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ARTICLE INFO

Oksana R. Jdanova and Alexander Karminsky (2013). The diffusion of banking innovations: bank cards on Russian market. *Innovative Marketing*, 9(3)

RELEASED ON

Friday, 27 December 2013

JOURNAL

"Innovative Marketing "

FOUNDER

LLC "Consulting Publishing Company "Business Perspectives"



NUMBER OF REFERENCES

0



NUMBER OF FIGURES

0



NUMBER OF TABLES

0

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The diffusion of banking innovations: bank cards on Russian market

Abstract

It is widely recognized that innovations play a crucial role in improving productivity. Equally important, however, is the rate at which innovations diffuse through an economy. Faster diffusion of innovations means a more immediate impact and thus a higher social return on the initial investment.

The main goal of this article is to evaluate the ability of Russian banks to accept and adopt innovations. The paper explored the classical theory of diffusion of innovations, including the effects of external and internal influence with the “rational-efficiency hypothesis” and the “bandwagon effects hypothesis” as well as the distribution velocity’s dependence on the number of “innovators” and “imitators” (S-shape spread).

The research also considers the main factors that directly have both positive and negative effects on the rate and extent of banking innovations’ diffusion. Thus, at the macro-level there can be distinguished: solvent customer demand; rate of the market competition (or the market concentration); geographical identity of the bank and its belonging to the innovative cluster. At the same time, the microeconomic factors include: bank’s size; bank’s profitability; specifics of the market (in our case this point was investigated by the bank’s retail activity, i.e. the share of loans and deposits to individuals); bank’s ownership structure.

This study is based on the example of bank cards’ development on Russian market that are among the most prominent innovative technologies emerged in the Russian banking sector in the end of the 20th century. The data include a representative sample of 118 Russian commercial banks that differ in size, profitability, ownership structure, location, orientation, etc. The survey covers 2005-2010, observations are recorded every six months. The research is based on the estimation of dynamic panel regression with fixed effect. To obtain consistent estimates there is applied the one-step estimation procedure within the confines of generalized method of moments. The procedure allows to figure out that: (1) The higher market concentration makes the banking innovation diffuse slower; (2) The profitable banks are more likely and quickly adopt innovations than others; (3) The particular focus on the retail business speeds up the spread of such innovation as bank cards; (4) The diffusion of innovations in state-owned banks and banks located in the financial center (Moscow) demonstrates a higher rate than others.

The Sargan test proved that the studied model of diffusion of innovations in this paper is correct and truly specified.

Keywords: banking, innovation, diffusion, bank cards, Russia, panel regression.

Introduction

The current stage of development of the global banking system passes through the crisis and increasing competition on the financial markets. One of the main points allowing banks to successfully develop is a policy of ongoing innovative behavior. Nowadays, innovation is the key factor of banks’ stability, competitiveness and sustainable growth.

The globalization of financial markets promotes a transition way to a more homogeneous market of banking services that leads to develop and implement innovative technologies for gaining competitive advantage. Due to globalization banking content has been changing: day-by-day it has been becoming more complex and diversified while banks faced new risks and involved other groups of customers.

The Russian banking sector is a typical “catching up” economy: innovation development mainly evolves due to implementation of existing international experience that is transferred between the banking systems through the process of diffusion.

The main goal of this paper is to estimate the ability of Russian banks to accept innovations as well as to explore macroeconomic and microeconomic factors that directly affect the rate of diffusion of banking innovations. The study was carried out on example of the Russian market of plastic cards that have been one of the most prominent innovative technologies that emerged in the banking sector in the 90’s of the 20th century.

As part of mentioned objectives the paper highlighted a number of tasks, including: the definition of innovation and diffusion of innovations, the estimation rate of diffusion and an effect on the diffusion rate of key characteristics such as bank’s size, profitability, core activity, market share and others.

The article discusses the morphology of banking innovation and diffusion as well as the theoretical basis of this research and the analysis of existing empirical works. Here are also described endogenous and exogenous model’s variables, statistical sample and the results.

1. Methodological basis of the research: the concept of innovation and diffusion

Innovation is an implementation of new market idea. In banking industry innovation can be considered as

economic implementation of a new banking product or service as well as a significant improvement of existing technology of marketing, management or business practices. Innovations are presented as a result of intellectual and technological developments that are aimed at improving bank's activities.

Innovations have some mandatory properties, such as degree of novelty, ability to meet market demand and commercial feasibility. In other words, innovative products and services have to represent a higher utility value compared to existing counterparts and meet the potential demand of new consumers. Other characteristic features are their strong mutual dependence and dual nature. Innovative banking technologies are vastly dependent on scientific and technological progress in other industries of the economy, IT sector in particular. "The Banker" publishes the annual ranking of technological banking innovation: this is noteworthy that among the winners there is no solution that would not have been previously used in any other industry.

Diffusion of innovations is a spread rate of innovative product. When innovation enters the market it becomes visible and accessible to other parties that could adopt and develop this technology. The rate of diffusion of innovations is a characteristic of business area's susceptibility: the easier innovations are being introduced and absorbed in a particular sector and the faster they are distributed in the market, the stronger economic growth is observed in the segment concerned. The higher speed of diffusion of innovations suggests greater economic and social benefits of the initial investments.

The appearance of a new product or technology always leads to disruption of the existing balance on the market that makes possible to obtain a kind of "innovation rent" – the additional income that could be received only by banks which first implement any basic innovations. Banks-followers have to carry out a policy of reactive and improving innovations to increase their productivity and competitiveness that enable them to enlarge the market share and to gain a temporary monopoly power. At the same time a new product's expansion on the market leads to lower profitability for each market player: the greater extent of diffusion of innovations being, the easier banks lost their competitive advantage and monopoly power. The diffusion rate depends on the current stage of the innovation's life cycle, industry and a variety of other macro- and micro-economic factors. In the current situation leading catalyst of most innovative processes seems to be the globalization of financial markets that is expressed in a directed change of markets for banking products and services as well as changes in consumer behavior.

2. Empirical studies' review

The theory of diffusion explores the distribution pattern of innovation at all stages of its life cycle and represents one of the most fundamental formation of a system-institutional approach to description of economy of innovations. The goal of any model of diffusion is to explain time pattern of diffusion process of a new technology on the market.

The first model of diffusion of innovations was proposed by Rogersin (1962). According to Rogers, diffusion is a process by which innovations are transmitted through certain communication channels over the time among members of a social system. The book introduced four basic concepts of the theory of innovations: innovation, communication channels, time and social system. Social system is a set of interrelated units engaged in joint decision-making process in order to achieve a common goal. The rate of diffusion of innovations is a relative speed with which the innovation is accepted by the members of this social system. In this process, each individual passes through five stages: knowledge, persuasion, decision, implementation and confirmation. Rogers' individuals themselves are divided into several categories: innovators, who are the first to adopt an innovation despite the risks involved, their "early adopters", "early majority", "late majority" and laggards. Rogers found that a likelihood of adoption of innovation and a speed of this process is influenced by such factors as relative advantages compared to the previous analogy, level of compatibility, complexity of use, ability of the pilot testing of the new technology, observability, transparency and accessibility to other users. In addition, he found that during the propagation of any innovation there is so-called "critical point" when the innovation reaches a critical mass and after its further spread demonstrates self-sustaining behavior.

Following Rogers, in Bass (1969) presented his model of diffusion of innovations that later became one of the fundamental models. Bass considered a time picture of sales of a new product in early stages. According to his predictions, sales reach a peak and then stabilize at a level somewhat below the peak (see Figure 1). The stabilizing effect is due to relative increase of replacement sales and decrease of initial sales.

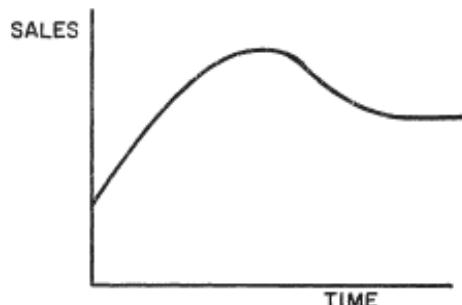


Fig. 1. Patters of a number of sales of a new product in time

Bass believed that there are two categories of individuals: innovators or decision-makers and the followers, the number of which depends on the number of innovators have taken innovation in previous times. Innovators make decisions about the implementation of innovation following the hypothesis of rational efficiency in order to optimize its business practice, increase welfare or maintain a competitive advantage. It means that innovators solely make a decision according to changing environment, legislation or any new knowledge from outside, for instance, information in media. Simulators or the followers in turn make a decision based on the experience of innovators located in the same social system. The probability that an original purchase will be made at time T is a linear function of a number of previous purchases: $P(T) = p + (q/m)Y(T)$. Here $Y(T)$ determines a number of buyers of a new product before the time T , and p and q/m represent the coefficients of innovation and imitation respectively (or the corresponding constants reflecting the importance of the influence of innovators and imitators in the system (external and internal influence), m – maximum number of possible sales of this product on the market. Thus, the dynamics of innovative product's sales at initial moment of time of its release in the market depending on the number of innovators and imitators in the system can be represented as follows:

$$\begin{aligned} S(T) &= pm + (q - p)Y(T) + \left(\frac{q}{m}\right)[Y(T)]^2 \\ &= pm + (q - p)Y(T) + \left(\frac{q}{m}\right)[Y(T)]^2. \end{aligned}$$

Later researches of the theory of diffusion of innovations were based primarily on the Bass model (1969). Theoretical basis of the theory of external and internal influence were described in detail in Molyneux & Shamroukh (1996).

Any innovation due to various external and internal factors is desired for a particular group of banks called innovators. Due to continuous changes in the regulatory environment and the nature of consumer demand, this small group of banks is the first to understand the importance of this innovation and assess its economic impact regardless of other market participants. This effect is known as the "external influence". At the same time in the banking sphere there are other financial institutions that make a decision on implementation of any innovation by exposure to some internal factors of the environment – other market participants. This effect is called the "internal influence" and reflects an extent to which leading banks impact to the banks-followers.

The effect of "internal influence" is based on two mutually complementary hypotheses: the "rational-efficiency" hypothesis and the "bandwagon effect" hypothesis. The hypothesis of "rational efficiency" implies a personal assessment of the economic impact of innovation. For example, the banks can not take up an innovative product or service in current time because of economic inefficiency. However, changes in the environment lead to a reduction of expected costs of innovation and expected increase in revenue from its future applying. Characteristics of income and costs vary depending on the number of other market participants who have taken the innovation earlier. Over the time any technology has reached a degree of elaboration when costs of its implementation become minimal. Positive experience with innovations made by other banks reduces uncertainty of a new technology for the remaining banks and allows to receive an additional information about the innovation. Thus, for a potentially profitable innovation the greater number of banks have already implemented mentioned technology to a certain point of time, the more information available has appeared on the market, the more likely that banks-followers rethink their assessment of its economic impact because of positive externalities.

The hypothesis of "rational efficiency" means an exchange of information between the market for which it is necessary the availability of transfer channels, the ability of banks and innovators to disseminate the information and the ability of banks-followers to be subjected to its influence. In real situations not all of these conditions are always feasible. Innovation is often a trade secret but even if it is presented in the market there are certain differences in the characteristics of banks (bank size, customer base, development strategy, cost function, risk tolerance, etc.) that objectively prevent rapid diffusion of innovative technology. "Bandwagon effect" hypothesis explains the process of diffusion of innovations in those cases when the hypothesis of "rational efficiency" is not working. Thus means that banks take a decision to introduce a new product or technology not because of changes in their individual assessment but due to a pressure from the growing number of leading banks. This pressure may be institutional or competitive. Banks have an internal institutional pressure when a failure of the introduction of innovation can lead to a loss of legitimacy or shareholder's support. Competitive pressure has to do with the threat of loss of the bank's competitive advantage in the market. Thus, the increase in the number of banks that have already implemented an innovative product leaves no chance to other banks not to implement it in danger of losing their competitive advantage and

market share. In the model used here both effects are presented but their separation is not possible.

Later Horsky (1990) introduced in Bass model (1969) the factor of price for a new product. He considered the various categories of household goods and found that a unit of an individual utility function is represented as a reserve price for this new product and depends on its benefits and wages of the individuals. It was proved that the number of sales of a new product significantly depends on the income level of the households and commodity prices.

To enlarge the traditional model of the diffusion with the price factor and the individual utility function Horsky & Simon (1983) considered an optimal advertising policy of a new product while it spread. On the example of introduction of telephone banking in the U.S. they showed that an active advertising company while a new product has just entered into the market increases the rate of its diffusion but when achieved the “critical point” the further process of its spread becomes self-sustaining through communications innovators and imitators and reduce the number of the first coupled with the increasing number of the second so the cost of advertising policy can be reduced to achieve the maximum economic benefit. Horsky & Simon (1983) also derived in the Bass (1969) S-shaped dynamics of diffusion of innovation.

It is worth noting that in addition to the researches mentioned above, S-shape of the diffusion of innovations has also been studied by Henrich (2001) who examined the effects of interpersonal communication and transmission of cultural values and traditions in a changing environment, Brown & Cox (1971), who investigated the possible deviations from a standard S-form as a result of changes in behavioral characteristics of users and external regulation, Mansfield (1961), Griliches (1957) and others.

Dewar & Dutton (1986) conducted an empirical study of the differences in the diffusion of radical and improving innovations. They found that large firms are more likely to introduce radical innovations as well as that the presence of technical specialists in the top management of company increases the likelihood of implementation of improving innovations.

Another group of researches can be distinguished on the removal of various error in Bass model (1969) with more complex mathematics. Most empirical studies have considered the diffusion of innovations as a logistic distribution and representation of the dependencies of individuals have taken the innovation over time. A fundamentally new approach offered by Trajtenberg & Yitzhaki (1989) addressed to truncated processes and intergroup comparisons of the usefulness of expected average Gini coefficient – a statistical exponent with respect to the studied lines.

Also we have to highlight the work of Boswijk & Franses (2005) in which the Bass model (1969) was introduced with a stochastic component.

Of particular interest there is an article of Talukdar, Sudhir, Ainslie (2002) who investigated the dependence of the rate of diffusion of innovations from the market potential of the country by the example of six products in 31 countries. Despite its positive impact of intercountry delays in introduction of an innovative product on the subsequent rate of diffusion the authors found that in emerging markets new technologies spread more slowly than in the developed. They also highlighted that the prior experience of implementing innovation in another country can explain the depth of penetration of innovation in a new market and identify the internal and external factors of influence in the Bass model (1969).

Conflicting results of a similar study was completed by Perkins & Neumayer (2005). They investigated the spread of innovative products and technologies between countries and found that in developing ones the diffusion rate was significantly higher than in the developed countries even in the absence of necessary infrastructure for innovation and incentives. But at the same time a positive effect on the rate of diffusion of innovations was observed on an open to international trade economy, and in the global financial systems, which corresponds more to developed countries. Confirmation of the hypothesis, that foreign direct investments in developing countries accelerate the process of diffusion of innovation, has been found.

Simultaneously, other researchers developed dynamic models of decision-making process on implementation of financial innovation. For example, Bulte (2000) expanded the area of research on the rate of diffusion considering its gradual increase over time for a basket of 31 consumer durable goods in the U.S. market 1923-1996 years. He determined that the acceleration of the diffusion process depends on various macroeconomic conditions and demographic changes. Statistically significant influence was demonstrated due to increased purchasing power, fluctuations of the business cycles and unemployment etc. The products that required large investments in related infrastructure and products based on the innovative development of other industries diffused faster than the other. Dynamic model of the diffusion of innovative technologies were considered also by Persons & Warther (1997). In this work they investigated firms receiving at any given time a decision to implement or not to implement innovative technology. Their survey showed that social welfare increases with the number of firms that have adopted the innovation as well as that the likelihood of adoption of a decision influenced by the existence of financial intermediaries.

However, for the purposes of this study the predominant interest is the work devoted to the study of the diffusion of products and technologies directly in the banking sector. We should highlight the work of Roberts & Amit (2003) who studied the dynamics of the innovation activity of Australian retail banks during 1981-1995. They found that the active involvement of banks in innovative policy increases their competitive advantage and strengthens their financial status, but in spite of this the banks that have implemented innovative technology first in the market do not receive windfall or extra bonuses.

Most studies in this area appeared in 1990-2000 were devoted to the diffusion of ATM in the U.S. market such as Hannah & McDowell (1984), Sinha & Chanrashekaran (1992), Saloner & Shepherd (1995), Molyneux & Shamroukh (1996) and others. Sinha & Chanrashekaran (1992) considered the static model which takes into account both the probability of making a decision to introduce some innovation and adoption time of a positive solution. They found that a probability of installation of ATM firstly affected bank's net interest income, the growth in deposits and changes in regulation. Pennings & Harianto (1992) for example discussed the introduction of video technology in commercial banks in the U.S. during 1977-1987. They found that the decision of the banks to implement the innovation influenced primarily by their previous experience with other technological innovations and the extent to which they are related with technology companies in other industries.

Hannah & McDowell (1984) in the ATM found a positive effect of the level of market concentration on the rate of spread of this technology. The impact of market power on the diffusion of innovations was also investigated by Quirmbach (1986). He developed the method of comparing the rate of diffusion of innovations for different market structures and showed that the joint venture innovates more slowly than two companies controlled each by its owner, and a monopoly introduces new products and technologies faster than required by the socially optimal rate and slows the subsequent transposition technologies by other companies. Quirmbach also showed that the diffusion of innovative products and technologies that requires large capital investments reduces the benefits of their implementation for businesses and innovators but at the same time the costs for firms-followers.

For this survey the works in which the subject of research presents as the process of diffusion of various financial innovations in the banking environment are of particular importance. One of the fundamental theories of this area can rightly be considered in the work of Molyneux & Shamroukh (1996) who studied the dynamics of development of the junk bonds and NIF in the U.S. in 1978-1988. They also

extend the model of Mansfield (1961) based on the already mentioned Bass model (1969):

$$m(t+1) = a(\bar{N} - m(t)) + b\left(\frac{m(t)}{\bar{N}}\right)^{\delta} (\bar{N} - m(t)) + cm(t),$$

where $m(t)$ is the total number of banks implemented the innovation at time t , \bar{N} is the potential number of banks in a position to introduce innovation, δ is the coefficient of "internal influence" (or the coefficient of reintroducing innovation).

Molyneux & Shamroukh (1996) found that the initial exogenous factors play a significant role in a rate of innovation's diffusion.

3. Diffusion of bank cards: the model and variables

In this paper we rely on the diffusion model proposed by Mahajan & Schoeman in 1977. Suppose that there are a finite number of potential consumers of a particular innovation \bar{N} , where appropriate for the purposes of this study is the maximum amount of emissions in card industry. At each time t there are a number of individuals N_t – consumers of new technology. The propagation of innovation can not be an infinite chain reaction similar to nuclear, that's why the diffusion rate should gradually decline over time while N_t is approaching to full capacity in the market \bar{N} , it can be expressed as follows:

$$\frac{\partial N_t}{\partial t} = g_t(\bar{N} - N_t),$$

where $\frac{\partial N_t}{\partial t}$ the diffusion rate at time t , g_t is the diffusion coefficient.

The diffusion coefficient g_t can be derived from the Bass model (1969):

$$g_t = a + bN_t.$$

Constant component of this ratio is interpreted as the proportion of potential consumers who make demands on specific innovations – bank cards – due to various external factors such as advertisement in media, increasing the number of outlets that accept bank cards, transition of the employer to use this service for calculation and payments of wages to employees. The variable component of the diffusion coefficient bN_t is the proportion of consumers that make a decision based on the number of previous customers. In other words, the parameter b can be interpreted as an index of "internal" effect or "imitation" that shows the interaction between the previous and subsequent potential customers.

Thus, the discrete analogue of the diffusion equation can be written as follows:

$$N_{t+1} - N_t = g_t(\bar{N} - N_t)$$

or replacing by β_1 , β_3 and β_2 ,

$$b = -\beta_3,$$

$$\overline{N} = \left(-\beta_2 \pm \frac{\sqrt{\beta \frac{2}{2} - 4\beta_3\beta_1}}{2\beta_3} \right) ua = \frac{\beta_1}{N},$$

we get

$$N_{t+1} = \beta_1 + \beta_2 N_t + \beta_3 N_t^2.$$

Suppose that $N_{i,t}$ is a volume of card issuance by bank i in a period t , but rather the number of cards in circulation at any given time, we can write the basic model of our study as:

$$N_{i,t+1} = \beta_1 + \beta_2 N_{i,t} + \beta_3 N_{i,t}^2 + \gamma X_{i,t+1},$$

for all $i = 1 \dots n$, $t = 1 \dots T$,

where $X_{i,t+1}$ is a vector of explanatory variables.

Hypotheses of “external” and “internal” influences here correspond to the signs of the coefficients $\beta_1 > 0$ and $\beta_3 < 0$ respectively.

Following the logic of Akhavein, Frame & White (2005), in this study we've identified several groups of factors that may have an effect on the diffusion of bank cards in Russia: the macroeconomic variables that are common to banking sector in general and microeconomic variables specific to each bank in particular.

3.1. Macroeconomic variables. Obviously, the main factor affecting the speed of propagation of various types of bank cards in Russia is the customer's demand. With all the new ideas and technologies market of plastic cards can rapidly develop in isolation from the general economic situation in the country, since it is only growing economies of possible strong demand for tools that are used in it. It can be assumed that the higher the overall welfare of the population corresponds to the higher purchasing power and demand for different payment instruments. In this regard, as a proxy we introduce in the model the GDP per capita and expect a positive relationship with the dynamics of development of the bank cards in Russia.

All papers on the diffusion of various innovations agree that regardless of type of innovation studied, a direct impact on the speed of its spread has a measure of market competition in the industry. At the same time, the exact direction of the influence of market competition on the diffusion of innovation has not been established. Of the existing empirical studies support the Arrow hypothesis (1962), according to which the companies under increasing pressure from competitors, are likely to drive innovation than a monopolist in the market. Thus, they can not lose

their competitive edge and gain additional income from innovation because it first introduced it on the market. Another part of the study was to confirm the hypothesis of Schumpeter (1934, 1942), which had the opposite view and argued that firms with greater market share and greater market power presents more innovative behavior than small companies due to its ability to finance large-scale R&D projects or multiple projects simultaneously, reducing this uncertainty of the expected results and the economy of scale. For our purposes we can conclude that in the case of distribution of various kinds of financial innovation in the banking sector is more likely to observe the effect of Arrow since the introduction of such innovations do not require significant capital investments and can be done over a fairly short period of time. We include in the model the Herfindahl-Hirschman Index that reflects the degree of monopolization of the industry. This indicator is calculated as the sum of the squares of each bank's sales share for the period. According to the production approach, the bank uses its resources for loans and deposits, which are the final product of his work. However, the specifics of the Russian market is that more widespread cards means primarily more deposit accounts related to the population, so the market share of a particular bank should be calculated as a weighted average of its market share of deposits to individuals and private lending market in the proportion of 90% to 10%. Based on the characteristics of the Russian market of bank cards, we expect a positive correlation between the rate of diffusion and the degree of market competition in the industry and, therefore, the negative – to the degree of market concentration. Lower concentrations correspond to low values of the market Herfindahl-Hirschman Index and the higher rate of diffusion of technologies.

Previous studies mostly suggest that the rate of diffusion of innovations varies geographically: in the “innovative clusters” innovations spread faster. For years Moscow was the Russian financial center with advanced banking technology and revolutionary IT systems, new types of financial products and services firstly appear there and later spread to other regions of Russia. We expect that banks situated in Moscow will be locomotives of innovation. To highlight this relationship, the model includes a dummy variable for bank's geography.

3.2. The microeconomic variables. Schumpeter (1950) predicted that mainly large companies, regardless of the possession of market power, will demonstrate their innovative behavior, thanks to economies of scale in innovation and the possibility to combine and eliminate associated risks. In this study, we firstly consider the effect of the size of the bank's total assets. We expect a statistically significant positive correlation of scale with the diffusion.

In addition, the rate of diffusion of cards could also be affected by profitability. Due to liquidity constraints less profitable firms are less likely to invest in innovation. Less profitable banks have less capacity to keep increasing the volume of cards issue, despite pressure from the market. To test this hypothesis in the empirical studies we use the indicator ROE (return on equity), but in our opinion it rather reflects the effectiveness of the credit institution. Taking into account the fact that we are interested in the activities of the financial institution primarily in market loans and deposits, we consider the quantity of net interest income and expect the positive impact of this factor on the emission rate as a bank.

Identifying whether the bank introduce an innovative technique or a new financial product, and how quickly he does it can not be resolved without taking into account the specifics of a particular bank and its development strategy. In relation to the studied problem can be assumed that the more the bank is focused on efforts to attract private deposits and issuing loans from non-banking private sector, the more it increase its issuance of plastic cards to customers. Taking into account this assumption, we track the effect of core business of the bank such as a share of retail deposits in the total deposits of the bank and a share of retail loans in the total loan portfolio. It is expected to have a positive relationship between these indicators and the number of cards issued by the bank.

As has already noted in this study, the leaders of card issuance in the Russian market, especially in recent years, were state banks. There were state-owned banks that first have become develop "salary" projects. Secondly, the state-owned banks have always been associated with high reliability that could affect the individual's demand. Thirdly, during the crisis of 2008-2010 exactly the state-owned banks have an advantage of access to additional financial resources from the government, which allowed them to greatly increase their customer base. Thus, we include in the model another dummy variable for the state banks and believe in its significance.

Diffusion of banking innovation can be measured with a number of indicators, such as the volume of transactions with new financial products, or the volume of their emissions, as well as the number of banks in the market, introducing innovative technology, or, on the contrary, the number of consumers considered innovations. In our case, to estimate the rate of diffusion is advisable to use the dynamics of growth of card issuance for the period for certain bank.

Thus, we will evaluate the following model:

$$\begin{aligned} N_{i,t+1} = & \beta_1 + \beta_2 N_{i,t} + \beta_3 N_{i,t}^2 + \gamma_1 gdp_per_capita_{t+1} + \\ & + \gamma_2 HHI_{t+1} + \gamma_3 assets_{i,t+1} + \gamma_4 intincome_{i,t+1} + \\ & + \gamma_5 deposit_share_{i,t+1} + \gamma_6 credit_share_{i,t+1} + \\ & + \gamma_7 dummy_moscow_i + \gamma_8 dummy_state_i, \end{aligned}$$

where $N_{i,t+1}$ is the card issuance volume (units) of bank i in the current period $t+1$; $N_{i,t}$ is the card issuance volume (units) of bank i in the previous period t ; $gdp_per_capita_{t+1}$ is the GDP per capita; HHI_{t+1} is the Herfindahl-Hirschman index for the current period; $assets_{i,t+1}$ are the total assets of the bank i in the current period; $intincome_{i,t+1}$ is the net interest income of the bank i in the current period; $deposit_share_{i,t+1}$ is the share of deposits in total deposits of the bank i in the current period; $credit_share_{i,t+1}$ is the share of retail loans in the total loan portfolio of the bank; $dummy_moscow_i$ is the location of the head office of the bank i in Moscow; $dummy_state_i$ is the presence of the state (more than 50%) in the ownership structure.

4. The data

The data analyzed include a sample of 118 Russian commercial banks differ in size, profitability, ownership structure, location and core activity and other characteristics. The study covers twelve periods – observations are recorded every six months during 2005-2010.

Correlation matrix of variables showed that there is a strong correlation between a number of issued by bank debit and credit cards and the size of its assets. Equally strong interference observed between the volume of card issuance and net interest income of the bank. This is not surprising, as high net interest income can be obtained either by a large margin in interest rates on loans and deposits of the bank or by a large amount of the loan and deposit portfolios. In a little less number of cards issued by the bank depends on the geographical origin as well as the structure of its ownership. Also noteworthy is the fact that the presence of the state in the list of major shareholders of the credit institution has a positive effect on the size of its assets, and this, in turn, to some extent increases the value of its net interest income and, accordingly, may affect the amount of the card issue, but indirectly. Also, the correlation matrix shows that the share of loans and deposits in the total portfolio of the is often lower for credit institutions located in Mosow. This observation can be easily explained by the fact that the regional banks primarily focus on the retail business: consumer credit and deposit accounts for individuals while Moscow banks often specialize in other "non-traditional" activities, such as investment or corporate banking. Moreover, a small positive correlation can be marked between the growth of the

welfare of the population and the share of retail loans in financial institutions and display the inverse relationship to the level of market concentration. The first reason is that as welfare increases its purchasing power is gradually growing. Raising their living standards, consumers can choose more expensive products and not be afraid to borrow from banks because of confidence in the wider scope of their income. And obtaining consumer credit is often accompanied by the release of a credit card. However, based on the correlation matrix, the mutual influence of GDP per capita and the volume of card issuance is insignificant. This is easily explained by the fact that an increase in their welfare people prefer to spend more rather than save, respectively, a significant increase in deposits, and as a result, debit cards, which are still the majority in Russia, is not observed.

5. The results

The study model of diffusion of innovation refers to the class of dynamic panel regression with fixed effects, that is, contains in addition to the right of the explanatory variables and lagged values of the dependent. The best estimates of the coefficients are obtained in the transition to the first differences with the introduction of instrumental variables, which themselves act lagged values of the dependent variable. Consistent estimate of the coefficients in such a case can be made using a one-step procedure for evaluating the generalized method of moments. The estimation results are presented in Table. 1.

Table 1. Estimation results and coefficient matrix

	Coeff	P-value
GDP per capita	4.22	0.407
HHI	-96.31	0.051
Total assets	0.94	0.130
Net interest income	3.27	0.000
Share of deposits	2561.45	0.088
Share of loans	5924.99	0.011

Thus, it was found that GDP per capita has no effect on the distribution of plastic cards. However, it can be assumed that consumer demand is actually significant but depends on a number of other factors, and not on the country's average welfare. As the analysis of the Russian banking market showed, the population is largely differentiated by income and financial literacy. Thus, most of the people living in villages has neither the information about the majority of products and services, nor the ability to access them due to lack of the necessary infrastructure. It is also possible that there are different psychological causes of failure of new instruments.

At the same time, we observe that the coefficient of market concentration is significant at the 10% significance level and negative. In other words, the

higher concentration of the market, the lower level of competition in this market, the more slowly innovations spread. It is widely known that in the Russian banking sector Top-5 banks owns most of the assets of the entire banking system, and most of the customer base. These banks do not need to accelerate the pace of card issuance to maintain its competitive edge in the market.

Surprising is the lack of significance of the coefficient of the total assets as the majority of empirical studies demonstrated the influence. However, this finding may be due to a specified period of study. At the beginning of innovation's life cycle under consideration in the Russian market only large banks can increase the volume of card issuance through greater resources and a large customer base. However, in this paper the model is estimated over the interval 2005-2010, that comes at a much later phase of the life cycle of innovation, when not to introduce it meant to lose its competitive advantage and market share, and therefore, in recent years the pace of card issuance has been actively increasing in all banks regardless of their size.

Conflicting results were obtained in an attempt to determine the effect of bank profitability on its innovative behavior. The coefficient of the net interest income of the bank is positive and statistically significant already at 1% significance level. In other words, the availability of financial resources and adequate liquidity of credit institutions have a positive impact on whether the bank to innovate – in our case, to increase its issuance of plastic cards, and how quickly this process will occur. However, in the research process rather than net interest income we also examined the net profit, including the results of all activities, not just the area of credit and deposit accounts – and it was not significant. However, our research interest is focused mainly on the retail banking, which main profit is derived from traditional activities.

In support of the above we should highlight the fact that the study confirmed the hypothesis about the influence of the specific activities of the bank on the pace of implementing them certain innovations. Positive and statistically significant coefficient with the share of private deposits in the total deposits of the bank there is in a 10% significance level, and a positive and statistically significant coefficient with the share of retail loans in total loans – in a 5% level. Thus, it was found that the larger the bank focused on retail business, the more it produces consumer loans and the more he accepts deposits from individuals, respectively, the more cards he should issue, and at a faster pace in order to meet the growing consumer demand.

Due to the fact that to obtain estimates of the coefficients for the dummy variables usage of the mentioned methods is not possible as they are already included in the fixed effects analysis of variance should be conducted separately, allowing to determine whether the variance of the dependent variable to some extent explained by the dispersion of indices. Based on the results of analysis of variance revealed the influence of the ownership structure of the credit institution on the diffusion process credit cards. The presence of the state as majority shareholder speed the rise of card issuance bank, which may be due to different reasons, such as access to additional sources of financing, the image of a stable bank and sizeable customer base through their loyalty, a more attractive interest rate, etc.

At the same time found that the fact that the main office of the bank in Moscow defines the part of the dispersion of the dynamics of the issue of debit and credit cards. Moscow, being the national financial center and even international financial center, is a kind of "innovative cluster" for banking technologies. Thus, the majority of innovations represented by Moscow banks, initially much faster spread within this cluster.

Table 2 summarizes the results of survey that reflect the existing hypotheses about the impact of certain factors on the diffusion of innovations in the banking sector and the data are based on analysis of the spread of bank cards in the Russian market as an innovation of applying new payment instruments.

Table 2. Summary of the results

Factor	Hypothesis of influence	Fact
Individual welfare (GDP per capita)	Significantly and positively	Insignificant
Market concentration (Herfindahl-Hirschman Index)	Significantly and negatively	Significantly and negatively at 10% significance level
The bank's size (total assets)	Significantly and positively	Insignificant
Profitability (net interest income)	Significantly and positively	Significantly and positively at 1% significance level
Coreactivity	Significantly and positively	Significantly and positively
Deposit's share	Significantly and positively	Significantly and positively at 10% significance level
Loan's share	Significantly and positively	Significantly and positively at 5% significance level
Ownership structure (the state-owned banks)	Significantly and positively	Significant
Geography, cluster (Moscow)	Significantly and positively	Significant

These results correspond to the realities of the Russian banking market and may not coincide with the results of previous empirical studies of the diffusion of innovations in the banking systems of other countries. There were also conducted the Sagan test, confirming the correctness of the model specification.

Conclusion

In recent years, the main trend of innovative development of the Russian banking sector has been in active applying of various information technologies to create innovations. This is primarily due to the processes of globalization and increasing competitive pressure on the Russian banks. One of the main characteristics of the sensitivity of the banking environment for innovative new feature is the rate of diffusion of innovations in the banking sector.

Despite the fact that in theory the decision to implement innovation should be based on analysis of expected economic results and the uncertainty and the possible risks, in practice, there hypotheses "external" and "internal" effect based on the presence of certain exogenous factors, subjective to each bank, as well as pressure from other market participants exist. Among other things, there is a set of macro- and microeconomic factors that directly affect this process for each individual considered.

In a highly competitive environment such innovation, as plastic cards, grows faster, due to the need to preserve the bank's competitive advantage, customer base and market share. Significant degree of market concentration, which is observed in the banking sector, respectively, has a negative impact on the speed of the process. Focus on customer needs and satisfaction of their purchasing power is one of the main causes of the spread of certain technologies, but to catch it with the impact of such a measure of welfare of the population, the GDP per capita, is not possible. The influence of geography banks, in particular the location in Moscow, affects on the dynamics of the development of new payment instruments – credit cards.

Also, there are a number of microeconomic indicators, based on the characteristics of individual banks that are interconnected to the speed of bank cards emission in Russia. Among them, it should be noted, first of all, the profitability of the bank. Thus, the availability of adequate liquidity, which could potentially be directed to the development of any innovation to some extent contribute to the speed of propagation. At the same time, the size of the bank and the access to certain resources play a role in the early phase of the life cycle of innovation, when its implementation is expensive and risky only large banks can afford it and get windfall profits. At the late stage of development of

the market, which is now observed in the segment of bank cards, this figure does not play such a significant role, since regardless of the size of a credit institution, it has to adopt a technology not to lose its competitive edge in the market.

Research has proven that the core activity of the bank has a significant influence on the development of this particular innovation. For example, banks focused mainly on the retail business, gained pace increasing their volume card issuance, so that each client in obtaining consumer credit or opening deposit gets a charge card, and contributes to the dynamics of their distribution in the Russian banking sector.

Thus, with respect to the development of banking cards in Russia, which at the time were revolutionary product innovation in the banking sector, we can conclude that the major constraints of the diffusion of innovations in the Russian banking market are, first, its high concentration, and second, the psychological barriers of the population, which, together with low solvent consumption demand hinder the rapid development of certain banking innovation. Eliminating these constraints will speed up the process of "learning" innovations by the Russian banking system and will have a positive impact on the economic situation in general.

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