not necessarily lead to improved performance.

The first fact is confirmed in works, where it is stated that it is expansion of company's presence borders, sales market, that provokes leaders to introduce innovations and various improvements that are a result of increasing efficiency and sustainable growth [Narula R., Marin A., 2003; Trachuk A. V, Linder N. V., 2016a]. The second fact is checked at theoretical and empirical levels: innovative activity and research create a competitive advantage for company, leading to an increase in productivity, which increases likelihood of becoming an exporter and strengthened not only in national market, but also at international one [Bernard A. B., Jensen J. B., 1999; Cassiman B., Golovko E., Martinez-Ros E., 2010]. The intuitive assumption about interdependence of innovations by these processes is ambiguous and needs to be studied in more detail on materials of different industries, companies and scientific institutions.

The questions mentioned above are also covered in article on self-selection of enterprises and on educational effect of exports using probit model and system of recursive simultaneous equations [Arkhipova M. Yu., Aleksandrova E. A, 2014] ,. The effect of self-selection is analyzed from collected data with addition of customs statistics [Kozlov K., Wilhelmsson F., 2007]. The existing experience of working in a foreign market is the key to success in future. Globalization leads to an increase in innovation activity [Gorodnichenko Y., Schnitzer M., 2010]. Hypotheses about innovative incentives of manufacturing enterprises when they enter foreign market (panel data as of 2005 and 2009 obtained in two surveys) are checked on micro- and macrolevel [Golikova V. V., Gonchar K. R. Kuznetsov B. V., 2011].

DEVELOPMENT OF RESEARCH MODEL AND HYPOTHESES

Empirical studies using variations of approach of A. Bernard and D. Jensen focused on one branch are also of interest for studying similarities and differences between companies that are exporters or not.

Differences between companies were studied on the basis of which countries, developed or developing, start exporting [Damijan J., Polanec S., Prasnikar J., 2004]. In developing countries, foreign companies have a greater profit compared to national ones, the opposite effect is observed in developed countries.

Hypothesis 1. Innovative companies are more likely to become exporters than companies that are distant from innovation. The main question is formulated as follows: "Are organizations really entering global markets as a result of self-selection, consistent with individual characteristics of each particular company?"

Hypothesis 2. Exporting companies are more likely to innovate (including organizational ones) than companies that focus on local market (the positive effect of learning from international interaction). At same time, export activity is not a guarantee of increase in company's productivity. The hypothesis reflects the role of educational effects of exports: exporting companies are more effective than companies that are present only in the national market. Knowledge cross flows between foreign buyers, suppliers and competitors help novice exporters to improve their activities, adopt positive business experience [Grossman G. M., Helpman E., 1992], to promote products and services faster, "to introduce technological innovations to preserve conquered niche and expand the zone of influence" [Greenaway D., Kneller R., 2007]. Companies entering foreign markets find themselves in a more intense and fierce competition and must develop faster to survive.

Export orientation and innovation are alternative investment projects competing with each other. Perhaps companies that have already entered foreign market do not need additional investment in innovation, since they already borrow all the best, new from abroad? To answer this question, second hypothesis was formulated.

Hypotheses mentioned above are by no means contradictory and mutually exclusive. On the contrary, they serve as a proof of existence of a bilateral relationship between export activities, innovation and efficiency [Wagner J., 2007]. As a result of introducing innovations, stronger, more enduring companies start exporting their own products, which makes them even more competitive and productive due to the "educational effect of exports".

METHODOLOGY OF THE STUDY

Answers to these questions should be provided by econometric modeling based on real data obtained during interviewing, consolidation of information on companies from various databases, statistical monitoring in order to test hypotheses. We believe that there are not enough comprehensive studies, where interrelations of exports, innovations and efficiency would be comprehensively analyzed. In our study, we considered companies from the most dynamically developing high-tech industry, taking methodology of work as a key reference [Wagner J., 2007; Golikova V. V., Gonchar K. R., Kuznetsov B.V., 2011; Trachuk A. V., Linder N. V., 2017b].

The empirical analysis was conducted on the basis of cross-data of Russian IT companies. The stratified sample of 152 high-tech industry enterprises can in general be considered a representative of a number of companies engaged in software development and various IT services. The sample characterizes incompleteness (the extension of sample is planned in the future more detailed study), priority inclusion of companies located in largest cities of the Russian Federation and available for engaging in a survey, and capabilities of companies themselves to manufacture and export high-tech innovations.

In general, around a half of companies that create software for corporate customers operate outside Russia's two mega-cities. In Moscow, average size of companies is higher at times than those in other cities (even in comparison with St. Petersburg, 80-90% averagely). In St. Petersburg, companies have average turnover and volume of exports similar to those of average IT companies throughout Russia. Metropolitan companies provide about 60-70% of B2B solutions export due to regions where development centers owned by Moscow and St. Petersburg parent companies are located.

The toolkit allows to interpret export of services and technologies from the point of view of its availability (implementation/absence of export activities), scale (the share of exports, more precisely, of foreign sales within the company's total sales), structures (technological services, finished products) and export orientation (near and far foreign).

Various export performance indicators were used to assess educational effects of exports; efficiency and productivity of companies (indicators are financial statements under RAS and IFRS); technological, food, organizational and managerial innovations, including costs of R&D (statistical form No. 4 - "Innovations"). The main data set was taken from system by SPARK counterparties and from questionnaires located on the site of the TAdviser analytical Internet portal.

The influence on innovative processes of "learning", the development is influenced not only by exports, but also by other factors. In particular, "the industry affiliation of an enterprise and its size may affect propensity to innovate and introduce new management technologies" [Trachuk A. V., Linder N. V., 2016c]. Also, innovative activity of enterprises can be related to the age of company and characteristics of the owner (belonging to a foreign holding company). The list of dependent variables and regressors is presented in Tables 3, 4.

If training spillover effects are present during export, what is their nature then? Perhaps, these are just some regularities: is the one who enters foreign market (as a result of self-selection) initially more productive, organized, tends more to innovate? On the basis of an analysis of works that focus on phenomenon of external effects of knowledge and question of their existence as such, we constructed a regression model for an empirical evaluation of effects' impact on productivity:

$$\ln y_i^t = b_t + \sum_{i=1}^{4} b_{i+1} EP_i + \sum_{i=1}^{3} b_{i+1} ES_i + b_5 Foreigh_{t,0} + b_6 Size_t + \sum_{k=1}^{3} b_{k+9} Age_k + \sum_{l=1}^{2} b_l Secton_l$$

where y^t_i – is one of indicators of innovative behavior (Table 3); b_x – are rates of explanatory variables from Table. 4.

To assess dependent dummy variables, we will use usual probit regression of dependence of corresponding indicator in 2017 on value of this indicator in 2015, export status and other characteristics of organization. To eliminate problems of endogeneity "associated with different direction of cause-effect relationships between size indicators and property parameters, values of these predictors in model are taken over previous period" [Trachuk A. V., Linder N. V., 2016c].

Attempt to apply linear regression for forecasting innovative activity of enterprises after entering foreign markets does not make sense, since values of linear form belong to a continuous quantitative scale, and variable varies discretely. Therefore, it is recommended to build special regression models to study dependencies between binary variables (innovation indicators) and quantitative data (in our case, regressors).

There are two approaches that allow building such models. The first one involves constructing a linear probability model (using robust standard errors), which we will not use, the second one is construction of nonlinear models (logit and probit). In case of constructing last two models, a relationship is established between variable and data set as well as between probability that the i-th value of binary variable is 1 under a certain condition.

The probit model differs from the logit model only because it uses instead of the derivative logistic curve:

$$f(Z) = \frac{dp}{dZ} = \frac{e^{-z}}{(1+e^{-z})^2},$$

where Z – is the argument of the function of standard normal distribution; p – is the density of distribution, function of density of normal distribution:

$$f(Z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}Z^2}.$$

In other aspects, probit and logit analyses are similar. Their idea is that likelihood function is maximized: there is a possibility that what is in our sample will be accidentally received. Practically this means that we pay attention to sums of squares of remainders no longer, we are interested in behavior of the likelihood function.

To build the model, we carried out necessary analysis of data collected by 152 companies, diverse in their characteristics and structurally resembling general population, on which we could extrapolate our results.

According to our data, 55% of respondents are located in Moscow, St. Petersburg and in Moscow region (80 companies are in Moscow, St. Petersburg, 5 companies are in Moscow region), or 53% are only in metropolitan cities. It would be good to reduce

Table 3.
Indicators of dependent variables of innovative behavior of IT companies

Model number	Dependent variable	Indicator
U1	Costs of R&D (RD_ cost, RD)	Availability of costs for R&D (takes 1 or 0 for each period)
U2	New product (NP)	Introduction of a new product, service (assumes a value of 1 or 0 for each period)
U3	New technology (NewTech, NT)	Introduction of a new technology (takes values of 1 or 0 for each period)
U4	Export (Exp)	Increase of the share of overseas sales (takes values of 1 in case of increasing share of exports or 0 in case of decrease for each period)
U5	Patents (P)	Presence of patents (takes values 1 or 0 for each period)
U6	Marketing (M)	Increase of marketing costs (takes 1 or 0 for each period)

Table 4 Predictors

Dependent variable	Predictor
Export period (Exp_period, EP)	Belonging to one of four groups: 1 – companies that exported products in 2015-2017; 2 – new exporters that did not have exports in 2015, but exported in 2017; 3 – former exporters who left export markets; 4 – companies that did not have exports during observation periods
Export status (Exp_status, ES)	A variation of main market for an IT company: 1 – local (local, market of a certain circle of buyers of a part of a city, region, etc.); 2 – national market (Russia and other CIS countries); 3 – international one
Region	1 – company is located in the capital (in Moscow and St. Petersburg, in Moscow and Leningrad regions); 0 – company is located in a region
International Office (Foreign)	Presence of an international office and/or parent company abroad (1, otherwise 0 – IT company is purely Russian)
Size	The size of the company (the log of number of employees)
Age	The age of the company (1 – created before 2003, 2 – after 2003)

the share of respondents from St. Petersburg to 15% (to match the general sample), but as data from regions was not enough, it was decided to leave it as 22%.

The majority of respondents (31%) worked in companies incorporated before 1999; approximately 20% of companies were incorporated in 1999-2003, 2004-2008 and 2009-2013 (about 65% in 1999-2013), and only 5% of respondents worked in new companies.

To build probit models, we divided companies into those that were incorporated before and after 2003 (54.6 and 45.4%, respectively).

Fig. 2. Distribution of IT companies according to geographical principle

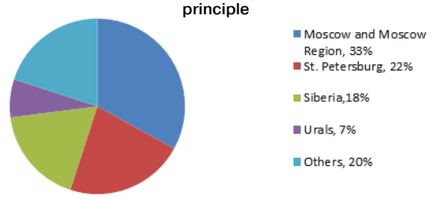


Fig. 3. Distribution of sample companies by year of occurrence

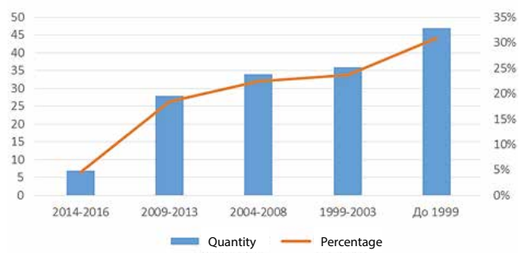


Fig. 4. The status of companies as exporters

Fig. 5. Distribution of companies depending on territorial feature of the outlet market

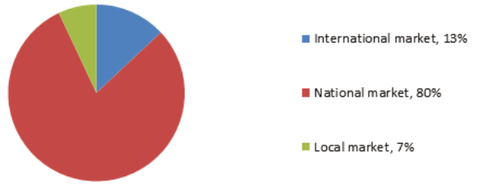


Fig. 4, 5 shows distribution of companies surveyed by status and market orientation. To divide up new and traditional exporters, we accept the moment of the "beginning of exports" in 2017 as a milestone. The former exporters are all those who left foreign markets during the considered period. We must understand that more domestic companies attended international markets in 2016-2017 (22%).

Fig. 6 shows distribution of companies depending on their specializations: each company had the right to choose among several directions. Leading developments were solutions on order (68%), creation of mobile applications (44%), production of replicable control systems (32%).

In Fig. 7 we have given the distribution of companies depending on their key activities, which they are engaged in and which they develop more as a percentage of other areas. companies were selected in one direction respectively, result for all positions was 100%. As we see, only custom development (39%) is a great success in overseas markets.

Fig. 6. Specialization of IT companies in the sample (multiple choice), %

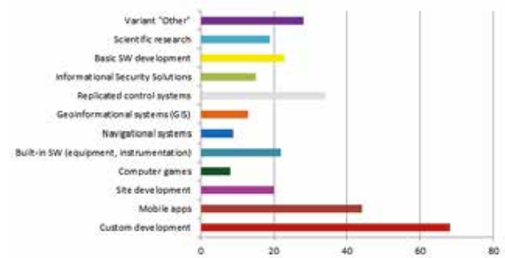
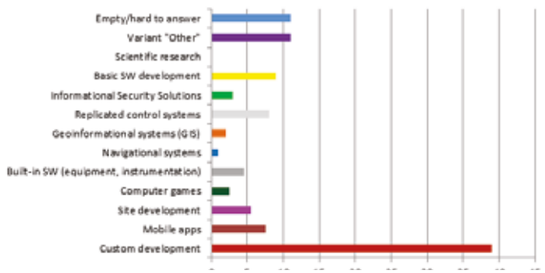


Fig. 7. Main specialization of companies



Many companies work and develop in various areas of information technology, with majority of respondents (39%) specializing in custom development of IT solutions tailored to needs of a specific customer (Figures 6 and 7). There were also such subjects who could not determine specialization of company – 12%.

The distribution of companies by share of export earnings to total revenue (in total turnover) in 2017 looked like this: 43% of companies have a relative share of exports less than 0.10; 13% of companies – from 0.11 to 0.25; 11% of companies – from 0,26 to 0,50; 11% of companies – from 0,51 to 0,75; 22% of companies – more than 0,75. Thus, about a fifth of all surveyed companies receive revenue mainly from foreign orders. The indicator is overestimated, since only large exporters (former, traditional, long present on foreign markets, new ones) participated in survey.

RESULTS OF THE STUDY

Table. 5 presents results of calculations of dependence of indicators of innovation behavior on export of IT companies.

Such an indicator, like patents, was excluded from the study due to the fact that it is a "bad" indicator in sphere of information technologies according to experts of software industry. On one hand, some IT companies simply have to register patents, because it is suicidal to go out with a good product that is easy to copy without lawyers: copyists will steal technology on legitimate grounds. In the US, for example, there are quite a lot of precedents. On the other hand, the majority neglects forming patents because it takes money and time. They reason as follows: "You can steal from them, but it's impossible to repeat it at same level and with same quality." Indeed, no one is talking about aforementioned problems.

KEY CONCLUSIONS

Our hypotheses about selectivity of enterprises (self-selection for external markets), existence of educational export effects and effect of export duration on strengthening of learning effects have been confirmed (the first hypothesis – partially).

Unlike traditional exporters, new IT exporters do not have a visible link between introduction of new products, technologies and beginning of exports (the significance of rates was not confirmed, Ɓ<p, where Ɓ is level of significance, hypothesis of absence of dependencies is not rejected, or Ɓ = 0). Rates of manifestation of innovative behavior are much lower than those of

Table 5

Results of regression analysis of seven models of dependence of indicators of innovative behavior on different criteria of export status of IT companies

Index	Research and development	Release of new products	Invention of a new technology	Exports increase	Marketing
Константа	0.376 (1.107)	0.412 (0.309)	0.267 (0.019)	0.174 (0.157)	0.674 (0.578)
Previous	0.253 (0.118)	0.270** (0.149)	0.104* (0.045)	0.213** (0.182)	0.843* (0.769)
Exp_period1	0.381*** (0.302)	0.182** (0.053)	0.081* (0.043)	0.241** (0.212)	0.085* (0.064)
Exp_period2	0.357* (0.302)	0.157 (0.123)	0.168 (0.125)	0.009 (0.004)	–0.108* (0.093)
Exp_period3	0.119 (0.081)	–0.327 (0.220)	–0.321 (0.249)	Variable not included	–0.389 (0.274)
Exp_status1	0.015 (0.003)	–0.299** (0.198)	–0.345 (0.275)	0.011 (0.005)	–0.458 (0.376)
Exp_status2	0.071 (0.019)	–0.031 (0.023)	–0.124 (0.096)	0.019 (0.013)	0.013 (0.008)
Exp_status3	0.236 (0.117)	0.087 (0.047)	Variable not included	0.058 (0.027)	0.225 (0.183)
Region	0.102* (0.081)	0.276* (0.179)	0.162 (0.124)	0.067 (0.048)	0.018* (0.004)
Foreign	0.013 (0.007)	–0.292 (0.194)	0.070 (0.018)	0.124 (0.045)	–0.145 (0.098)
Size	0.248 (0.224)	0.330 (0.201)	0.223* (0.183)	–0.006 (0.001)	0.163* (0.124)
Age	–0.204 (0.102)	0.352 (0.245)	Variable not included	–0.067 (0.031)	0.114 (0.101)
Ind1	0.542* (0.398)	0.384** (0.361)	0.276 (0.145)	0.240 (0.231)	0.241* (0.184)
Ind2	–0.382 (0.301)	0.082 (0.059)	0.012 (0.004)	0.175 (0.154)	0.121 (0.102)
Ind3	Variable not included	Variable not included	0.004 (0.000)	Variable not included	–0.167 (0143)
Ind4	–0.289 (0.141)	–1.441 (0.046)	–0.018 (0.012)	0.153 (0.127)	0.007 (0.001)
Ind5	0.102 (0.035)	–0.876* (0.792)	0.008 (0.002)	0.019 (0.015)	0.124 (0.076)
Ind6	Variable not included	Variable not included	Variable not included	Variable not included	Variable not included
Ind7	–0.498 (0.278)	–0.636 (0.742)	–0.487 (0.354)	–0.031 (0.019)	–0.453 (0.378)
Ind8	–0.074 (0.004)	–0.096 (0.494)	–0.017 (0.005)	0.021 (0.015)	–0.324 (0.299)
Ind9	–0.480 (0.056)	0.116 (0.797)	0.012 (0.004)	0.046 (0.022)	–1.879 (0.974)
Ind10	0.185** (0.094)	0.521* (0.514)	0.121 (0.096)	0.184 (0.145)	–0.127 (0.075)
R-квадрат Макфаддена	0.217	0.228	0.192	0.267	0.254

*Note. Standard errors were calculated based on of Hessian, *** – significance at the level of 1%, ** – 5%, * – 10%. Standard errors are indicated in parentheses.*

traditional exporters. Investments in R&D, which may have been initiated after entering foreign markets or simultaneously with it, have not yet yielded results. The status of traditional exporters increases probability of investing in latest research and development by 38%. We assume that this statement is also true in the opposite direction. For all five indicators of innovative behavior for a group of traditional exporters, the sign in models of dependence on regressors of last period (2015) considered by us is positive, statistical significance (at level of 1, 5 and 10%) is proved, which indicates that stable export activity serves as an incentive to apply new technological, process and marketing innovations that were not previously the part of the company's plans, much more often than non-exporter companies.

It is proved that the influence of external knowledge effects the performance of IT companies depends on geographical direction of exports: markets of the near foreign (other CIS countries) + Russia itself; markets of the far foreign. When exporting abroad (mainly to Western Europe and America), effects of knowledge have a significant positive impact: Russian software companies are beginning to develop latest technologies, increase R&D costs and marketing to increase sales of software and IT services and a share of international market. Dependence of spillover effects and innovation activity, efficiency in the whole high-tech industry (in our case, software development industry and IT services) is quite large. It is worth emphasizing that training requires special efforts, ability to absorb knowledge and time, so learning effects are manifested after a while.

Investments in R&D, marketing and production of new products are more typical for capital companies (at a significance level of 1%). The relationship between availability of an international office and introduction of innovations, on contrary, has not been proven. The size of companies (according to log of number of employees) affected only the release of new technologies: if a company belongs to medium-sized enterprises (101-250 people) or is larger, then the probability of inventing novation is increased by 22% (at a significance level of 1%).

The impact of learning spillover effects of knowledge is manifested in organizations as a result of a change in their innovative behavior: The longer companies work in foreign markets, i.e. longer process of learning, cross flow of knowledge, the more pronounced are the transformation of innovative behavior of companies (changing business processes, updating staff of companies, improving creativity and skills of employees (IT professionals), changing business model and other indicators.

We attempted to construct linear-probabilistic models, considered a large number of variations of factors that could influence the innovative behavior. Strange as it may seem, same variables as probit model were found to be significant. We also considered variants with logarithms from multiple status variables, a period of export and specialization, which changed the situation slightly. The number of correctly predicted cases was approximately 118-126 (77.6-82.9%). The R-square in all models fluctuated around 0.20, which is not high enough to confirm hypotheses put forward by us. When constructing models, we also checked variables for multicollinearity by the method of inflation factors (Table 6). The minimum possible value is 1.0, values greater than 10.0 may indicate multicollinearity.

Rate of variance inflation (variance inflation factor, method of inflation factors): $VIF\ (j) = 1/(1\text{-}R\ (j)\ \text{^}2)$, где $R\ (j)$ – is the rate of multiple correlation between variable j нand other independent variables. All values of rates make less than 10; therefore, there is no strong correlation between explanatory variables in models.

Table 6. Analysis of multicollinear indicators

Parameter	Inflation rate of variance
Age	1.549
Region	1.144
Sector	$1<x_i< 2.5$
Export status	$1.5 <x_i< 3$
Export period	$6 <x_i< 7$
International office	1.262
Size	1.282

RESULTS OF THE STUDY

Today, only a few innovators have resources to implement opportunities in a global competition based largely on knowledge. Since there is no required means for successful launch of innovative, export or other activities, there has been a tendency to increase the share of innovation that has arisen as a result of combining competencies of various players both within and outside the value creation chain (internal and external ones).

Until 2008, experts actively discussed open innovations, mainly about their external effects from international location of industrial R&D. To a lesser extent, attention was paid to developments in other areas and activities not directly related to R&D, spillovers of a different nature (as we found out, there are quite a few of them), as well as to network interaction between companies at various stages of the value chain.

Now everyone understands how great is the importance of diversified relations for initiating export activities or creating successful innovations. Such relations are useful and effective only if there are favorable framework conditions, necessary knowledge infrastructure built on local, national and international levels. First of all, a company, of course, must have a competently built innovative policy, and a state has developed tools and mechanisms for direct and indirect support of innovation in business. Globally, processes of open innovation make demands for synthesis of innovative strategies of a company and its external partners (with an agreed corporate strategy for a current or a new market).

Regarding building of innovative potential and entering foreign markets, small and medium-sized companies depend more on external knowledge, sources of information, know-how and technologies than large enterprises. Regardless of the sphere of interests of activity, small and medium-sized businesses need direct or indirect access to authoritative sources of a new knowledge (online platforms with databases where it is possible to communicate with experts, to consult in case of controversial business issues).

For large organizations, partnership means, as a rule, an increase in costs of innovation, for smaller ones – a sharp increase in competition with major players. Small companies are limited in financial and human resources, are focused on a shorter perspective, are not always ready to receive new information and its application in work. They are less risky, prefer to avoid help from

outside, except rare cases when it is necessary to meet specific needs.

Undoubtedly, all participants benefit from network interaction regardless of their type of activity and size. However, we have revealed patterns in relation to Russian IT companies in the course of empirical research:

- New IT exporters do not have a visible link between introduction of new products, technologies and beginning of exports. The rates themselves, probability of manifestation of investigated innovative behavior, are much lower than those of traditional exporters. Investments in R&D, which may have been initiated after entering foreign markets or simultaneously with it, have not yet yielded results. The status of traditional exporters increases probability of investing in latest research and development by 38%.
- Stable export activities stimulate IT companies to apply new technological, process and marketing innovations that were not a part of company's plans previously, much more often than companies on local market.
- The influence of external knowledge effects on performance of IT companies depends on geographical direction of exports: markets of the near foreign (CIS countries) + directly Russia itself; markets of the far foreign.
- Investments in R&D, marketing and production of new products are more typical for metropolitan companies. The relationship between availability of an international office and introduction of innovations, on contrary, has not been proven. The size of companies (according to logarithm of number of employees) affected only the production of new technologies: if company is an average enterprise or larger, the probability of inventing an innovation is increased by 22%.
- The smaller the company, the lower is its desire to take part in extensive innovative networks, increase number and variety of external relations. The size of company predetermines the level of influence of cooperation with other market participants on its internal innovation process.
- One way or another, the study showed that the extent and direction of exports significantly affect the innovative activity of organizations, while innovations do not always push IT managers to export.
- The effects of redistribution, unquestionably, exist within the paradigm of open innovations that contribute to changes both in the structure of geographical distribution of investments in R&D and in the topography of the corresponding cross flow of knowledge. As a result, the impact on all units (companies, regions, countries) becomes more balanced over time. The degree of this influence directly depends on availability of a critical mass of a potential to accumulate and apply knowledge borrowed from companies with developed foreign relations. Spillover effects allow companies to ensure return on investment in exports and innovations on a regular basis only due to continuing influx of complementary knowledge and experience from international partners. However, such openness of companies provides for loss of independence, opportunity to be absorbed and need for a significant market demand.
- For many high-tech companies, investments in research and development [Trachuk A. V., Linder N. V., 2016b] favorable to creation of scientific and technological breakthroughs, spread of spillover effects of knowledge, are a pledge of prosperity. In the issue of advancing competitors, efficiency, development of absorptive capacity and mechanism of cooperation between companies, research laboratories, government institutions and other participants of the NIS subject to cross flow of knowledge within the framework of the concept of open innovation, are important.

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