GROWTH FACTORS OF RESEARCH-BASED SPIN-OFF COMPANIES*

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Abstract

This paper is built on findings from case studies with 15 research-based spin-off companies (RSOs) undertaken in Belarus in 2003-2007. It considers the demand, supply and specific factors influencing the direction, speed and mode of growth of RSOs: those specific to Belarus as a Post-Soviet economy, and those common in the world due to economic nature of RSOs. The factors shaping the geography of RSO's market (international vs. local) are distinguished. Special attention is paid to economic relations and in particular conflicts of interests between RSO's internal decision-makers and external actors as factors impacting RSO's growth trajectories.

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Introduction

Encouragement of closer interaction of science and industry and intensification of research and development (R&D) results transfer to industry, in particular through innovative entrepreneurship, is widely discussed on scientific, practical and political levels in Europe and in the world. Though the practical value of scientific and technical entrepreneurship for innovative development of the national economy and social sphere is high, the nature and the modes of organization of firms that manufacture science-intensive and technological products belong to underdeveloped directions of the modern economic theory. Also the available theoretical understanding of mechanisms of interaction of scientific and technical enterprises with external economic agents is insufficiently profound. Development of theoretical body of knowledge on such firms and their economic relations is thus a scientific problem of high relevance.

This paper is devoted to particular sector of scientific and technical enterprises, known as "research-based spin-off enterprises" (RSOs). This sector embraces the firms branched off from scientific organisations and high schools for introduction of R&D results in the manufacture. Classification attributes of these enterprises are: their specialisation on R&D, and the previous or current employment of their founders as researchers of scientific research institutes, universities, other organisations of scientific sphere. RSOs serve the stages of the innovation process which are not served by academic science, developing the technological solutions for concrete profiles of demand of industrial customers.

In a framework of dissertation research and on the empirical data from Belarus, Estonia, Austria and France conditions, preconditions and reasons of RSO emergence during transformation of scientific and technical sphere into the national innovative system have been studied; the essence, content and structure of RSO activity organization was revealed; economic relations of RSO in NIS by agents and subjects of interaction have been identified and analysed; contradictions and conflicts of these relations have been revealed; the factors of evolution of RSOs' forms of existence in NIS and forms of their interaction with NIS have been determined, as well as the functions of RSO and economic effects from existence and functioning of RSOs in the transformation economy, with resulting innovation policy implications (Pobol, 2008).

In particular, it was found that commercial efficiency of RSOs in Belarus is yet far from its potential level. The profitability level varies from 3-4% to 15-20%; the survival rate of firms is low. Most RSOs provide to researchers somewhat higher wages than the state scientific sector; but only part of RSOs have achieved significant commercial results since their foundation in early 1990-is, and have grown to medium-sized enterprise; only few RSOs have grown to large-sized enterprises with over 250 employees. And still, commercial efficiency of companies which have survived and got established at the market is rather attractive in comparison with other sectors of economy.

This paper considers the factors of RSOs' growth and development: those specific to Belarus as a Post-Soviet economy, and those common in the world due to economic nature of RSOs. We will summarize the evidences for explanation of geographical orientation of RSOs. A special contribution of the paper consists in consideration of RSO's economic relations with other actors of the national innovation system as important factors for RSO's growth trajectories.

Theoretical background and literature review

Theoretical background of scientific and technological enterprises dates back to the concept of *„integrated learning base"of* Chandler (1962, 1977) built on empirical analysis of evolution of corporations in USA since late 19 century. It acknowledges technological changes to be the central axe around which the corporate business has grown through vertical integration with suppliers and wholesale buyers. The firms' „learning base" is based not on the key competence or mastering of

new technology but on studying of „unique for this firm combination of technological challenges, market profile, distribution schemes“ (Moss, 1999).

Most frequently used for explanation of science-intensive firm's competitive advantage for growth is the *„resource-based firm theory“* of E. Penrose dating back to 1959, where the contemporary corporative enterprise is represented as an organisation administrating the set of human and physical resources. People and teams that provide services to the firm learn continuously how to use the firms' productive resources in a more efficient way; thus they provide the productive opportunities which are not available to the firms working in the same industry but have not accumulated such experience. W. Lasonik (2006) notes that the resource firm theory „focuses attention on characteristics of valuable resources of one (innovative) firm which are difficult to imitate; but it does not shed light on why and how some firms accumulate more valuable and non-imitatable resources than the others and what makes these resources valuable and non-imitatable».

Growth paths of firms which perform and introduce innovations have been modelled by Nelson and Winter (2002) in their 1982 *evolutionary theory* „of potential opportunities and behaviour of commercial firms functioning in the market conditions“. „Organisational differences, especially... in capabilities to generate innovations and make use of them“ are considered to be the sources of sustainable, hardly imitatable differences between firms to a greater extent than disposal of particular technologies (Lasonik, 2006).

Conceptual blocs of *technology-based firm theory*, explaining the principles of functioning of the firm which produces technologies have been built only recently by Mustar (1997, 1998), Autio (1997) and Granstrand (1998). Philippe Mustar shows the important role of the state policy in growth of research-based spin-offs especially on the early stages of their development. Application of systemic approach allows Erkko Autio to reveal the role of external linkages for development of science-intensive firms. Ove Granstrand develops particular elements of the new theory by analysis of the largest technology corporations of the world.

Parallelly in 1998 the *entrepreneurial theory of the firm* of M.Casson (2000) is developed, which shifts the focus in the theory of the firm from flows of physical resources to flows of information and its administration. Account of knowledge flows in the firm was underestimated in previous theories.

In the latter years the works on particular aspects of spin-off firms' functioning have appeared. Parhankangas and Arenius (2003) study relations between corporate spin-offs and parent companies concerning resource sharing and relations that lead to emergence of networks and development of industrial clusters. Chesbrough (2003) studies the efficient structures of technological spin-offs' administration at the microlevel, though these firms are not considered as subjects of the dynamically developing national innovation system. Semadeni (2003) integrate the 'agency theory', the 'upper echelons' theory and transaction costs economics for building up the model of organisation of spin-off firms from managerial point of view, though leaving without attention the distribution of technologies. Fuentelsaz, Gomez and Polo (2003) study the speed and factors of technologies diffusion, but only at the intrafirm level. Metcalfe (2000), Belussi and Arcangeli (1998), Balconi, Breschi and Lissoni (2004) consider the importance of firm's linkages with universities from the viewpoint of exploitation by the firm of scientific knowledge and equipment and provision of the firm with qualified workers. They also study the networks of innovative entrepreneurship, but do not consider the issues of integration of these networks into international technological networks. Fontes and Coombs (2001), Benneworth and Charles (2005) raise question about the contribution of new technology-based firms to strengthening of technological capabilities of developing economies. These authors point at non-absorptive to innovations demand to be the

main factor restraining the diffusion of new technologies in countries with transitive economies. Clarysse, Heirman, Degroof (2001), Clarysse, Knockaert, Lockett (2005) analyse the role of environment for commercial efficiency of new technology based firms at various stages of their development, though they do not analyse the reverse influence of such firms on the formation of environment. Etzkowitz (2004) consider the evolution of entrepreneurial university and speaks about the "second academic revolution" – the possibility to capitalise knowledge through scientific and technical entrepreneurship. However, the specificity of role of scientific and technological entrepreneurship in developed and transitive economies is not differentiated. Helm and Mauroner (2007), based on Gartner's framework of new venture creation as a substitute of entrepreneurial theory, differentiate three major groups of success factors for generation, development, and growth of RSOs, concerning the founder, the environment, and the later company itself.

The deepest economic research of innovative SMEs in Belarus has allowed to study the main features of the mode of functioning of enterprises in high-tech sector (Slonimski, Litskevich and Matrunich (2002), Slonimski and Linchevskaja (2003). Among sociological studies the study of innovative potential of the small scientific and technical entrepreneurship (Pavlova, 2008) excels.

In Post-Soviet economies one of deepest empirical studies was undertaken by Rogalev (1997). In his book devoted to issues of university technologies commercialisation on example of Moscow Energetic Institute also the economic factors of development of high-tech subsidiary companies with share of university ownership come into consideration. Akhmetova (2005) has carried out research of spin-off firms founded by technical entrepreneurs in Ural region of Russia with emphasis on their configuration in comparison with western spin-offs, primary motivation of founding and choice of business-model. Litvak (2005) has interviewed 19 innovative small enterprises in Moscow to their problems in attraction of external financing and products promotion.

Methodology and empirical background

Due to rarity of scientific publications devoted to research-based spin-off companies as a sector of Belarusian economy and scarcity of available statistical data concerning small innovative enterprises, an independent empirical research of RSOs has been undertaken. Because RSOs as economic phenomenon in Belarus have not been studied before, and their population in Belarus is rather small, qualitative research methods have been used: case studies and expert analysis. The works of Ragin and Becker (1992), Eisenhardt (1989), Dyer and Wilkins (1991) have constituted the methodological basis of empirical research.

Objected to case studies have been 10 research-based spin-off companies in Belarus, with emphasis on factors of their functioning, development, networking and interaction with NIS. When selecting the RSOs for case studies the enterprises with more developed linkages with customers and suppliers have been preferred, since their economic relations with NIS could be observed in a most expanded form. Half-formalised questionnaires and guidelines to interviews have been used as a background of interviews.

Among the studied RSOs three have been founded in 1991, four – in 1992, two – in 1993 and one in 1994. Of them two enterprises have no competitors on price and innovative products parameters in the territory of Belarus; four enterprises – in the territory of the former Soviet Union; three enterprises have no competitors in the world. The main respondents of seven enterprises have been directors; of two – deputy directors; of one – manager. Eight enterprises are situated in the capital city Minsk, one in Mogilev, one in Smorgon.

Due to limitations of the case method in number of studied enterprises the empirical research was confined to one industry branch – machine building and metal processing, - which has allowed to provide the relative comparativity and complementarity of interviews results. This industry was

chosen due to highest probability to find in it the most developed evolutionary forms of RSOs, because it is the most innovative one in Belarus, providing 39,4% of advanced technologies created in industry in 2006 (Korshunov et al, 2007).

For study of economic relations of RSOs with other participants of the innovation process, data verification and objective estimation the method of opportunistic data collection from various groups of economic interests has been used. It included various levels of parent organisations (directors of state scientific research institutes, managers of laboratories, researchers, book-keepers) and organisations of innovation infrastructure (directors of technoparks, business-incubators, technology transfer centers; employees of these organisations). Two protocoled interviews with foreign RSOs (Estonia, France) and 14 protocoled interviews with managers of the innovation infrastructure organisations; 8 interviews with experts from science and innovation infrastructure without protocolling have been carried out. As additional tools of data gaining, participation in technology transfer activities and assistance in their organisation, visits to RSOs‘ and their customers‘ manufactures have been used. Cross-case analysis and iteration approach have been used for generalisation of empirical material and drawing theoretical conclusions.

Primary growth factors of research-based spin-off companies

The general level of RSO sector development in the country depends on the size of economy itself, on the strength and specialisation of the national innovation system, on availability of the state support for RSOs, as well as on the general economic policy which determines the depth and the quality of demand of industrial customers of innovative technologies.

The specificity of activities, products and markets of RSOs affect the specificity of growth paths of technological firms in comparison with other types of firms (Lasonik, 2006).

Specificity of RSO’s activities and products

RSOs seldom manufacture the products for final consumers (households). Main customers of RSOs are the industrial enterprises which manufacture the mass goods for final consumers, but more often are engaged into manufacture of production means themselves, being an intermediary link in the value added chain of the final product (Pobol, 2005a).

The companies studied by authors produce the following kinds of goods: new installations and equipment (vacuum, laser, plasma); technologies of production of new innovative materials (as nanodiamond powders) and improvement of useful features of the known materials (e.g. by application of thin and superthin coatings on details); technologies which allow to manage the useful features of recently created innovative materials (as superhard tools for cutting of highly solid materials). The other types of products of RSOs include mechanical facilities for equipment, control and steering systems, hardware tools, software, imitation models, substances and preparations and other, depending on branch of science and consumer industry.

A widely discussed in the literature but difficult to overestimate factor is that the high-tech products and services due to their science-intensiveness need large expenditures on R&D before these products can be offered to market and during their promotion at the market.

A derivative but less considered factor is that expansion of firms in certain sectors is very capital-intensive. For example, possessing one installation, RSO can service the definite size of market. Expansion of demand provides opportunities for expansion of manufacture, but if the productive capacity of the available installation does not suffice, additional demand can be serviced only after acquisition or construction of a new installation. The costs of a high-tech installation can

make 300-500 thousands to over one million USD, which is not an easily affordable purchase for a company with 5-10 employees.

Specificity of products of RSOs preconditions the specificity of demand on it. Demand of industrial enterprises for new technologies and equipment is objectively differentiated, because:

- within concrete territorial market there exists a certain branch division of labour;

- the structure of industry inherited from the Soviet Union has been featured by significant division of labour among Soviet Unions‘ republics;

- specialisation of production means not only the differences in the final products but also the certain specificity of manufacturing process, that is, applied technologies and equipment.

Completely in line with these theoretical knowledge, our empirical findings have shown that the specificity of manufacturing process of RSOs is that for each concrete customer RSOs have to modify the production process, because profiles of the ordered products (the ensemble of required characteristics and the range of useful properties) vary for each customer. Entry by RSO of international market also does not mean the automatic extension of the client base for one ready modification of the product, because there also exist the cross-country differences between modes of production organisation for the same final product. That is why, though generally the palette of manufactured products is joined by a common idea of one technological innovation, for each next manufacturing cycle RSOs have to carry out additional R&D and experimental works. Hence, the *increment of value added during the works undertaken by RSO, in most orders contains the increment of knowledge*.

Theoretically this means that RSOs belong to economic actors which provide the shift of structure of the gross national product to more knowledge-intensive one.

In practice this also means that most contracts with customers are concluded on a one-time basis. The long-term contracts are possible only with clients, which manufacture the products with high stability on the market and guaranteed demand, or the products with standardised characteristics which can be applied even if the final products are modified.

Demand and the volume of market

As a result of prolonged economic crisis of the transitive period, which has sharply reduced the solvency of industrial enterprises, the mass industrial demand on innovative technologies is very poorly developed in Belarus. In transitive countries the fact that RSOs customers – industrial enterprises – lack current capital hampers the RSOs development strongly. Even if industrial enterprises can afford buying innovative technologies themselves, they are still confronted with the necessity to pay a multiple sum for introduction of the new technology and mastering of it: provision of necessary infrastructure for employment of new technology, modification of complementary equipment, investments into advanced training of workers for servicing the innovative installations, but also the costs of discharge of workers need to be taken into account. A number of economically efficient innovative technologies which could waive from elementary labour 10-70% of workers cannot be introduced in Belarus because the intersectoral mobility and the system of requalification are insufficiently developed. Thus, many potential customers who can afford the innovation cannot afford the costs of extracting value from it.

Taking into account this factor of low-solvent demand, RSOs in Belarus try to maximise their client base: they look for most affordable schemes of technology development for their customers. For example, the workers of the customer may be involved into execution of works required for

manufacture of details and assembly of the ordered equipment in order to lower the expenditures of customer to be paid in monetary form. The simultanuous learning may also enhance the absorptive capacity of customers to innovation.

The other tactic of RSOs directed at involvement of customers with possibly wider range of technical needs and financial capacities consists in identification and offer of alternative forms of collaboration with the customer. For example, they may include supply of finished parts; supply of raw materials; supply of semifinished items for finishing of manufacture in the territory of the customer; adjustment of manufacture with supply of equipment to the enterprise of the customer; joint manufacture and patenting of products; sale of licenses etc.

Quality of demand is also important. Evidences from Belarusian RSOs have shown that especially successful collaboration was developed between RSOs and clients which possessed the high technological competence. The latter is confirmed to provide the high quality of formulation by customer of the technical task; the high quality of feedback concerning the solutions suggested by researchers; customer's capacity of extraction of the full value from introduced innovation.

Resource base of the company and availability of capital

Alongside with backwardness of solvent industrial demand for innovations, main barriers to development of RSOs in Belarus include those of framework conditions for companies' functioning, namely the deficit of venture capital in the economy; weakness of operating legislative base for protection of intellectual property rights on innovative technologies, which constrains diffusion of knowledge in the economy; absence of mechanisms of the state support of foreign patenting for RSOs entering the markets of the EU, South East Asia, USA.

A serious barrier to RSOs development in transitive countries is the lack of current capital. Because of this RSOs cannot perform R&D in advance without having R&D being ordered and at least half pre-paid; similarly they cannot develop the technological equipment and manufacture the products and look for customers only afterwards.

A curious case in this context is an example of RSO-monopolist which *aspires to occurrence of competing companies in order to support its own growth* (Smallbone, Slonimski and Pobol, 2008). Preconditions of this case are that the market of the innovative technology is young and very extensive; the technology is a "general purpose technology", and the firm is the world leader on the level of technological development. For example, the key technology of one Belarusian RSO (nanomaterials) allows developing a cluster of high-tech areas with their own innovative technologies and products in variety of industries (automobile, chemical branch, medicine and medical products, etc.). The full-fledged development of this RSO would be able to provide the growing high-tech export, large-scale modernisation of existing and occurrence of variety of new manufactures with novel products. However, the market is not prepared yet to recognise the whole spectrum of these technological solutions and to introduce them in practice; large marketing expenses for increase of awareness of industrial enterprises about extensive possibilities of new technologies are required; but Belarusian banks suggest no lending instruments for financing the marketing company. That is why strategy of attraction of competitors which would «warm up the market», carry out advertising expenses and waken the interest of potential customers by their versions of innovative technology would be favourable to the studied RSO. Competitors with weaker R&D capacities would thus provide a platform for a fast growth of the technological leader. This strategy is safe for RSOs in the short-term period while the competitors who lag behind in R&D are capable to offer to the market only simplified versions of technology. However, in the long-term period competitive advantage can move to those firms which possess not only the know-how, but also the expensive sophisticated equipment for further R&D.

Because R&D works are increasingly expensive, most innovators agree on that the primary condition for expansion of activity of scientific and technical enterprise is an essential investment of capital. Especially this is true for young RSO's which need to pass from the seed to start-up to early stage to expansion stages. It has been found that the companies which have received support from parent university or financial support from the state at the early stages of lifecycle, start growing much earlier and quicker than the firms which have started without support, even if they have got access to it later. Clarysse, Heirman and Degroof (2001) have distinguished two types of factors of scientific and technical firms dynamic development – combinatory learning (knowledge and expertise drawn from the links with the already existing firms and support organisations (imitation) and cumulative learning (experience, knowledge and skills of work on the market, firm management including planning of administration and intellectual property rights management), which the firm accumulates from its own experience. As shown by these scholars, the degree of firms' learning and accumulation of necessary resources defines their chances on penetration to the market, further growth and sustainability, and depends on type of environment.

Successful scenarios of RSO development suggest that the innovators have managed to find the new ways of additional financing of their activity.

Interaction with a large science-intensive company is a usual source of resources for young RSOs in developed economies. Main schemes of such interaction include the subcontracting, direct investments and acquisition. The benefits of it include not only the financial flows, but also access to new technologies and rare equipment; access to tacit technological knowledge; opportunity to adjust the system of professional training to the world market of the working force; opportunity of learning by doing; opportunity to gain the skills of international business communication, international business management and decision-making abroad. These positive externalities can become an equally important asset for a young RSO as the initial capital accumulation.

Due to growing complexity of innovative technologies and products, often the scheme of purposeful bringing a young science-intensive company to its acquisition by a large one is used in the countries with a well-financed scientific base. The strategy of RSO's development is built as follows: researchers establish a small enterprise where the innovative technologies or products are developed for the market stage, their future success chances at the market are proved, patent portfolio is formed; contacts with the main customers in the world are established. The system of these measures increases the RSO's value manifold in comparison with net value of core innovations. After the high market value of the young firm is formed, it is sold to large corporations which can afford large investments in marketing, promotion of the product to customers and further R&D. Conditions on which RSOs conclude contracts with foreign corporations, often infringe upon interests of RSOs, but other possibilities to finance their development are rather limited.

Numerous young enterprises, especially in countries with lacking science-intensive corporations and venture capital, do not succeed in attraction of large capital investments and have to *cease their existence*. From the viewpoint of the national economy it is not RSO as a concrete registered firm which is important, but the innovative products of RSO's activity – technologies – and their background – competence of researchers. If the concrete RSO ceases its existence, its technological knowledge and competencies may be preserved, or lost for the country (figure 1). Because RSOs are founded by the intellectual elite of the country in the given technological field, their „death" means that the national economy can fully loose the capability to create innovations in this area. Important to stress is that not only the passive knowledge needs to be used (for example through lecturing), but also the active knowledge of innovators about the mechanisms of technologies' introduction to industry.

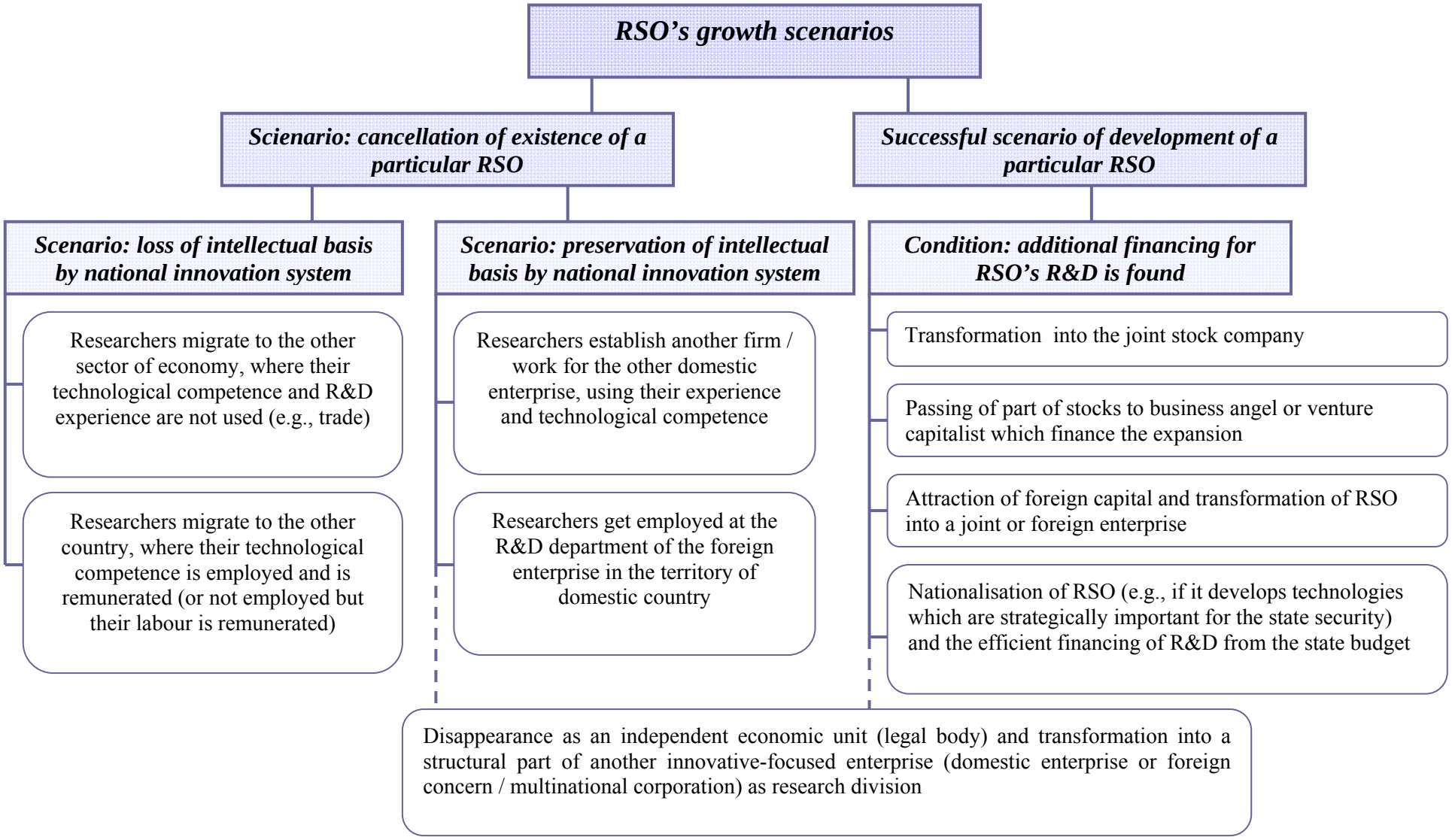

Figure 1 – Scenarios of RSO growth: conditions and forms of realisation

Local market versus internationalisation

Important dimension of enterprise‘s development is the *geography of its market*. Provided the firm possesses a growth capacity, the most important factors that form the geography of market are demand factors: the *presence, complexity and solvency of demand*.

Insufficient number of advanced users of technology in the country might make a serious barrier for RSOs in expansion of their local markets and survival when operating a science-intensive activity. Simultaneously it can serve as incentive towards *internationalisation of activity*, if the level of technological innovations of the firm is internationally competitive.

The other factor of RSO activity internationalisation is the *oligopolistic demand on high technologies*, which becomes especially weighty in small economies. Due to complexity, expensiveness and specificity of the innovative equipment there is only a limited number of enterprises in the market which put forward a regular demand on it. The customers may need certain model of technological equipment only once in the lifecycle of this model: this is a durable good which depreciates morally within 10-15 years. As a result, the strategy of RSOs growth consists in constant search for new markets.

One Belarusian RSO has overcome its main barrier – low solvency of Belarusian enterprises – by full orientation on Russian market. But, though the Russian market is extremely capacious, this RSO does not plan to increase its current sales volume because of the system of progressive taxation, which is designed for a very low level of populations‘ income and deprives RSOs of incentives to increase the payroll.

RSOs may have a low motivation to expand their activities on the markets of EC, USA and other countries because of direct proximity to Russian market which „provides such a volume of demand that capacities of one enterprise of an optimal size would hardly suffice to cover the whole demand“ (from interview with respondent). Entrance to the new markets is perceived in such case as a needless risk, and the favourable scenario of development of such firms with the high probability follows the path of *expansion of the already known market*.

This case considered an RSO which currently has no competitors in the territory of the former Soviet Union and is not expecting that competitors will appear, because the entry barriers to their technological sphere are difficult to overcome due to highly specialised qualification and high costs of equipment required for launching of new production. „It is scarcely probable that the competitor will suddenly appear from nowhere“ (from interview with respondent), because the most important resource of RSOs are the researchers-innovators, and the experts of such high professional level do not stay unknown in the scientific community. Expansion of RSO’s activity by organisation of subsidiary or second generation spin-off firm would also infringe the monopolistic (thanks to unique know-how and technologies) position of the existing RSO at the market.

One could also bring a contrary example of a firm which is also a monopolist now but is conscious of the future changes in the market structure. This Belarusian RSO together with Chinese large state enterprise has organised a joint company with production in China and transfered to this firm the exclusive right of sales in the market of South East Asia. By establishing this type of cooperation with a thoroughly selected corporation, Belarusian RSO penetrates and becomes tightly integrated in advance into the structure of the market which in the future is supposed to become one of world leaders in the given technological area.

O.Granstrand has studied the largest technological corporations and shown that for them the successful scenarios of development include the technological diversification. Due to necessity to economize on increasingly expensive technologies, corporations follow the strategies of internationalization on the markets of both resources and products. Particular tools are the search for external technologies, rationalization of R&D and technological partnerships on a multinational scale (Granstrand, 1998). It seems logical to assume that if the firm possesses unique resources of knowledge and competencies, expansion of its commodity market should contribute to commercial success. One could thus suppose that successful scenarios of RSO growth are connected with their entrance to the world market.

The analysis of relations of RSOs with suppliers and customers undertaken by the authors shows that RSOs are not always „born“ for the global market; *efficiency of certain RSOs is limited by the local market*.

The factors of localisation of efficiency on domestic market include:

- local knowledge of specific characteristics of the domestic market;
- geographycal specialisation of resources market or product market by complexity and structure;
- close binding of RSO to technological partners.

Hayek (1945) has defined ‘local knowledge’ as the knowledge of people, social relations, knowledge of those who possess the required knowledge, knowledge of local conditions and special circumstances, for example of place and time.

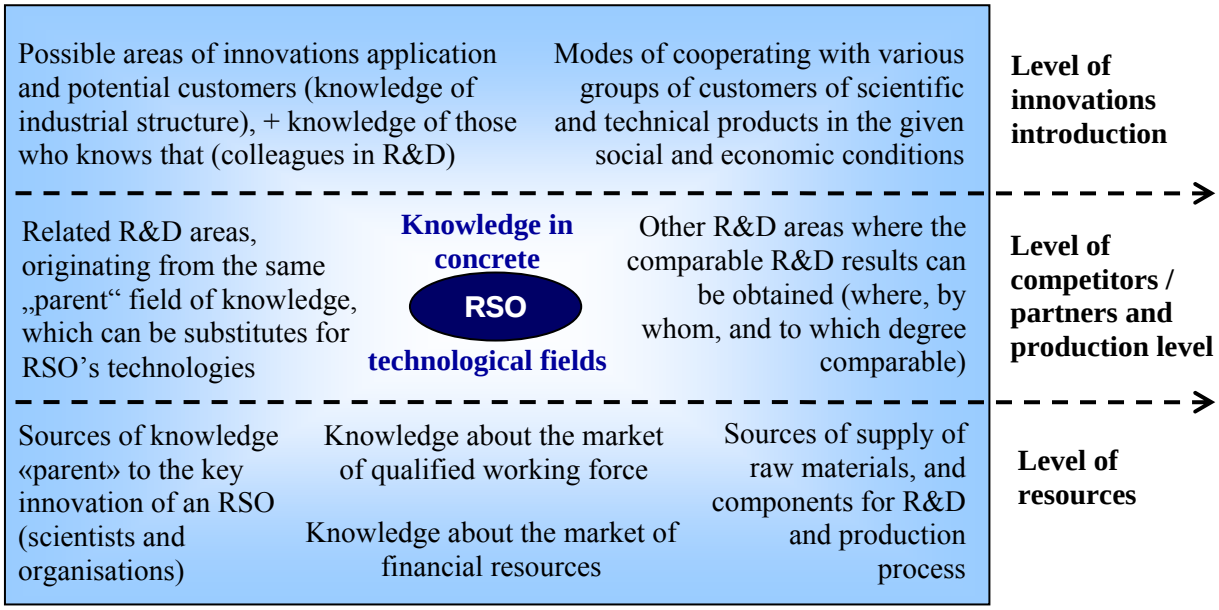

Figure 2 – Classification of knowledge and competences of RSOs

Local knowledge base is important for RSOs because the products of RSOs are not the mass demand goods but the highly specialised on users technological solutions. From the economic viewpoint the local knowledge of RSOs can be classified by stage of innovation

process organisation on three levels (Pobol, 2005b): resources; competitors and partners of manufacture; level of innovations introduction (more detailed on figure 2). Both the base of contacts with industry and science matter. The large part of commercial success of RSOs is preconditioned by that the managers know, which enterprises due to specificity of their manufactures can be potential customers and suppliers, and where in the scientific community the highly qualified experts for scientific consultations can be found. Especially on the early stages of lifecycle RSOs depend strongly on informal social links, which develop most intensively within limited geographical space.

The type of the innovative technology itself decides a lot about its potential market. Some technologies (as „general purpose technologies“) have a global implication. As shown by Carlaw and Lipsey (2002), technological complementarities from such technologies are very diverse, enhance each other, and make an important mechanism of cumulativeness of economic development. The possibilities they open make their diffusion in the world only a question of time.

However, there also exist the firms, which specialise on technological solutions of another type. Such technologies «suit the technological profile» of demand of only localised market characterised by definite technological structure of industry; equipment and technical infrastructure which are not always corresponding to international standards, poor technological qualification of workers and «severe exploitation conditions».

For example. one of respondents (RSO) has completely superseded western competitors from the market niche, though competitors have a much more multipurpose product than the respondent. RSO’s success was determined by that «there have been too many buttons and levers which need to be pressed correctly. Our workers at factories could not use them correctly, - if the equipment does not work, they fist it in a hope that it will start working after that. Logically enough, expensive western equipment was broken very quickly“. The responding RSO has developed an installation that has provided the same resulting product, but the level of automation and informatisation of it was lower, allowing the workers to operate the equipment with just a few buttons.

Operational characteristics are another kind of competitive advantage: «Our factories inherited from the Soviet period are rather cold. During the big frosts they have been heated poorly, and the installations of the western competitors who were not assuming that the temperature in the shop will fall lower than minus 5, have frozen, whereas our installations endure the temperature up to minus 40».

For another market, probably more developed one, technological solutions successful at the local market might be completely useless, not suiting the technological profile of the economy. Thus, *the markets of both resources and products of scientific and technological firms can be (geographically) specialised by complexity*. That means that outside certain markets some resources can be unavailable, technological products can be unclaimed and RSOs specialised on them can be inefficient.

Last but not least, efficiency of RSOs is tightly connected to *technological partners*. The process of knowledge production in high-tech areas strongly depends on achievements of other high-tech areas (nanotechnologies, vacuum technologies etc.). Highly qualified experts in new technological areas are objectively rare. Because of specialisation of labour and R&D among republics of the former Soviet Union, firms with highly qualified experts in new technological areas are oligopolistic. Also the networking and clustering in highly specialised

high-tech areas takes place between innovators-oligopolists, which, on one hand, restricts the number of competitive firms, and on the other limits the opportunities of technological partnerships aimed at mutual growth.

Conflicts of economic interests as factors influencing RSO's growth

Orientation and goals of RSO's internal decision-makers as well as the economic interests of external actors which intensively interact with RSOs in the innovation process and at the market play the tremendous role in the direction, speed and mode of RSOs growth.

The first decades of existence of RSOs as new forms of the innovation process organisation in all countries have been accompanied by economic conflicts of them with traditional subjects of the innovation process (Popovich, 2006). One has to acknowledge that this is an objective historical regularity of economic development which always exerts when system-wide transfer of property rights to strategically important economic resource (in case of RSOs – intellectual capital) takes place. Our in-depth research has shown that the emergence of RSOs as an institute itself is a result of conflict of interests between industrial enterprises and academic science concerning strategic targets of activity, R&D directions and terms of order execution.

Distinguishing features of economic interests in concrete sector are preconditioned by the objective conditions of production and by degree to which the economic actors are conscious of their economic interests. Both objective and subjective sides of the economic interest influence the shaping of economic relations (Kanapukhin and Haustov, 2004).

At the market of technologies the number of consumers on the market can be low as well as the number of producers; that is why some players have the market power and can affect the market price. The other objective feature of this market are the knowledge externalities (knowledge spillovers), which re-distribute the benefits from innovations and affect the strategies of innovation process participants.

Objective conditions of science-intensive production require combination of intellectual property resources with other resources in the dynamics of knowledge development, as well as tight interaction between RSOs and other actors of the national innovation system. The multiplicity of participants of these interactions often causes the conflicts of goals.

Relative youth of the RSO sector, the absence of specialised education of the innovative managers, underdeveloped institutional framework for the non-linear model of the innovation process precondition that not always the parties that interact in the innovation process are conscious of their own and each others necessities, goals and economic interests. As a result, the resolution of conflicts of interests often takes place with low efficiency and upon conditions that are non-optimal in terms of resources allocation in the economy.

In line with the new institutional theory of the firm, RSOs aim at profit maximisation only as a particular case; especially in the long run targets of RSOs differ.

Tactical targets of RSOs are survival and achievement of favorable economic results. Achievement of these targets requires from RSOs solution of the following tasks: 1 - preservation of internal stability and viability of the firm; 2 - creation of product with characteristics demanded by the market; 3 – introduction to the market of demanded

technological processes; 4 – provision of these technological processes with properties required by the market.

Strategic goals of RSO differ depending on internal potential of technology core to RSO. They are formed with account of possibility of attraction by firm of resources for expansion. For technologies novel in the world the strategic goal is setting up in the world market and preservation of technological leadership. For technologies with insignificant novelty level the strategic goal can include setting up in the local market, entrance to the less developed markets, establishment of subcontracting relations with transnational corporations or joining the formal structure of the large company. However, the long-term survival of scientific and technical firms always requires interaction with sphere of science and maintenance of key competence at the advanced scientific level.

Specificity of economic interests of RSO founders is determined by the ownership form of the enterprise and the specificity of its activity.

Because the entrepreneurs founding RSOs are also the developers of technologies, their interests are not limited to profit maximisation. They also include the scientific curiosity; the parental relation to created technologies and the desire to observe the further fate of innovations; the need to provide themselves with conditions for R&D. Often these goals contradict to each other.

Besides, the owners of RSOs might include the state; private stakeholders not involved into R&D activity; venture capitalists; other companies which have made direct investments. Each of these types of actors is characterised by specific economic interests.

The *state* can participate in the RSO's statutory fund being interested in promotion of the young enterprise with innovative technologies by rendering of primary support and divestiture from participation in the operative management. The other interests can include the motivation of the state to preserve the strategic control over breakthrough technologies, technologies which provide productivity growth in various industries; technologies with large export potential; the need to guarantee the availability in the country of scientific and research capacities for manufactures which make the background of the national industry.

The conflict of interests of state with private owners of RSOs can emerge due to ambition of the state to influence the choice of customers, pricing, technological direction of firm's development. The efficient schemes of solution of this conflict are based on understanding of sources of efficiency of RSOs as a form of innovation process organisation, and on understanding of justification of state intervention preferably only in case of market regulation deficiencies.

Worthwhile mentioning, many RSOs in Belarus have been grounded as state enterprises (investments of parent state scientific organisations have been made to the RSO's capital). However, it was private initiative of innovators which has led to firms' foundation. Most of such firms are state companies only nominally; in fact the parent organisations delegate the main functions to innovators who have been hired by the state as RSO managers. This leads to personalisation of responsibility and increases the flexibility of management and production organisation.

Private stakeholders not involved into research activities as well as *venture capitalists* who invest capital at the early, high-risk stages of the innovative firm's development, are

usually interested in rapid manifold growth of RSO's value. Their strategy than usually consists in concentration of resources on the rapidly growing markets and following withdrawal from the firm through sale of stocks with a grown value to the interested companies or through the stock market. This does not decrease the assets of the grown innovative firm and actually coincides with the interests of profit maximisation shared by all stakeholders of an RSO. However, the scheme itself of firms value monetisation through sale of its stocks to *competitors* can significantly interfere with the goals of RSO's founders (innovators) concerning the activity profile, expansion of their niches at the markets etc.

Specificity of science-intensive products makes RSOs to look for specific means of realisation of their economic interests by cooperation with other science-intensive enterprises (which can be potential competitors) or binding customers to RSOs. In interaction with other participants of the innovation process a number of other conflicts arise.

Example is the *conflict of interests between industrial enterprises and RSOs concerning transfered knowledge.* The rationally acting customer enterprises that introduce the innovative technology or equipment seek to decrease their dependence on oligopolistic innovators by means of learning. The rationally acting RSOs seek to hold the customers by passing them only some links from the technological chain and by retaining control over the key fields of knowledge. This contradiction is resolved by adding to the agreement of conditions about technical support of the introduced technology and about customers training. At the macrolevel these interests lead to acceleration of growth of customers innovative capabilities, make customers demand more aware and sophisticated, stimulate acceleration of scientific and technical progress and shortening of the final stages of the innovation process.

Conclusions

Main findings of the paper can be summarized as follows.

On the macrolevel the general state of RSOs sector in the country depends on the size of economy itself, on the strength and specialisation of the national innovation system.

On the microlevel the undertaken study has allowed allocating three primary groups of factors influencing the direction, speed and mode of growth of research-based spin-off enterprises: specific nature of RSO's activities and products, demand side and supply side. Some of these factors along with those commonly discussed in the literature include:

Specificity of RSO's activities and products: growing R&D expenditures for science-intensive products and services; capital intensiveness of firms' expansion in certain sectors; knowledge increment in value added by RSOs in most orders.

Demand and the volume of market: solvency of demand of RSOs customers (industrial enterprises) in transitive countries; multiple costs for introduction of the new technology and mastering of it in comparison with costs of technology purchase; quality of demand (level of technological competence of customers).

Resource base of the company and availability of capital (supply side): availability of qualified researchers; operating legislative base for protection of intellectual property rights; availability of resources for innovations promotion and marketing; availability of venture capital; mechanisms of state support; networks of interaction and possibilities of sourcing resources from other economic actors.

The major factors which shape the geography of RSO's market include: presence, complexity and solvency of demand in the market; entry barriers to technological area (e.g., required qualification and costs of equipment); customers' level of advancement and their specialization; proximity of receptive local or neighboring market and oligopolistic character of demand; market structure and firm's consciousness of its future changes.

Important factors which restrict the efficiency of RSO at local markets include local knowledge of specific characteristics of the domestic market, geographical differentiation of markets on complexity and structure, and tight connection to technological partners.

A special attention among factors impacting the growth trajectories of the knowledge-based companies should be paid to economic relations inside and around them. We argue that orientation and goals of RSO's internal decision-makers as well as the economic interests of external actors which intensively interact with RSOs in the innovation process and at the market play the tremendous role in the direction, speed and mode of RSOs growth. The conflict of interests between industrial enterprises and university and academic science concerning strategic targets of activity, R&D directions, terms of order execution is a source of RSO emergence as an institute. Main conflicts of interests include those of RSOs with industrial enterprises concerning transfered knowledge; RSOs with foreign actors concerning distribution of the property rights in case of joint activity; RSOs with parent organisation concerning distribution of intellectual property rights on R&D results.

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