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## **The development of risk management system for small innovative enterprises with principal components method**

**Boiko Anna Igorevna**

Postgraduate student,  
Kuban State University,  
P.O. Box 350040, Stavropol'skaya str., No. 149,  
Krasnodar, Russian Federation;  
e-mail: boiko.ai@vtb24.ru

### **Abstract**

The article presents the results of studies of risk factors in the innovation of small businesses, carried out by the method of principal components. Particular attention is paid to the account type of innovation the company, the quality of its information system, the business climate in the territory of the entity and its integration with existing scientific and innovation networks.

### **Keywords**

Small business, innovation, risk management factors, research and innovation networks.

### **Introduction**

The development of small innovative ventures in Russia is an important strategic objective, as it is for small and medium-sized enterprises who form the backbone of the national innovation system of most countries – technological

leaders. However, innovation activity is the most risky type of economic activity, and even more so for small businesses that do not have, as a rule, "protective block" of reserve funds and opportunities for the use of administrative resources, risks associated with the development and use of innovations are often too high.

Nevertheless, the results of empirical<sup>1</sup> and theoretical<sup>2</sup> research in the field of formation and development of science and innovation networks show that there are strategies, which following helps small businesses to reduce the risk level of innovation activities to an acceptable level, among which the most effective are the strategy for cooperation

with the scientific center and the strategy of "embedding" in the project chain of scientific innovation network<sup>3</sup>.

### SIE risk management system

Thus, the risk management system of small innovative enterprise (SIE) should take into account both traditional risk factors and specific, peculiar to innovation activities, namely: type of cooperative strategy, view of ongoing innovation, information risks, etc. In practice, monitoring of such a broad range of risk factors is rather difficult, so there is an objective need for the reduction of the entire set of risk factors to several observable and relatively easily evaluated factors.

In this paper considered the most significant risk factors of small innovative enterprise based on the collection and analysis of statistical data on 46 SIEs both of qualitative and quantita-

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- 1 Sheresheva, M.Yu. (2006), "Inter-organizational information systems in the network inter-firm cooperation" ["Mezhorganizatsionnye informatsionnye sistemy v setevom mezhhfirmennom vzaimodeistvii"], *Rossiiskii zhurnal menedzhmenta*, Vol. 4, No. 1, pp. 76-94; Zaichenko, S.A. (2008), "Centers of excellence in the modern scientific policy" ["Tsentry prevoskhodstva v sisteme sovremennoi nauchnoi politiki"], *Forsait*, No. 1(5), pp. 42-51.
  - 2 Babeshko, V.A., Temerdashev, Z.A., Ratner, S.V. (2003), "On innovative activities at the university" ["K voprosu ob aktivizatsii innovatsionnoi deyatelnosti v vuze"], *Innovatsii*, No. 1(58), pp. 38-40; Ratner, S.V. (2010), "The influence of the flow rate of innovative knowledge on the efficiency of research and innovation network" ["Vliyaniye moshchnosti potoka innovatsionnogo znaniya na effektivnost' funktsionirovaniya nauchno-innovatsionnoi seti"], *Ekonomicheskii analiz: teoriya i praktika*, No. 2 (167), pp. 69-73; Ratner, S.V., Malkhas'yan, S.S., Arakelyan, N.R. (2009), "Designing and managing research network of regional innovation cluster" ["Proektirovaniye i upravleniye nauchno-issledovatel'skoi set'yu regional'nogo innovatsionnogo klastera"], *Ekonomicheskii analiz: teoriya i praktika*, No. 4(133), pp. 20-24.

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- 3 Golichenko, O.G. (2006), *National innovation system in Russia: current situation and ways of its development* [Natsional'naya innovatsionnaya sistema Rossii: sostoyaniye i puti ee razvitiya], Moscow, 396 p.; Ratner, S.V., Filatova, O.V. (2011), "Network model of the development of university business incubators" ["Setevaya model' razvitiya universitetskikh biznes-inkubatorov"], *Ekonomicheskii analiz: teoriya i praktika*, No. 13 (220), pp. 2-10.

tive nature, namely: the data on balance sheet (quantitative), on income statement (quantitative), data about the kind of innovation activities (qualitative), the geographical location of the enterprise (qualitative), its cooperative strategy (qualitative), information system (qualitative) and the success of economic activity (market share + profitability + time of market presence). In addition, the indicator of the enterprise success was considered by us as a dependent, and other parameters as independent variables. To select the most significant factors that have the greatest influence on the resulting figure, we use the method of principal components. The choice of this method of research is explained by the fact that it allows identifying latent resumptive characteristics of the organizational structure and the mechanism of development of the studied phenomena and processes on the basis of actual relations of the parameters (or objects). Moreover, the method does not impose strict restrictions on original statistical data that can be used both for quantitative and qualitative data.

We need to transfer qualitative data into quantitative in order to proceed with the direct statistical analysis of the data. For this purpose we will use a point-based system, since this method with

sufficient capacity of point scale allows transferring the qualitative estimates into quantitative without loss of precision. By the properties of point scales<sup>4</sup>, the stricter rules in the scoring scale, the closer in its properties to an absolute scale, and the more "fuzzy" the rules for calculating the score, the closer point scale in its properties to an ordinal scale. We will evaluate the quality of cooperative enterprise strategy and the quality of its information system in a 100-point scale, using the rules given in Tables 1 and 2 respectively.

As justification of the scoring rules to assess cooperative enterprise strategy, we present the following overview of the results obtained during the bibliographic analysis of modern scientific literature on economics and management theory, as well as regulatory background:

1. The resolution of the Government of the Russian Federation on 22.04.2005 No. 249 "On the conditions and procedure for funding in 2006, provisioned for state support of small business, including the peasant (farmer's) economy" contains a separate chapter dedicated to providing grants for the creation and development of business

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<sup>4</sup> Novikov, D.A. (2004), *Statistical methods in educational research* [*Statisticheskie metody v pedagogicheskikh issledovaniyakh*], M3-Press, Moscow, 67 p.

**Table 1. Scoring rules for the assessment of cooperative strategies of small innovative enterprise**

Signs of a cooperative strategy	Number of added points
SIE affiliation into business incubator or technology park at the large research center	90-100
SIE affiliation into a number of suppliers or contractors of large innovative enterprise	80-90
Permanent scientific and industrial relations with a large research center (at least joint project every year)	70-80
Permanent scientific and industrial relations with a large innovative enterprise (at least joint project every year)	60-70
The presence of an overall development strategy and permanent production ties with other SIEs (at least joint project every year)	50-60
Permanent scientific and industrial relations with other SIEs (at least joint project every year)	40-50
Periodic scientific and industrial relations with the research center or large innovative company (at least 1 project in 3 years)	30-40
Periodic scientific and industrial relations with other SIEs (at least 1 project in 3 years)	20-30
Organizational and informational interaction with the research center or large innovative company	10-20
Organizational and informational interaction with other SIEs	0-10

incubators. The resolution defines business incubators as an organization created to support entrepreneurs in the early stages of their activities through the provision of premises and provision of consulting, accounting and legal services (Paragraph 14). Since 2005, the Russian Government subsidizes the subjects of the Russian Federation for construction, reconstruction, repair of buildings and facilities of business incubators. Only in 2008 667,95 million rubles have been allocated for the development of regional business incubators from the federal budget, from regional budgets – 374,53 million rubles. According to the Minister of

Economic Development of Russia E.S. Nabiullina, business incubators can significantly improve the survival of startup companies from 15% to 85%.

At that, business incubators can vary significantly in its profile. Depending on local conditions and goal setting, the focus can be made largely on the production of goods or provision of services (or on both). E.g., in technology cities business incubators can be rather of the nature of techno park or innovation center, while in other cities as participants may be invited either exclusively persons who start their own business or partly established companies.

When creating a business incubator by a large university or research center, its development priority usually becomes the commercialization of research and development solutions of scientists on the basis of small innovative enterprises, created specifically for this purpose. Often, university or research center becomes a co-founder of small innovative enterprises, making a stake in the share capital by cash or intangible assets. Reducing the risk for SIE is achieved through the use of scientific potential of the research center, its experimental and laboratory facilities, social ties and preferential financing of innovative projects, preferential payment of leased offices and industrial premises, consulting and other services<sup>5</sup>.

2. Significant reducing of the risk of innovation can be achieved by incorporating the SIE into a focal supply chain, in which one (usually large) company is a central unit (focal firm), and its suppliers, located at different steps of the value creation (distributors of the first, second, third level) are in a dependent position. The focal company is trying to coordi-

nate all the value chain, but at the same time forced to take care of "calibration" of partners' interests, since its abilities to hierarchical coordination have their limits. Case studies of focal supplier networks exist in the automotive industry. The matter is in the supplier network of such companies as Volkswagen, BMW, GeneralMotors, DaimlerChrysler and others<sup>6</sup>.

Focal enterprises gradually concentrate in its hands all the important solutions about the product and production, standardize their quality requirements, and this leads to increased concentration processes through mergers and acquisitions. The result is a configuration of the industry, in which, on the one hand, a small number of large "global players" remain behind, on the other – local hierarchies of suppliers. They correspond to network-based hierarchies according to form of partnership between manufacturers and suppliers of the "first level" at main location areas of the manufacturer (e.g., DaimlerChrysler development centers in Sindelfingen or BMW in

5 Ratner, S.V., Filatova, O.V. (2011), "Network model of the development of university business incubators" ["Setevaya model' razvitiya universitetskikh biznes-inkubatorov"], *Ekonomicheskii analiz: teoriya i praktika*, No. 13 (220), pp. 2-10.

6 Sheresheva, M.Yu. (2006), "Inter-organizational information systems in the network inter-firm cooperation" ["Mezhorganizatsionnye informatsionnye sistemy v setevom mezhfirennom vzaimodeistvii"], *Rossiiskii zhurnal menedzhmenta*, Vol. 4, No. 1, pp. 76-94.

**Table 2. Scoring rules to assess the information system of small innovative enterprise**

Signs of the information system	Number of added points
Integration within the ERP-II system of information environment of the enterprise with IT environment of large research center or innovative company; presence of a common Internet portal with a feedback system	90-100
Integration within the ERP-II system of information environment of the enterprise with IT environment of network of small innovative enterprises; presence of a common Internet portal with a feedback system	80-90
Integration within the CRM or MRP system of information environment of the enterprise with IT environment of large research center or innovative company; presence of a common Internet portal with a feedback system	70-80
Integration within the CRM or MRP system of information environment of the enterprise with IT environment of network of small innovative enterprises; presence of a common Internet portal with a feedback system	60-70
Single integrated system for planning and accounting of all business processes with integrated mathematical software that provides support for decision-making; presence of personal website with organized feedback system	50-60
Single integrated system for planning and accounting of all business processes with integrated mathematical software that provides support for decision-making; presence of personal website	40-50
Single integrated system for planning and accounting of all business processes with integrated mathematical software that provides support for decision-making	30-40
Single integrated system for planning and accounting of all business processes	20-30
Automation of all basic control functions of the enterprise	10-20
Presence of automated bookkeeping and management accounting	0-10

Munich). Below is the next level of parts manufacturers with regional orientation, but technologically and financially tied to the focal company, and even lower – a mass of small parts suppliers in the state of competition on costs and being highly dependent, that is a certain "payment" for the reduction of risks.

3. Conditions of fierce competition in the market when there are a large number of firms with equal opportunities for development, forcing companies to look for additional resources to attract and

retain customers. In competitive markets the customer becomes more demanding and expects more attention. Small and medium-sized businesses grow using the efficient system of crediting and government support, but most companies very quickly reach a critical point in its life cycle. Additional qualified staff employment becomes too costly, but to develop further without specialists in certain areas is almost impossible. At this stage the company becoming aware of the need to unite and form networks, within which



various functions are divided between the companies, and each of them focuses on core competencies, while other tasks are transferred to partners in the network<sup>7</sup>. This situation contributes to the reduction of risks not only at the expense of specialization, but also by developing a common strategy of market behavior.

Analyzing the Table 2, it is easy to notice that the main requirement to the SIE information system is its integration into common information space of the research and innovation network that allows "embedding" in the flow of information, accompanying the generation and innovation in the production process, as well as monitor information risks. Moreover, the most important requirement for an enterprise information system is a high level of security that is best provided by modern ERP, MRP and CRM systems. Effective ways to protect the flow of information from unauthorized access by using information systems such as ERP-II, allowing fully integrate information space of one economic agent to another, are firewalls and virtual private networks. The firewall is a system or combination of systems forming a protective barrier between two or more networks, that protects against unauthorized access to the network or data packets leakage.

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<sup>7</sup> Ibid.

Basic principle of operation of firewalls – checking each data packet to match incoming and outgoing IP-based addresses with allowed addresses. Consequently, firewalls greatly expand the opportunities for segmentation of information networks and circulation data control.

Speaking about cryptography and firewalls, it is worth mentioning secure virtual private networks (VPN). Their use allows us to solve the problem of confidentiality and integrity of data during transmission over open communication channels.

The use of VPN can be traced to three main objectives:

1) protection of information flows between various offices of the company (the encryption of information is made only at the external network log-on);

2) secure access of remote network users to the information resources of the company, usually conducted via the Internet;

3) protection of information flows between certain software within corporate networks (this aspect is also very important because most of the attacks come from internal networks).

We now proceed to develop a method of transfer of qualitative parameter SIE "geographical location" into

quantitative measurement. The first, qualitative parameter was introduced to take into account the business climate of that region, in which the economic activity of the enterprise is undertaken. For this purpose we use calculations on small business development in various regions of Russia<sup>8</sup>. We shall use the following conversion formula for "geographical location":

$$\text{SIE location region} = \frac{C_i}{C_{max}} + \frac{B_i}{B_{max}}$$

$C_i$  – the proportion of small businesses and individual entrepreneurs, calculated as a ratio of the number of employees of small businesses and individual entrepreneurs to the total population in the  $i$ -th region;

$B_i$  – the ratio of balanced financial result of small businesses / entrepreneurs to the total population in the  $i$ -th region;

$C_{max}$ ,  $B_{max}$  – maximum values of indicators in all regions of Russia.

8 Boiko, A.I., Voronina, L.A., Ratner, S.V., Nizhegorodtsev, R.M. (2010), "Structure of the controlling system for small innovative enterprises", *Innovation management – 2010: Proceedings of the international scientific conference on November 15-17, 2010* ["Struktura sistemy kontrolynga malykh innovatsionnykh predpriyatii", *Upravlenie innovatsiyami – 2010: Materialy mezhdunarodnoi nauchno-prakticheskoi konferentsii 15–17 noyabrya 2010 g.*], LENAND, Moscow, pp. 223-228.

For the transfer of a quality attribute "Type of Innovation" we will also take the point scale and scoring rules introduced by the Table 3. Use the results obtained in the analysis of statistical data on the most popular types of innovations introduced in small enterprises<sup>9</sup>.

**Table 3**

Type of Innovation	Number of added points
Process modifying	90-100
Process improving	80-90
Process cutting-edge	70-80
Improving organizational	60-70
Improving marketing	50-60
Organizational cutting-edge	40-50
Marketing cutting-edge	30-40
Modifying product	20-30
Improving food	10-20
Product cutting-edge	0-10

Consequently, for each of the surveyed small businesses we obtain a set of quantitative statistical indicators that reflect different aspects of the enterprise, one of which is dependent, and the remaining are independent.

To conduct a factor analysis we will use the software package STATISTICA, in which several different ways factors rotation are implemented, including the method of principal components.

9 *Indicators of innovation activities: 2009. Statistical handbook [Indikatoriy innovatsionnoi deyatel'nosti: 2009. Statisticheskii sbornik]*, GU VShE, Moscow, 2009, 488 p.



Factor loadings, obtained as a result of the analysis, allow conducting the reduction of the original data, leaving only two significant factors, each presents a linear combination (factor loadings rounded to 2 decimal places):

$$F_1 = -0,82X_1 - 0,92X_2 + 0,97X_4 - 0,96X_6 - 0,97X_7 - 0,89X_8 + 0,7X_9 + 0,98X_{11} - 0,97X_{16} + 0,97X_{17} - 0,73X_{19}$$

$$F_2 = 0,72X_5 + 0,95X_{12} + 0,95X_{13} + 0,96X_{14} + 0,96X_{15}$$

Thus, the first factor included the following indicators of the enterprise: fixed assets, intangible assets, accounts receivable, short-term investments, additional and reserve capital, share capital, retained earnings, long-term loans, income before taxes, net income, geographical location of the enterprise. From in-depth point of view, this factor can be interpreted as financial leverage of innovative enterprise.

As is known<sup>10</sup>, for the purpose of determining whether it is expedient to use debt capital, the question is associated with financial leverage effect: an increase in leverage can increase return on equity. The effect of financial leverage for innovative enterprises can be interpreted as an increment to the ROE ob-

tained through the use of borrowed funds and *intangible assets*.

Investigation of the structure of the second statistically significant factor leads to the conclusion that it can be treated as a factor of operating (or production) leverage, since it depends on the structure of production costs and, in particular, on the ratio of semi-constant and semi-variable costs in the structure of original cost<sup>11</sup>. Consideration of this aspect of the structure of SIE production costs allows, first, to solve the problem of maximizing profits at the expense of the relative reduction of certain costs during the growth in sales volumes, and, second, the division of the cost on semi-constant and semi-variable allows judging on cost recovery and providing the ability to calculate enterprise financial strength in the event of difficulties, complications in the market; third, allows to calculate the critical sales volume covering costs and providing a break-even enterprise activity.

Solving these problems can prove the following conclusion: if the company creates a certain amount of semi-constant costs, any change of sales revenue generates even stronger profit change (effect of operating leverage).

10 Arkina, N.A., Arkin, V.G. (2004), *Financial management. Textbook. 2nd ed. [Finansovyi menedzhment. Uchebnik. 2-e izd.]*, Yuniti-Dana, Moscow, 416 p.

11 Wilson, P. (1995), *Financial management in small businesses [Finansovyi menedzhment v malom biznese]*, Audit, Moscow, 256 p.

In addition to the indicators characterizing the cost structure, the factor F2 also includes estimates of the type of innovation and evaluation of SIE cooperative strategies. Therefore, the effect of SIE operating leverage can be regarded as characteristic of the business risk of the enterprise arising in certain field of innovation activities or in connection with the implementation of a cooperative strategy. This effect can be measured as the percentage change in profits from sales after compensating variable costs

for a given percentage change in sales volumes.

## Conclusion

The obtained results allow us to conclude that the risk management system of SIE should be divided into two major subsystems: the subsystem of financial and operational risks management and the subsystem of information risk management of the enterprise, which aggregate all activities of risk controlling.

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**Разработка системы управления рисками малых  
инновационных предприятий с помощью метода главных  
компонент**

**Бойко Анна Игоревна**

Аспирант,  
Кубанский государственный университет,

350040, Российская Федерация, Краснодар, ул. Ставропольская, 149;  
e-mail: boiko.ai@vtb24.ru

### **Аннотация**

В статье приводятся результаты исследования факторов риска в инновационной деятельности малых предприятий, выполненного с помощью метода главных компонент. Особое внимание уделено вопросам учета вида инновационной деятельности предприятия, качества его информационной системы, делового климата на территории деятельности экономического агента и его интегрированности с существующими научно-инновационными сетями.

### **Ключевые слова**

Малый бизнес, инновации, риск, управление, факторы, научно-инновационные сети.

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