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CONCEPTUAL MODEL OF FACTORS DRIVING THE INNOVATIVE IT CLUSTER DEVELOPMENT

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In the paper, the insights of the concepts on innovative clusters; national innovation systems; networks theory and institutional economy are used to further elaborate the toolbox for studying and fostering the innovative clusters. A set of additional criteria for measuring the qualitative characteristics of development of an innovative cluster along the stages of its lifecycle and an extended conceptual model of factors driving the innovative cluster development specifically for the IT industry are suggested. This model extends over the existing models by delineating the qualitative characteristics of demand such as demand sophistication, risk-tolerance and innovativeness; specific resources such as networks and professional services; multiple factors of the industry structure such as critical mass of enterprises and employment, degree of specialization, advanced business practices and innovative business models and factors of qualitative shift such as tacit knowledge and R&D results. Attention is put to informal linkages; service infrastructure factors and institutional environment as well. The role of cluster-forming agents in the cluster development is specified. The suggested model can be used as a framework for elaborating the strategy of IT cluster development and for refining the list of appropriate policy measures.

Key words: innovative cluster; institutes; networks; lifecycle; information technologies.

КОНЦЕПТУАЛЬНАЯ МОДЕЛЬ ФАКТОРОВ РАЗВИТИЯ ИННОВАЦИОННОГО ИТ-КЛАСТЕРА

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Разработан набор критериев, позволяющих измерить качественные характеристики развития инновационного кластера по стадиям его жизненного цикла, представлена расширенная концептуальная модель факторов развития инновационного кластера для ИТ-отрасли. Последняя отличается от существующих моделей определением качественных характеристик спроса (сложность, риск-толерантность и инновационность спроса), специфических ресурсов (сети и профессиональные сервисы), ряда факторов структуры отрасли (критическая масса предприятий и занятости, степень специализации, передовые бизнес-практики и инновационные бизнес-модели), факторов качественного сдвига (неявные знания и результаты исследований и разработки). Уделено внимание неформальным связям, факторам сервисной инфраструктуры и институциональной среде. Уточнена роль кластерообразующих агентов в развитии кластеров. Предложенная модель может быть использована в качестве основы для разработки стратегии развития ИТ-кластера, а также для уточнения перечня соответствующих мер политики. В целях дальнейшего развития инструментария изучения и стимулирования развития инновационных кластеров используются наработки концепций инновационных кластеров, национальных инновационных систем, теории сетей и институциональной экономики.

Ключевые слова: инновационный кластер; институты; сети; жизненный цикл; информационные технологии.

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Introduction

In most transitive economies, creation and development of innovative clusters is relatively high in the political agenda today. Yet, by now, the understanding by policy-makers of the main principles of emergence, functioning and development of such clusters is insufficiently developed.

Typical for policy-makers is the assumption that clusters as agglomerations of innovative enterprises will automatically emerge after application of a 'proper' set of cluster policies tested by other countries. However, developing an innovative cluster is much more difficult than importing the foreign cluster policies that have exhibited the best performance abroad. Numerous case studies of clusters in Cambridge, India, Malaysia etc. confirm that even in the same industry, clusters formation is such a peculiar process that a single business model and even the set of best foreign policy practices will rarely produce the intended cluster growth, because of specific national institutional conditions, resource base and mentality; institutional and system deficiencies. In this paper, some tools are suggested for a detailed analysis of factors important at different stages of cluster development specifically in IT industry.

Theoretical and empirical background

The paper leans on the four conceptual streams of economic thought: innovative clusters; national innovation systems; networks theory and institutional entrepreneurship.

We refer to the classic definition of innovative clusters understood as "a geographical proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and externalities" [1]. In the last decades, the scholars have made substantial efforts in identifying the driving forces of clusters development [2–4]. This work is mostly driven by observation of practical experiences on how the clusters function and perform. Impressive initiatives are undertaken in US and EU for mapping the clusters and elaborating the best practice for fostering their development [5–10].

Since the diffusion of innovations has received attention as a driver of economic development of a country in 1960s [11; 12], the role of *social networks* for cluster development was widely studied and their high importance was recognized by scholars in 1980–90s, since they build trust [13], inspire the diffusion of innovations [14] and organizational practices [15] and create new markets [16]. The impact of networks is so high that the network forms of organization were acknowledged to be an alternative to markets and hierarchies [17–19].

The theory of *national innovation systems (NIS)* helps explaining how the specific national institutional structure affects the dynamics of innovation processes. The NIS theory has deeply integrated the rationale of the institutional theory by describing the structure of each national innovation system through the prism of nation-specific institutions for knowledge generation, diffusion, exchange and employment [20–22]. One of the core statements is that at a country-level these institutions may have some national peculiarities that do not prevent these institutions from fulfilling their knowledge-related functions. Besides that, NIS-scholars argue, that national innovation systems can perform below their potential output (of learning, knowledge, innovation etc.) because of so-called in-efficiencies and ineffectiveness, when innovation-related actors and institutions fail to fulfill their innovation-related functions. The sources of institutional inefficiency (understood as a gap between observed effectiveness and existing better levels of performance observed in equivalent organizations working in similar conditions) include: organizational inertia; poorly defined contracts and information asymmetry; lack of required training routines. X-effectiveness (the extent to which institutions achieve their organizational missions) can suffer from the lack of appropriate internal resources to achieve the mission and the lack of resources in the system [23]. The frequency of institutions' malfunctioning observed in real life serves as justification for the state intervention into the innovation sphere in form of national innovation policy that aims at elimination of these failures and creation of favourable conditions for innovation processes in the country.

Generally, in the new institutional theory the institutes are acknowledged to get formed either by natural way (as a result of stochastic process of unintentional interactions of agents, when the accumulated changes in the social life cause the need to eliminate the contradictions, and the interactions that are organized according to some more efficient patterns gradually substitute the less efficient interaction modes [24; 25], or in an artificial way (when they are borrowed from other countries and "transplanted" into the economy, or when they are "projected" by the governmental authorities that seek to regulate the economic relations and lower the uncertainty in the economic system) [26]. In the more recent literature, a conceptual view of the so-called "institutional entrepreneurship" has emerged which considers individuals and businesses as agents of institutional change [27–30].

Our empirical background is based on the in-depth qualitative study of software engineering business cluster in Belarus undertaken by the author and the association of software developers "Infopark" in 2010–2011. It was followed by a series of complementary studies of particular sectors and dimensions in 2013, 2014, 2015 and 2016.

Research methodology included conducting interviews with IT companies, largest customers, regulating bodies, experts from management and employees of the association of software developers, desk-analysis of primary data from websites of IT companies, materials of specialized IT conferences and forums of IT specialists.

Structuring the conceptual model of factors driving the IT cluster development

The initial model of business cluster by Michael Porter [1] includes the following key factors of cluster competitiveness (Porter's Diamond): demand conditions; factor conditions; firm strategy, structure and rivalry; related and supporting industries.

Specifically for export-oriented industry of software engineering, Heeks and Nicholson [2] highlighted the integral factors of its development:

- *driving forces*: demand from the world market, the national idea and strategy of the government sector;
- *factors that ensure the implementation of development*: the characteristics of the software industry (clusters, competition, cooperation), resource and infrastructure factors of the domestic market (human resources, technology, finance, research and development etc.);
- *factors that provide conjunction*: international relations and trust.

In order to capture and gain control over the guiding forces of cluster development, the scholars have made substantial efforts in understanding the nature of an innovative cluster. Menshenina & Kapustina [31] have distinguished the following necessary characteristics of a genuine cluster: geographic concentration; a wide range of participants and the presence of a "critical mass"; specialization; the linkages and interactions between the participants of clusters (firms in the cluster must be related in some way) including vertical links (chains of purchases and sales) and horizontal links (additional products and services, similar specialized costs, usage of similar technologies and institutions); social relationships or networks that produce benefits for the companies involved; competition and cooperation; innovation (competition as an incentive and cooperation as an opportunity to innovate); life cycle.

The last characteristic of an innovative cluster (its life cycle) implies that the cluster is not a machine put into operation when ready and tested, but rather a living organism passing through the stages of agglomeration, emergence, development, maturity and transformation. That is why, besides the criteria applied by the European Cluster Observatory [8] to identify the existence of a cluster and rank its size, we suggest a set of ***criteria to measure the qualitative characteristics of development of an innovative cluster along the stages of its lifecycle***.

Indicators of the *developing stage* of the cluster lifecycle are as follows:

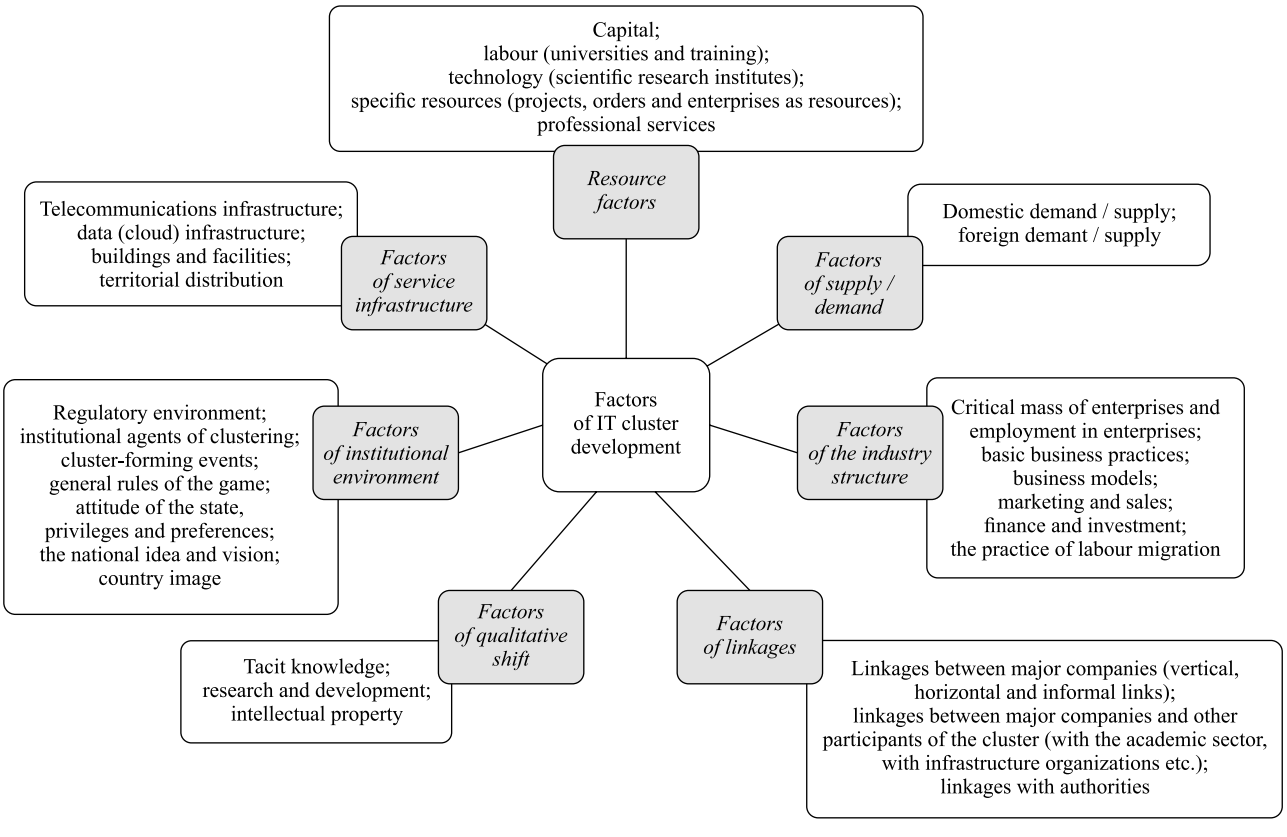
- different forms of interaction between the participants of the cluster emerge;
- the number of participants in the cluster tends to increase;
- there are examples of regular contacts among some members of the cluster;
- the association of companies in the cluster is growing;
- core members of the cluster can be distinguished;
- original rules of the game and the rules of interaction between the companies, including moral and ethical standards of behaviour in the market emerge;
- cluster's companies are aware of belonging to the cluster;
- a cluster brand has emerged and marketing activities for the whole cluster have been launched.

Indicators of the extent to which cluster has achieved a *mature stage* of its life cycle are:

- the cluster has reached a critical mass of resources;
- there are many companies in the cluster;
- the internal competition between companies is high;
- cluster companies include several groups: end-manufacturers; suppliers of components, suppliers of raw materials and services; distribution agents; manufacturers of byproducts;
- both the core and associated production are well developed and balanced;
- cluster companies have imitators in the country and abroad;
- the environment is conducive to the emergence of new enterprises (start-up, spin-off) and joint ventures;
- the level of trust in the cluster is high; there is cooperation between enterprises that produce the same or very similar product (are direct competitors);
- collaboration in joint projects within cluster is high;
- different types of business relationships and different types of linkages among businesses and other organizations are practiced;
- more than one institutional structures are available to maintain cooperation among cluster companies;
- specialized services for cluster companies are well developed and balanced;

- processes of providing specialized services to cluster companies have become routine;
- cluster operates with a synergistic effect;
- research and innovation potential of world-class is available;
- the cluster is characterized by self-awareness;
- there is a recognition of the advantages of belonging to this cluster from outside (in other industries and other countries);
- there are advanced cluster communication in the environment, with other clusters, activities, regions.

Building on numerous classifications of cluster competitiveness factors and acknowledging the cluster's capacity to dynamic development over its lifecycle, we have elaborated an ***extended model*** of the innovative cluster development factors specifically for the IT industry (see figure).



An extended model of IT cluster development factors
(source: adapted from [32])

This model extends over the existing models:

1) by delineating the qualitative characteristics of *demand* (inspired by the concept of domestic markets by Linder [33] that was further integrated into the concept of national innovation systems. The solvency of demand and its budgetary limitations are only the primary conditions to cover the costs of supply of new technologies. However, such advanced characteristics of demand as the sophistication of demand (the complexity of requirements to software developers), and its risk-tolerance and innovativeness (ability to test innovative solutions and change the internal business processes if needed) that genuinely lead to development of supply in terms of quality and value added;

2) delineating specific *resources* as networks and professional services as additional types of resources used by software engineering companies;

3) delineating multiple factors of the *industry structure*. Critical mass of enterprises and employment in enterprises provides its ability to accomplish large-scale projects and guarantees the vitality of the cluster even if some companies disappear. High degree of specialization of companies facilitates them finding their specific market niche and increase of productivity. Advanced business practices and innovative business models applied by companies lower their costs, including transaction costs, and create new development opportunities;

4) delineating factors of *qualitative shift*. Tacit knowledge (non-codifiable know-how) diffusion across the cluster is important equally to transfer of codified research and development (R&D) results and registered

intellectual property assets. Alltogether, these assets inspire the transformation of quantitative achievements of companies into the qualitative shift in the quality of their products and services and their market vision.

We put particular attention to networks, cooperation and informal *linkages* that are the "glue" needed to produce the synergetic effects in an innovative cluster and to pipeline the positive externalities like knowledge spillovers [34; 35].

Among *service infrastructure* factors, it is important to study the infrastructure used as a service delivery channel between suppliers and final customers, including both the Internet access, data storage infrastructure (cloud facilities), and availability of portable devices able to use the value proposition from software companies (smartphones etc.).

Institutional environment is analysed in this model not only through a prism of regulatory environment including privileges and preferences for innovative businesses. It is acknowledged that institutional agents of clustering play a leading role in facilitating the cooperation and networking among the otherwise competing companies and in the evolution of regulatory environment. The other important characteristics of institutional environment include transparent rules of the game and informal codes of behaviour in business-customers-state relations; the attitude of the state embodied in the practices and mechanisms of private-public partnership; national idea and vision of the clusters' value; an international image of the country.

Practical application of the model

Using the innovative approach to measure the ***cluster development*** along the stages of its lifecycle, we have identified that Belarusian cluster of software engineering is currently in between the developing and developed stages of lifecycle. The remarkable fact about this position is that the cluster did not develop evenly according to the textbook description of cluster lifecycle stages.

It was found that though some characteristics of the developing cluster are still not achieved, already over 40 % of characteristics of a mature cluster are evident in Belarusian IT cluster. Both the underdevelopment of some characteristics, and the accelerated development of the other ones have been a consequence of systemic imbalances between factor markets of labor and capital, which IT companies in Belarus had to cope with.

For example, the number of IT companies is large enough, but their critical mass is not achieved yet due to fast speed of technological progress. The formal institutional structures are present that directly focus on implementation of the needs of cluster members and transmit their interests in the related industries; the common rules of the game get elaborated and accepted by IT-companies; networks with foreign clusters are institutionalized and become regular; however, the sense of identity of cluster, is yet not common among all the businesses that constitute the cluster.

As a next step after identifying the stage of development of the IT cluster in Belarus, we have applied our extended model of IT cluster development factors to perform a qualitative analysis on strong and weak sides, opportunities and threats for the IT cluster development. When performing the SWOT analysis of IT cluster, we kept in mind the specifics of the clusters' lifecycle. The SWOT analysis has revealed a number of system deficiencies and institutional gaps which are intrinsic to the economic system of Belarus and constrain the further application of the traditional Silicon Valley model of cluster development. On the other side, it has revealed the unique opportunities that make software engineering cluster in Belarus another specific type of business cluster. As a result, this model has proved its usefulness as a framework for elaborating the strategy of IT cluster development and for refining the list of policy measures appropriate for support of particular cluster.

This study has also allowed specifying the ***role of cluster-forming agent***.

A genuine innovative cluster cannot emerge just by signing a decree on establishment of a cluster and allocation of funding. Its evolution requires sustainable efforts of competent and devoted agents and institutional structures that are able to generate partnerships among competitors, unite experts from different organisations, coordinate and align the activities of actors who have conflicting interests, nurture the trust among the businesses and bring up the innovative spirit in the market and by regulating authorities.

Rather than a set of companies, an innovative cluster is a set of linkages among companies, academic community and government. The diversity of these linkages is necessary for unfolding of positive externalities as network effects and knowledge spillovers that are critically important for cluster development. The agents bringing up these linkages are driving the cluster development.

The regular activities of cluster-forming agent (thematic annual conferences, seminars, expert communities) target at consolidation of IT companies and formation of vertical (subcontract), horizontal (cooperation), and informal (non-market) linkages among businesses. For example, the annual conference BankIT organized by Scientific and technological Association "Infopark" attracts over 1300 participants from banks, IT companies and academy and serves as a main event for developing the existing and new partnerships in the sector of financial information technologies.

The cluster-forming agent is promoting the cooperation of businesses with academic organisations and universities by organizing thematic scientific research studies, promoting the establishment of joint research laboratories of IT companies and universities and advancing the solution of systemic problems in IT education.

The cluster-forming agent also serves as a driver of private-public partnership development among IT companies and the government. In the case of Belarusian IT cluster, the core cluster-forming agent has elaborated a set of efficient tools helping to reveal common problems preventing the development of IT companies in a cluster, including the legislation gaps, to awaken the understanding of regulating bodies of how these problems hamper the economic development, and to launch a negotiations platform uniting the state and the businesses. The regulating bodies also approach it for expertise and consultancy when making decisions impacting the development of IT industry.

Finally yet importantly, the role of cluster-forming agent in the development of cooperation with international organisations needs to be mentioned. In case of Belarus, Infopark was the author and initiator and is the main driver, facilitator and Belarusian partner of the initiative "Harmonising Digital Markets in the Eastern Partnership" with European Commission, helping to bridge the IT clusters of Eastern Partnership countries with EU. Infopark is also acting as a driver of digital transformation and harmonization of digital markets within Eurasian Economic Union.

These functions can be split among several specialized institutional bodies in case if dedicated budgets and human resources are available. However, the main requirements to cluster-forming organization(s) are:

- *efficiency* – the solutions implemented should lead to real increase in productivity and efficiency of IT cluster;
- *focus on changes* – the agent should have the systemic vision of perspectives, barriers and needed solutions for IT cluster development;
- *implementation power* – ideas and decisions should be applied on practice;
- *special status in the system* – the agent should be independent from government and represent the interests of the wide IT business community, academic and educational sphere.

Conclusions

Using the notions of innovations, networks and institutions has allowed to specify the factors driving the development of an innovative cluster throughout its lifecycle. Acknowledging the cluster's capacity to dynamic development over its lifecycle, has allowed to elaborate an extended model of the innovative cluster development factors specifically for the IT industry.

This model can be applied to analysis of any national IT cluster, because it embraces the whole set of cluster characteristics at various stages of development (not only that of mature clusters), and simultaneously takes cognizance of specific national factors like specific institutional environment. This model provides the framework for determining the special conditions of fostering particular innovative clusters and can serve as a toolbox for building the national cluster development strategies beyond the classical Silicon Valley model. In particular, for transitive economies we suggest a hybrid Silicon Valley model of innovative clusters development in between the exogenous approach of foreign direct investment and the endogenous approach of incubation and technology transfer from local sources.

Another focus of this paper was on the role of cluster-forming agent. As practical experience of IT cluster in Belarus shows, evolution of an innovative cluster requires sustainable efforts of competent and devoted agents and institutional structures that are able to generate partnerships among competitors, unite experts from different organisations, coordinate and align the activities of actors who have conflicting interests, nurture the trust among the businesses, bring up the innovative spirit in the market, serve as a driver of private-public partnership among cluster companies and the government.

References

1. Porter M. E. The Competitive Advantage of Nations. New York, 1990.

2. Heeks R., Nicholson B. Software export success factors and strategies in developing and transitional economies. IDPM Working Papers. Manchester, 2002.

3. Sölvell O. Clusters. Balancing Evolutionary and Constructive Forces. Stockholm, 2008.

4. Birukov A. Formirovanie innovatsionnykh klasterov v vysokotekhnologichnykh otraslyakh promyshlennosti [Formation of innovative clusters in high-tech industries]. Moscow, 2009 (in Russ.).

5. Sölvell O., Lindquist G., Ketels C. The Cluster Initiative Greenbook. Watertown, 2003.

6. Andersson T., Serger S. S., Sörvik J., et al. The Clusters Policies Whitebook. Malmö, 2004.

7. Desrochers P., Sautet F. Cluster-Based Economic Strategy, Facilitation Policy and the Market Process. *Rev. Austrian Econ.* 2004. Vol. 17, issue 2–3. P. 233–245. DOI: 10.1023/B:RAEC.0000026833.26220.2d.

8. Europe Innova Cluster Mapping Project. Cluster policy in Europe. A brief summary of cluster policies in 31 European countries. Kristiansand, 2008.

9. Arthurs D., Cassidy E., Davis C. H., et al. Indicators to support innovation cluster policy. *Int. J. Technology Management.* 2009. No. 46. P. 263–273.

10. European Cluster Alliance: Improving the cluster infrastructure through policy actions. 2009. URL:www.proinno-europe.eu/eca (date of access: 10.02.2017).

11. Rogers E. Diffusion of innovations. New York, 1962.

12. Coleman J. S., Katz E., Menzel H. Medical Innovation: A Diffusion Study. Indianapolis, 1966.

13. Piore M. J., Sabel C. F. The Second Industrial Divide. Possibilities for Prosperity. New York, 1984.

14. Saxenian A. The Origins and Dynamics of Production Networks in Silicon Valley. *Res. Policy.* 1991. No. 20. P. 423–437.

15. Davis G. F. Agents without principles? The spread of the poison pill through the intercorporate network. *Adm. Sci. Quarterly.* 1991. Vol. 36, No. 4. P. 583–613.

16. Granovetter M. Economic action and social structure. The problems of embeddedness. *Am. J. Sociol.* 1985. Vol. 91, issue 3. P. 481–510.

17. Powell W. W. Neither market nor hierarchy. Network forms of organization. *Res. in Organ. behav.* 1990. Vol. 12. P. 295–336.

18. Titov L. Y. Ekonomicheskie innovatsionnye struktury i instituty setevogo tipa: teoriya i metodologiya [Economic innovative structures and network-type institutes: theory and methodology]. Orlov, 2011 (in Russ.).

19. Borgatti S. P., Halgin D. S. On Network Theory. *Organiz. Sci.* 2011. Vol. 22, issue 5. P. 1168–1181. DOI: 10.1287/orsc.1110.0641.

20. Lundvall B.-A., Johnson B., Andersen E.S., Dalum B. National systems of innovation and competence building. *Res. Policy.* 2002. Vol. 31, issue 2. P. 213–231. DOI: 10.1016/S0048-7333(01)00137-8.

21. Carlsson B., Jacobsson S., Holmen M., Rickne A. Innovation systems. Analytical and methodological issues. *Res. Policy*. 2002. Vol. 31, issue 2. P. 233–245. DOI: 10.1016/S0048-7333(01)00138-X.

22. Nelson R. R., Nelson K. Technology, institutions, and innovation systems. *Res. Policy*. 2002. Vol. 31, issue 2. P. 265–272. DOI: 10.1016/S0048-7333(01)00140-8.

23. Niosi J. National systems of innovation are “x-efficient” (and x-effective): Why some are slow leanears. *Res. Policy*. 2002. Vol. 31, issue 2. P. 291–302. DOI: 10.1016/S0048-7333(01)00142-1.

24. Schotter A. The Economic Theory of Social Institutions. New York, 1981.

25. North D. C. Institutions, Institutional Change and Economic Performance. Cambridge, 1990.

26. Schastitko A. [Conditions and Results of Institutes’ Formation]. *Vopr. Ekon*. 1997. No. 3. P. 27–39 (in Russ.).

27. DiMaggio P. Interest and agency in institutional theory. In: L. G. Zucker (ed.). *Institutional Patterns and Organization*. Cambridge, 1988.

28. Hwang H., Powell W. W. Institutions and Entrepreneurship. In: S. A. Alvarez, R. Agarwal, O. Sorenson (eds). *Handbook of Entrepreneurship Research.* New York, 2005. P. 179–210.

29. Dorado S. Institutional Entrepreneurship, Partaking, and Convening. *Organ. Stud.* 2005. Vol. 26, issue 3. P. 385–414.

30. Canales R. From Ideals to Institutions. Institutional Entrepreneurship in Mexican Small Business Finance. *SSRN*. 17 Febr., 2011. DOI: 10.2139/ssrn.1763385.

31. Menshenina I. G., Kapustina L. M. Klasteroobrazovanie v regional’noi ekonomike [Clustering in a regional economy]. Yekaterinburg, 2008 (in Russ.).

32. Pobol A., Basko V. [Positioning the business cluster of software engineering in Belarus]. Minsk, 2011 (in Russ.).

33. Linder S. B. An Essay on Trade and Transformation. Stockholm, 1961.

34. Pobol A. Knowledge spillovers around research-based spin-offs : empirical case studies in Belarus. *Triple Helix 5: the capitalisation of knowledge: cognitive, economic, social and cultural aspects.* (Turin, Italy, 18–21 May, 2005). Turin, 2005. P. 336–338.

35. Pobol A. Subcontracting around research-based spin-off firms as a channel for knowledge distribution. *Res. in Social Change.* 2011. Vol. 3, issue 1. P. 53–73.

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