

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

5,100

Open access books available

127,000

International authors and editors

145M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Knowledge Spillover Effects: Impact of Export Learning Effects on Companies' Innovative Activities

Arkady Trachuk and Natalia Linder

Abstract

The global nature of knowledge production has blurred the boundaries between many scientific and technical fields. New, enhanced processes, technologies, products, services, and business models emerge leveraging integrated solutions with different roots. The existing spillover or flow of knowledge has influenced the creation of new cross-disciplinary areas of research into this phenomenon: knowledge economics and management. This chapter explores the impact of knowledge spillover effects on companies' innovative activities and presents a classification of spillover effects based on seven attributes. The empirical analysis was conducted by using cross data of Russian industrial companies. The stratified sample comprises data for 252 high-tech industry enterprises. It is concluded that knowledge spillover effects contribute to changes in both business models of industrial enterprises and their performance. The degree of this influence directly depends on whether companies that have well-developed foreign relations possess a “critical mass” of absorption material. Knowledge spillover effects enable companies to ensure payback of investments in exports and innovations on a regular basis solely through the continuous inflow of complementary knowledge and experience from international partners. However, such openness comes along with loss of independence, the possibility of being taken over, and the need for the presence of a significant market demand.

Keywords: the flow (spillover) of knowledge, knowledge spillover effects, research and development (R&D), channels and forms of innovation “cross-flow”, knowledge transfer, export sales

1. Introduction

The latest technologies and knowledge today play a huge role in the rapidly changing global economy [1, 2]. Studies that analyze how knowledge is created, accumulated, and transferred make it possible to identify and explain the performance and productivity gaps between specific enterprises, activities, industries, and even countries that have “knowledge potentials”—dynamic knowledge absorption capabilities [3].

Companies currently tend to reorient their efforts toward applied rather than fundamental research, which makes organizations dependent on the state and academic institutions [4, 5]. A similar situation, although smaller in scale and coverage, is faced by scientific organizations due to the increasing financial and political pressure on them [6, 7]. As a result, the structure of the body of knowledge is undergoing significant changes: despite the increasing number of patent applications and scientific publications, scientific activity results are mostly incremental in nature, the consequences of which are hard to predict [8]. In view of the foregoing, ensuring the flow of scientific knowledge, results, and the process of evaluating and monitoring the transfer and adaptation of accumulated experience to one's own work environment within the "triple spiral" system (various knowledge-sharing institutions, science and education) is becoming ever more critical every day [9, 10].

In this chapter, we review the knowledge flow phenomenon and the related learning spillover effects as well as their impact on companies' innovative activities.

2. Knowledge and innovation spillover effects

Knowledge is a resource, a specific asset capable of generating vast external effects (spillovers), or externalities, expressed in the accumulation of knowledge and the continuous production of new knowledge based on acquired competencies, skills, and experience [11]. On the other hand, "learning" effects are, as a rule, associated with a positive phenomenon that contributes to the enrichment of all spheres of life in society [12]. Knowledge created by one economic entity (whether an individual or an entire organization) will definitely become available to other entities over time [13]. This phenomenon can be described as knowledge transfer and knowledge spillover. For firms with an underdeveloped technological, intellectual base, the knowledge-borrowing process becomes essential for their further development [14]. Knowledge gained from the external environment will not always be able to take root in an internal differently tuned system. Effects that arise from the borrowing of experience can differ in nature and direction. In theory, there are several classifications of external knowledge effects, which are outlined in **Table 1**.

The econometric model measuring the effect of R&D investment on knowledge stock and economic growth was first introduced by [15]. Later, in 1986, [16] proved this relationship, based on the fact that the total relevant activity of other firms influencing innovation of a particular firm can be represented as a weighted sum of R&D investments, with weights proportional to the technological proximity of the firms to the one under consideration. Similar studies in terms of topics addressed can be found in works [17, 18]. Evaluation of patenting activity in neighboring regions of France and its relationship with the level of corporate and university R&D expenditures was dealt with by [19]. The paper [20] measures how the geographical distance between firms affects their participation in the Small Business Innovation Research program that awards grants. Software industry in the USA studied and proved that clustering directly affected innovative outputs and growth [21].

In 2004, [22] explored the effectiveness of various channels of R&D spillover effects at the intra-industry level through a survey of 358 Swiss R&D managers representing 127 different lines of business. This monograph, in particular, considers the following factors: R&D activity, reverse engineering (design capability), publications, patents, technical meetings/discussions, and intra-corporate communications as potential knowledge flow channels, with in-house R&D investments being named as the principal factor contributing to spillovers.

Another group of studies investigates relationships between spillover effects and innovations. Compared the geographical location of companies that published

I. Positive and negative	
Positive: improvement of a product, process, and technology by one company as a result of imitation, borrowing from another company	Negative: theft of confidential information, trade secrets, causing damage to another enterprise
II. Internal and external	
Internal: result from information, experience, and knowledge being shared between employees of the same entity or technologies, equipment, staff being shared within divisions of the same company	External: result from the company's interaction with the external environment
III. Horizontal and vertical	
Horizontal: occur between firms in similar stages of the production chain	Vertical ¹ : occur between firms that have a supplier/seller-consumer relationship (strong diversification of knowledge, concentrated in complementary sectors)
IV. Direct and indirect	
Direct: knowledge not mediated by market transactions, trade; is translated into improvements in structural elements of production (material output)	Indirect (monetary): arise from dependence upon strategies and pricing policies
V. Temporary and spatial	
Temporary: have an impact on next generations, e.g., as a result of scientific and technological progress, development of alternative energy sources	Spatial: have an impact on agents operating in the same economic space
VI. Innovation and technological knowledge spillover effects	
a. External knowledge effects: transfer of knowledge beyond the intended boundary, defined range of individuals, organizations (as opposed to knowledge sharing)	
b. Innovation effects are derivatives of knowledge externalities	
c. Technological effects arise from the diffusion of technologies, with the only difference being that the diffusion takes place in an uncontrolled fashion, without any payment for technology; knowledge is transformed into one of the production factors; technologies are applied in various sectors of the economy	
VII. Marshall-Arrow-Romer (MAR), Porter, and Jacobs spillover effects	
Key attribute: firms are located close to each other (are geographically concentrated)	

Source: developed by the authors.

¹They are divided into direct and reverse. Direct ones result from foreign investments when national firms gain access to less expensive or new intermediate resources. Reverse ones constitute effects of the dissemination of state-of-the-art technologies through the supply chain from companies with foreign capital to local, domestic suppliers.

Table 1.
 Classification of knowledge spillover effects.

patents and those that cited patents in order to demonstrate the local nature of explicit knowledge spillover [23]. The importance of the impact that tacit knowledge has on innovation, which, unfortunately, is unmeasurable and hard to reach, should also be taken into consideration.

Economists have distinguished two types of knowledge spillover effects that are important in terms of growth and innovation: MAR spillovers and Jacobs spillovers.

2.1 MAR spillovers

In 1980 Alfred Marshall developed knowledge spillover theory that was further finalized by Kenneth Arrow and Paul Romer and named "MAR spillover" after its authors [24]. According to that theory, concentration of firms in one sector (industry) facilitates scientific knowledge transfer between firms encouraging growth

and innovation. Employees of different companies of the same sector (industry) exchange ideas of new products and processes. That is, the higher the concentration of employees of the same specialization on that territory, the higher the possibility of idea exchange that can further lead to innovative solutions. Frequently the latest data on technological breakthrough and know-how keeps its value for a very short period of time, spreading among the professional community afterward. That is why firms aim to locate their R&D centers close to the sources of such data determining the formation of technological clusters [25].

2.2 Jacobs spillovers

In 1969 Jane Jacobs developed another knowledge spillover effect theory [26]. Jacobs believes that knowledge spillover effects are connected with differentiation of industries on the territory. In her opinion, concentration of different industries in one place stimulates innovation by uniting people having different knowledge and professional experience, forming the ground for idea exchange from different perspectives. Also reasoning on the competition, Jacobs claims that developed markets with a large number of players are the most positive environment for innovation. At the same time, high monopolization level restrains innovations from emergence [26].

Jacobs inter-sectoral effects occur between companies belonging to different sectors: knowledge flows occur between complementary sectors of industry or suppliers and customers [27]. It is not clustering but the diversity of industries that triggers mutual, cross-enriching spillovers: movement, flow of ideas, techniques, tools to other industries lead to their different, completely new application, and, accordingly, to a different result, end product [28].

Table 2 below provides a systematization of knowledge spillover effects based on “location within/outside the industry,” where the horizontal axis displays two main types of market structures by a degree of competition (competitive and monopolistic environment), while the vertical axis shows industry-specific characteristics of the geographical concentration of firms (cluster type, diversified industry base).

The abovementioned theories of dynamic spillover effects formulate a kind of a hypothesis on the nature of a diversified and concentrated industry base and which of the industries is more likely to experience the flow of knowledge and the fastest growth.

The role of exports as a factor driving growth in general and productivity in particular was empirically proven quite a long time ago using aggregated cross-country and cross-industry data in time (macro level) [29]. And it was just recently that researchers decided to test longitudinal data at the inter-company level (micro and meso level) by reviewing the difference in productivity and efficiency between exporting companies and their opposites—companies that only operate in the domestic market [13].

One of the most well-known, frequently cited papers investigating this phenomenon at the macro level is [30]. The paper is based on 45 econometric models built

	Competitive environment	Monopolistic environment
Technological cluster	Porter effects	MAR effects
Diversity of industries	Jacobs effects	—

Source: developed by the authors.

Table 2.
Classification of knowledge spillover effects by industry geographical concentration.

from data of companies representing 33 countries, published between 1995 and 2004. The conclusion is formed from two key statements: (1) exporting companies appear to be more efficient and innovative than non-exporting companies and (2) as a result of a “self-selection” process, more productive firms are prone to enter export markets, while export activities do not necessarily lead to improvements in effectiveness.

The first fact finds its confirmation in the papers [31, 32] arguing that it is the expansion of the company's footprint and sales market that encourages managers to introduce innovations and various improvements resulting from an increase in efficiency and sustainable growth. The second fact is presented at the theoretical and empirical level in [33]: innovation activity and research create a competitive advantage for a company, which leads to productivity growth that increases the likelihood of becoming an exporter and gaining a foothold not only in the national but also in the international market. An intuitive suggestion regarding a relationship between innovations and exports has been confirmed by experts at various times; however, the relationship between these processes is ambiguous and should be researched in more detail using various industries, companies, and scientific institutions.

The “self-selection” effect is analyzed in [34] on the basis of register data with the addition of customs statistics. Previous experience in a foreign market is a key to success in the future. Globalization leads to an increase in innovation activity, as shown in the papers [35, 36]. [37] test the hypotheses regarding innovation incentives for processing enterprises when entering a foreign market at macro and micro levels (panel data for 2005 and 2009 obtained during two surveys).

Studies that address the question whether exports influence growth or growth are influenced by exports actually appeared in 1995 when Bernard and Jensen [38] published a number of articles that turned how things were viewed upside down. The same phenomenon was addressed in papers by [39, 40]. They used a vast sample of data obtained from surveys represented by US official statistics to explore the effectiveness of firms across all industrial sectors from a different perspective, depending on whether they were engaged in exports.

3. Development of the research model and hypotheses

More contemporary empirical studies using variations of the approach were employed by [38], but, unlike them, focusing on one particular industry is also of interest for studying the similarities and differences between exporting and non-exporting companies [41, 42]. [32] studied differences between firms based on another fact: whether firms engaged in exports enter developed or developing countries. In developing countries, foreign companies earn more substantial profits than national markets, with an opposite effect observed in developed countries.

Thus, our first hypothesis has been formulated.

H1: Innovation-active firms more often become exporters compared with firms that do not engage in active innovation.

The second hypothesis is devoted to the role of learning by exporting: exporting companies are more efficient than companies that are only present in the national market. [43]. Flows of knowledge between international foreign buyers, suppliers, and competitors help novice exporters improve their activities (higher postentry performance), adopt positive business experience, promote products and services faster, implement technological innovations to keep the acquired niche, and expand the zone of influence [42]. In addition, firms that enter foreign markets face more intense and fierce competition and must develop faster to survive in the future.

Export orientation and innovation are alternative, competing investment projects. Perhaps, firms that have already entered a foreign market do not need additional investments in innovation development, since they are anyway borrowing the best, new things from abroad. To answer this question, the second hypothesis has been formulated.

H2: Exporting companies are more likely to implement innovations (including organizational innovations) than firms oriented toward the local market (a positive learning effect of international interaction). Export activities, however, are not a linchpin of growth in the company's productivity.

The abovementioned hypotheses serve as a proof of the existence of a two-way link between export activities and innovation and effectiveness [13]. As a result of implementing innovations, stronger, more durable companies start to export (are self-selected in an attempt to expand abroad), which makes them even more competitive and productive through learning by exporting. Some researchers have proven [21] that companies' export orientation still leads to productivity growth even where there is a "self-selection" effect.

4. Research methodology

To answer the questions posed, we used econometric modelling based on data obtained by interviewing, consolidating information on companies from different databases, and carrying out statistical monitoring in order to test the hypotheses. The empirical analysis was based on cross data of Russian industrial companies. The stratified sample is represented by 252 Russian high-tech industry enterprises.

The limitations of the sample are that it is incomplete (the sample can be expanded during a more detailed research in the future) and biased toward companies located in Russia's largest cities because respondent companies were more readily available and had their own capabilities to produce and export high-tech innovations.

The tools used in this work make it possible to interpret exports of products, services, and technologies in terms of whether exports actually exist (export activities are carried out), scale (share of exports or, more precisely, of "foreign sales" in the firm's total sales), structure (technological services, finished products), and destination of exports (CIS and non-CIS countries; accordingly, CIS countries with a market similar to the Russian market and all other countries).

Learning-by-exporting effects were evaluated using information on different indicators of the levels of export activities, companies' efficiency and productivity (with the indicator being financial reporting metrics), and technological, product, organizational, and management innovations, including R&D expenditures. The principal body of data was taken from the Russian statistical database and questionnaires posted on the website of the analytical portal TAdviser (URL: <http://www.tadviser.ru/index.php/Компании>).

Apart from exports, there are other factors influencing innovational learning processes and development. In particular, "the industry to which an enterprise belongs and its size may affect propensity to innovate and implement new management technologies" [27]. An enterprise's innovation activity may be also associated with the age of the firm and characteristics of its owner (affiliation with a foreign holding company) [17, 20, 28]. A list of dependent variables and regressors is presented in **Table 3**.

If learning spillover effects are present in exports, then what is their nature? Perhaps, these are just some regularities; is the one who enters a foreign market (as a result of self-selection) originally more productive, organized, or more prone to innovation? To empirically evaluate the impact of these effects on productivity,

Model number	Designation of dependent variable	Dependent variables = indicators of companies' innovation behavior
Y ₁	RD_cost	Existence of R&D expenditures (takes values 1 or 0 for each period)
Y ₂	NewTech	New technology implementation (takes values 1 or 0 for each period)
Y ₃	NewProduct	Release of a new product, service (takes values 1 or 0 for each period)
Y ₄	Marketing	Existence of marketing innovation expenditures (takes values 1 or 0 for each period)
Y ₅	Exp	Increase in the share of foreign sales (takes value 1 in case of an increase in the share of exports or 0 in case of its decrease for each period)
Predictors		
Size		The firm's size (logarithm of the number of employees)
Age		The company's age (1, established before 2003; 2, after 2003)
Foreign		Availability of an international office and/or parent company abroad (1, otherwise 0—a purely Russian company)
Region		1, the company is located in the capital (Moscow, St. Petersburg, Moscow or Leningrad Region); 0, the company is located in a region
Exp_period		Classification of the organization into one of the four groups (1, firms that exported their products in 2015–2017; 2, “new exporters” that did not have exports in 2015, but had exports in 2017; 3, “former exporters” that have left export markets; 4, firms that did not have exports in both periods of observation)
Exp_status		Type of the company's principal sales market: 1—local (market with a certain range of buyers in a part of the city, region, etc.) 2—national (Russia and CIS countries) 3—international

Table 3.
Indicators of dependent variables and predictors

we constructed the following regression model based on an analysis of works that focus on exploring the phenomenon of external knowledge effects and the question regarding their existence as such:

$$\ln y_i^t = b_1 + \sum_{j=1}^4 b_{j+1} \text{Exp_period}_j + \sum_{j=1}^3 b_{j+1} \text{Exp_status}_j + b_8 \text{Foreign}_{1,0} + b_9 \text{Size}_j + \sum_{k=1}^3 b_{k+9} \text{Age}_k + \sum_{l=1}^2 b_l \text{Sector}_l \quad (1)$$

We will use a common probit regression examining the dependencies of the value of the respective indicator in 2017 from its value in 2015, export status, and other characteristics of the organization to assess dummy variables (the variables are presented in

Table 3). To eliminate the endogeneity problems “associated with the different direction of the cause-and-effect relationships between the size indicators and property parameters, the values of these predictors in the model are taken for the previous period” [27].

An attempt to use a linear regression to predict innovation activity of enterprises after entry into a foreign market does not make sense, as the linear form values are on a continuous quantitative scale, while the variable is measured discreetly [44]. Therefore, it is recommended that special regression models be constructed to investigate dependencies between binary variables (innovation indicators) and quantitative data (in our case, regressors).

There are two approaches that allow to construct such models. The first one involves building a linear probability model (using robust standard errors), which will not be used by us, while the second one involves building nonlinear models (logit and probit) [37]. These models capture dependencies between a variable and a data set as well as the probability that the i^{th} value of a binary variable is equal to 1 if a certain condition is met [32].

The probit model differs from the logit model only in that the normal distribution density function is used instead of derivative logistic curve. In the other respects, probit and logit analyses are similar.

Their idea is that the likelihood function is maximized—there is a probability that what is present in our sample will be obtained randomly. In practice this means that we no longer pay attention to the sums of squares of the residuals and are interested in the behavior of the likelihood function.

We performed the required analysis of the collected data for 252 Russian companies, different in terms of affiliation with a variable, to construct a model.

In our sample, 55% of the respondents are located in the capital and in the Moscow Region (128 companies in the two capitals, Moscow and St. Petersburg, and nine companies in the Moscow Region).

	2003	2017	Panel
Characteristics of the selection of firms in the sector (%)			
High-technology industries	4.6	28.9	25.4
Middle-technology industries	45.7	34.9	44.9
Low-technology industries	49.7	36.2	29.7
Total	100	100	100
Average headcount characteristics of companies (%)			
100–199	5.4	2.7	3.0
200–499	7.9	6.2	7.1
500–999	7.6	13.4	9.7
1000–4999	52.4	47.9	51.7
5000–9999	16.3	15.5	16.1
10,000 and more	10.4	14.3	12.4
Total	100	100	100
Foreign proprietary ownership characteristics of companies (%)			
Share of exporting companies with foreign ownership	34.2	49.8	54.2
Share of non-exporting companies with foreign ownership	7.1	22.4	16.5

Table 4. Descriptive statistics of inspected firms in the analyzed timeframe of 2003–2017, % of respondents.

Most of the surveyed respondents (31%) worked in companies established before 1999; about 20% of the firms were established during 1999–2003, 2004–2008, or 2009–2013 (about 65% during 1999–2013), and just 5% of the respondents were young novice exporters.

Exporting and non-exporting companies' characteristics are in **Table 4**.

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

We take 2017 as the “start of exports” for the purpose of dividing new and traditional exporting firms, while “former exporters” are understood to mean all those who left foreign markets in any year within the period under review.

The export status, or the type of the principal sales market for Russian industrial companies (just as the other regressors), is fixed at the 2015 level to eliminate the endogeneity of factors, as the percentage of presence in international markets is higher in 2016–2017 at about 22%.

As regards the distribution of companies by the share of exports in total revenue, the picture in 2017 was as follows: 43% of the firms had a relative share of exports of <0.10, 13% between 0.11 and 0.25, and 22% over 0.75. Thus, about one-fifth of all surveyed firms mainly generated revenue from exports.

5. Research results

Table 5 presents the results of the calculation of the relationship between the innovation behavior indicators and the export status of industrial companies.

The hypotheses put forward by us on the selectivity of enterprises (“self-selection” for foreign markets), the existence of learning-by-exporting effects, and the influence of the duration of exports on the enhancement of learning spillover effects were confirmed (the first hypothesis—partially).

Thus, “new” exporting companies, unlike “permanent” exporters, do not have a visible relationship between implementation of new products, technologies, and the start of exports (the significance of the coefficients was not confirmed, $B < p$, and H_a is not rejected, where B is the level of significance, H_a is the hypothesis on the absence of dependencies, or $B_i = 0$). The coefficients themselves and the probabilities of the innovation behavior under study being exhibited are much lower than for similar traditional exporters. This can be explained by the fact that R&D investments which might have been initiated after or at the time of entry into foreign markets have not yet yielded results. That said, the status of “traditional” exporters increases the likelihood of investments in advanced research and development by 38%. We believe that this statement is also true vice versa.

For all innovation behavior indicators out of the five indicators considered for a group of traditional exporters, the sign in the models estimating regressor dependencies for a past period (2015) considered by us is positive, and the statistical significance (at the level of 1, 5 and 10%) was proven, indicating that stable export activities serve as an incentive for industrial companies to apply new technological, process, and marketing innovations, which previously were not included in the firm's plans, much more often compared to non-exporting firms.

Our research shows that the impact of external knowledge effects on the productivity of industrial companies depends on the geographical destination of exports: (a) markets in CIS countries plus Russia itself and (b) markets in non-CIS countries. In the case of exports abroad (primarily to West Europe and America), knowledge effects have a significant positive impact on Russian industrial companies, which begin to develop state-of-the-art technologies and increase R&D and marketing expenditures to boost sales of products and services and increase the

	Y ₁ (R&D)	Y ₂ (New_Tech)	Y ₃ (New_Prod)	Y ₄ (Exp)	Y ₅ (Marketing)
Const	0.416 (1106)	0.392 (0.209)	0.254 (0.022)	0.169 (0.138)	0.675 (0.563)
Previous	0.264 (0.119)	**0.269 (0.147)	*0.105 (0.046)	**0.214 (0.184)	*0.851 (0.771)
Exp_period1	***0.381 (0.305)	**0.182 (0.049)	*0.081 (0.051)	**0.241 (0.231)	*0.085 (0.071)
Exp_period2	*0.361 (0.302)	0.159 (0.123)	0.172 (0.125)	0.012 (0.004)	*-0.113 (0.093)
Exp_period3	0.124 (0.001)	-0.331 (0.210)	-0.319 (0.238)	Dropped	-0.378 (0.267)
Exp_status1	0.016 (0.004)	** -0.302 (0.193)	-0.351 (0.268)	0.016 (0.007)	-0.461 (0.386)
Exp_status2	0.081 (0.017)	-0.041 (0.019)	-0.134 (0.089)	0.029 (0.019)	0.018 (0.009)
Exp_status3	0.256 (0.119)	0.087 (0.052)	Dropped	0.068 (0.033)	-0.225 (0.193)
Size	0.252 (0.227)	0.338 (0.211)	*0.226 (0.173)	-0.006 (0.003)	*0.163 (0.134)
Age	-0.206 (0.102)	0.356 (0.245)	Dropped	-0.059 (0.031)	0.118 (0.109)
Region	*0.109 (0.081)	*0.282 (0.169)	0.174 (0.134)	0.057 (0.098)	*0.028 (0.005)
Foreign	0.015 (0.006)	-0.289 (0.192)	0.073 (0.019)	0.134 (0.042)	-0.153 (0.097)
Ind1	*0.561 (0.368)	**0.374 (0.371)	0.269 (0.156)	0.247 (0.237)	*0.239 (0.194)
Ind2	-0.379 (0.302)	0.082 (0.061)	0.014 (0.007)	0.178 (0.160)	0.128 (0.106)
Ind3	Dropped	Dropped	0.005 (0.000)	Dropped	-0.167 (0.143)
Ind4	-0.289 (0.141)	-1.441 (0.046)	-0.018 (0.012)	0.153 (0.127)	0.007 (0.001)
Ind5	0.102 (0.045)	*-0.876 (0.782)	0.008 (0.002)	0.019 (0.025)	0.137 (0.066)
Ind6	Dropped	Dropped	Dropped	Dropped	Dropped
Ind7	-0.488 (0.279)	-0.656 (0.739)	-0.497 (0.362)	-0.041 (0.022)	-0.443 (0.368)
Ind8	-0.081 (0.005)	-0.089 (0.495)	-0.021 (0.007)	0.032 (0.018)	-0.344 (0.289)
Ind9	-0.479 (0.056)	0.121 (0.797)	0.015 (0.004)	0.051 (0.022)	-1.884 (0.974)
Ind10	**0.193 (0.095)	*0.522 (0.524)	0.134 (0.086)	0.177 (0.151)	-0.132 (0.069)
McFadden R-squared	0.221	0.229	0.189	0.271	0.261

Source: constructed by the authors.

Note: Standard errors were calculated from the Hessian.

***Significance at the level of 1%.

**Significance at the level of 5%.

*Significance at the level of 10%.

Table 5.

Results of the regression analysis of seven models measuring the relationship between the innovation behavior indicators and various criteria of the export status of industrial companies.

share of the international market. The dependence of spillover effects and innovation activity, efficiency across the high-tech industry, is quite high. It should be emphasized that learning requires special efforts, the ability to assimilate knowledge, and time, and therefore learning effects do not manifest themselves immediately, and they become visible only with a certain time lag.

According to the performed calculations, investments of industrial companies in R&D, marketing, and release of new products are more characteristic for metropolitan companies (at a significance level of 1%). The relationship between the availability of an international office and introduction of innovations, on the contrary, was not proven. The companies' size (based on the logarithm of the number of employees) only had an impact on the production of new technologies: if a company

Minimum possible value = 1.0 Values > 10.0 may indicate multicollinearity	
Age	1.561
Size	1.293
Foreign	1.274
Region	1.149
Exp_period <i>i</i>	$6 < x_i < 7$
Exp_status <i>i</i>	$1.5 < x_i < 3$
Sector <i>i</i>	$1 < x_i < 2.5$

Note: $VIF(j) = 1/(1-R(j)^2)$, where $R(j)$ is the multiple correlation coefficient between variable j and other independent variables. As all values of the coefficients are <10, the models do not exhibit a strong correlation between the explanatory variables.

Table 6.
 Analysis of the multicollinearity of indicators.

belongs to medium-sized enterprises (101–250 people) or is larger, the probability of inventing innovations is increased by 22% (at a significance level of 1%).

It can also be concluded that the impact of learning spillover effects of knowledge is manifested in industrial companies as a result of a change in their innovation behavior: the longer a company operates in foreign markets, i.e., the longer the learning process, the flow of knowledge, the more pronounced the transformation of the firm's innovation behavior (changes in business processes, renewal of company staff, increase in the creativity and skills of employees, changes in the business model and other indicators).

The study has shown that the duration and destination of exports significantly influence organizations' innovative activities, but innovations do now always encourage managers of industrial companies to start exporting.

It should be noted that we also attempted to build linear probability models. We considered a large number of variations of factors that could influence innovation behavior. However, the same variables proved to be significant as in the probit model analysis. We also considered variants with logarithms of multiple status variables, the period of exports, and specialization, which changed the situation slightly. The number of correctly predicted cases was about 196–209 (77.6–82.9%). The R-squared in all models fluctuated around 0.20, which is not high enough to confirm the hypotheses put forward by us.

When constructing models, we also tested variables for multicollinearity by the inflation factor method (Table 6).

6. Conclusions

The study carried out by us was aimed at exploring the impact of knowledge spillover effects on the innovative activity of industrial companies in Russia. Special attention was paid to which characteristics of a company contributed to knowledge accumulation and stimulated an increase in innovation activity.

The obtained results allow drawing conclusions about the positive impact of knowledge spillover effects stemming from the companies' export activities. "New" exporting companies, unlike "permanent" exporters, do not have visible links between implementation of new products, technologies, and the start of exports. The coefficients themselves and the probabilities of the innovation behavior under

study being exhibited are much lower than for similar traditional exporters. This can be explained by the fact that R&D investments that might have been initiated after or at the time of entry in a foreign market have not yet yielded results. The status of “traditional” exporters increases the probability of investments in advanced research and development by 38%.

We obtained evidence that exporting firms increasingly begin to introduce technological, process and marketing innovations, which previously were not included in the firm’s plans, much more frequently compared to non-exporting firms.

It should be emphasized that the impact of external knowledge effects on the productivity of industrial companies depends on the geographical destination of exports: thus, companies exporting to CIS countries operate in the domestic market. Therefore, the effects of learning by exporting to CIS countries are much weaker, whereas for companies exporting to non-CIS countries, learning is much more characteristic. This conclusion is in line with the study [15], which shows that productivity growth is more characteristic for firms operating in industrially developed countries.

Another conclusion is that investments in R&D, marketing, and release of new products are more characteristic for companies located in metropolitan regions (at a significance level of 1%).

It should be noted that we did not find any significant dependence between the availability of an international office and implementation of innovations. This fact is in line with other studies showing that competition conditions are more significant for the firms’ innovation behavior than the form of ownership. The companies’ size (based on the logarithm of the number of employees) only had an impact on the production of new technologies: if a company belongs to medium-sized enterprises or is larger, the probability of inventing innovations increases by 22% (at the significance level of 1%).

The derived conclusions are generally in line with most of advanced foreign works on the topic in question.

Thus, the impact of learning spillover effects of knowledge is manifested in organizations as a result of a change in their innovation behavior: the longer a company operates in foreign markets, i.e., the longer the learning process, the flow of knowledge, the more pronounced the transformation of the firm’s innovation behavior (changes in business processes, increase in the creativity and skills of employees (IT specialists), a change in the business model, and other indicators). Knowledge spillover effects enable companies to ensure payback of investments in exports and innovations on a regular basis solely through the continuous inflow of complementary knowledge and experience from international partners. However, in some cases such openness can increase the risk of loss of independence and the possibility of being taken over.

Our study has a number of limitations. Overcoming these limitations predetermines the direction of its further development. The survey sample was conditioned by the possibility of collecting data; therefore, the model should be tested additionally on a larger sample embracing more Russian regions. Some indicators in the model can be reformulated; new factors, whose analysis would make it possible to increase the model’s explanatory power, can be incorporated in the model.

Conflict of interest

There is no conflict of interest.

IntechOpen

IntechOpen

Author details

Arkady Trachuk* and Natalia Linder
Department of Management, Financial University under the Government of the
Russian Federation, Moscow, Russia

*Address all correspondence to: atrachuk@fa.ru

IntechOpen

© 2019 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Abramovitz M. Catching-up, forging ahead, and falling behind. *The Journal of Economic History*. 1986;**46**(2):385-406
- [2] Trachuk AV. Innovation as a condition of long-term stability of the Russian industry. *Strategic Decisions and Risk Management*. 2012;**6**:66-71. (in Russ.). DOI: 10.17747/2078-8886-2012-6-66-71
- [3] Crespo N, Fontoura MP. Determinant factors of FDI spillovers—What do we really know? *World Development*. 2007;**35**(3):410-425. DOI: 10.1016/j.worlddev.2006.04.001
- [4] Tarasov IV, Popov NA. Industry 4.0: Production factories transformation. *Strategic Decisions and Risk Management*. 2018;**3**:38-53. (in Russ.). DOI: 10.17747/2078-8886-2018-3-38-53
- [5] Lisovsky AL. Optimization business processes for transition to a sustainable development In the conditions of the fourth industrial revolution. *Strategic Decisions and Risk Management*. 2018;**4**:10-19. (in Russ.). DOI: 10.17747/2078-8886-2018-4-10-19
- [6] Aghion P, Leah B, Caroline H, Jerome V. The Causal Impact of Education on Economic Growth: Evidence from U.S. Working paper. 2009
- [7] Hausman N. University Innovation, Local Economic Growth, and Entrepreneurship. Harvard University Working Paper. 15 September 2011
- [8] Hashiguchi Y, Tanaka K. Agglomeration and firm-level productivity: A Bayesian spatial approach. *Papers in Regional Science*. 2015;**94**:S95-S114. DOI: 10.1111/pirs.12147
- [9] Wei X, Wang H. Research on productivity and spillover effect of high-tech industry in China-empirical analysis based on provincial panel data. *Technical Economics and Management Research*. 2017;**4**:116-121
- [10] Zhang Y, Zhao F. Research on the impact of international technology spillovers and absorptive capacity on independent innovation in high-tech industries. *Financial Research*. 2017;**43**(3):94-106
- [11] Corredoira RA, Rosenkopf L. Should auld acquaintance be forgot? The reverse transfer of knowledge through mobility ties. *Strategic Management Journal*. 2010;**31**(2): 159-181. DOI: 10.1002/smj.803
- [12] Nicoletti G, Scarpetta S. Regulation, productivity and growth: OECD evidence. *Economic Policy*. 2003;**36**:9-72. DOI: 10.1111/1468-0327.00102
- [13] Cerchione R, Esposito E. Using knowledge management systems: A taxonomy of SME strategies. *International Journal of Information Management, Part B*. 2017;**37**(1):1551-1562. DOI: 10.1016/j.ijinfomgt.2016.10.007
- [14] Trachuk AV. Innovations as a condition of long-term stability of the Russian industry. *Efficient Anti-crisis Management*. 2012;**6**(75):66-71
- [15] Griliches Z. The Search for R&D spillovers. Working Paper No 3768 (Reprint No r1758). November. NBER; 1992
- [16] Jaffe A. Technological opportunity and spillovers from R&D: Evidence from firms' patents, profits and market value. *American Economic Review*. 1986;**76**(5):984-1001
- [17] Arnold JM, Hussinger K. Export behavior and firm productivity in German manufacturing. A firm-level

- analysis. *Review of World Economics*. 2005;**141**(2):219-243
- [18] Singh L. Domestic and international knowledge spillovers in manufacturing industries in South Korea. *Economic and Political Weekly*. 2004;**34**(5):498-505
- [19] Malerba F, Mancusi ML, Montobbio F. Innovation and knowledge spillovers: Evidence from European data. In: Paper presented at the AEA 2004 Annual Meeting, 3-5 January, San Diego, CA. 2004. DOI: 10.1007/s10290-013-0167-0
- [20] Kesidou E, Szirmai A. Local knowledge spillovers, innovation and economic performance in developing countries empirical evidence from the Uruguay software cluster, Maastricht (Netherlands). 2007. DOI: 10.1080/09578810802060769
- [21] Breschi S, Lissoni F. Knowledge spillovers and local innovation systems. A critical survey. *Liuc Papers No 84. Serie Economia Impresa*. 2001;**27**:1-30
- [22] Keller W. International technology diffusion. *Journal of Economic Literature*. 2004;**XLII**(September):752-782
- [23] Wagner J. Exports and productivity: A survey of the evidence from firm-level data. *The World Economy*. 2007;**30**(1):60-82
- [24] Romer PM. Growth based on increasing returns due to specialization. *The American Economic Review*. 1987;**77**(2):56-62
- [25] Arrow KJ. The economic implications of learning by doing. *Review of Economic Studies*. 1962;**29**(3):155-173. DOI: 10.2307/2295952
- [26] Jacobs J. *The Economy of Cities*. London: Jonathan Cape; 1969
- [27] Antonelli C, Crespi F, Mongeau Ospina CA, Scellato G. Knowledge composition, Jacobs externalities and innovation performance. *European Regions Regional Studies*. 2017;**51**(11):1708-1720
- [28] Yamada E, Kawakami T. Distribution of industrial growth in Nagoya metropolitan area, Japan: An exploratory analysis using geographical and technological proximities. *Regional Studies*. 2016;**50**(11):1876-1888. DOI: 10.1080/00343404.2015.1072273
- [29] Aarstad J, Kvitastein OA, Jakobsen S-E. Related and unrelated variety as regional drivers of enterprise productivity and innovation: A multilevel study. *Research Policy*. 2016;**45**(4):844-856. DOI: 10.1016/j.respol.2016.01.013
- [30] Narula R, Marin A. FDI spillovers, Absorptive Capacities and Human Capital Development: Evidence from Argentina. *MERIT-Infonomics Research Memorandum Series*, 2003-2016. Maastricht. 2003
- [31] Fariñas JC, Martín-Marcos A. Exporting and economic performance: Firm-level evidence of Spanish manufacturing. *The World Economy*. 2007;**30**(4):618-646
- [32] Damijan J, Polanec S, Prasnikar J. Self-selection, export market heterogeneity and productivity improvements: Firm level evidence from Slovenia. *LICOS Discussion Papers*. LICOS Centre for Institutions and Economic Performance, Leuven; 2004
- [33] Trachuk A, Linder N. Learning-by-exporting effects on innovative performance: Empiric study results. *Knowledge Management Research and Practice*. 2018;**16**(2):220-234
- [34] Wilhelmsson F, Kozlov K. Exports and productivity of Russian firms: In

search of causality. *Economic Change*. 2007;**40**:361-385

[35] Fallah H, Ibrahim S. Knowledge spillover and innovation in technological clusters. *Journal of International Association for Management of Technology (IAMOT)*. 2004:1-4. Available from: <http://www.personal.stevens.edu>

[36] Carlino GA. Knowledge spillovers: Cities' role in the new economy. *Business Review (Federal Reserve Bank of Philadelphia)*. 2001;(Q4):17-26

[37] Golikova VV, Gonchar KR, Kuznetsov BV. Empirical evidence of the learning effects of exports. WP1 Preprint. Moscow: National Research Institute (HSE); 2011

[38] Bernard AB, Jensen JB. Exceptional exporter performance: Cause, effect, or both? *Journal of International Economics*. 1999;**47**(1):1-25

[39] Cassiman B, Golovko E, Martinez-Ros E. Innovation, exports and productivity. *International Journal of Industrial Organization*. 2010;**28**(4):372-376

[40] Johansson B, Lööf H. Innovation activities explained by firm attributes and location. *Economics of Innovation and New Technology*. 2008;**17**(6):533-552

[41] Arnold JM, Hussinger K. Export behavior and firm productivity in German manufacturing. A firm-level analysis. *Review of World Economics*. 2005;**141**(2):219-243

[42] Leahy D, Neary JP. Absorptive capacity, R&D spillovers and public policy. *International Journal of Industrial Organization*. 2007;**25**(5):1089-1108

[43] Altuzarra A, Bustillo R, Rodríguez C. Understanding export market

success: Evidence from manufacturing firms. *Open Economies Review*. 2016;**27**(1):161-181. DOI: 10.1007/s11079-015-9368-6

[44] Cassiman B, Golovko E. Innovation and internationalization through exports. *Journal of International Business Studies*. 2011;**42**(1):56-75. DOI: 10.1057/jibs.2010.36