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The Institutionalization Model of Sustainable Development of Supply Chains for Innovative Products

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Abstract: The study comprises the institutionalization model for innovative products used supply chains. Developing the typology of the market power, the author mentions an alternative concept of SCM, stipulating so called "fasciculation" (variability of functioning scenario) of separate segments of supply chains. While realizing the innovative process, innovations created by the competitive institution could be sold to the industry leader or the latter places an order on R&D. The high level of innovative activity within the created institution is a stimulating factor of industry's branch-wise development.

Key words: Institutionalization model, innovative product, supply chain, macrotechnology, ecosystem, co-evolution, transaction effect, glocalization, biotechnology

INTRODUCTION

There are plenty of stimuli for enterprises to implement technological innovations. The most important one is to increase market power and the influence of it is two-way: it could occur either in the form of a new product manufacturing or improvement of productiveness for a traditional products (Birch, 2008; Burrill, 2011). Amid the broaden investigation of innovation management changes in a firm's trajectory of innovative development occur. It is conditioned by a possibility of small and big enterprise's coexistence within the macrotechnology on the same market (Glaziev, 1991; Kleinknecht, 1986). Exploitation of knowledge about the patterns of the market structure's development in terms of innovations by an enterprise results in a transformation of the business-model. These models are oriented to the prolongation of a life cycle for an enterprise and products as far as it steps over the borders of a focus firm and exploits possibilities of exchange of knowledge between internal and external environment of the firm, integrated organization of business-processes and formation of the single vector of an economic system's evolution.

Such management technologies widen the borders of classical models of the market balance as a result of appearance of new forms of interaction between enterprises in B2B and B2C sectors, virtual enterprises and network structure (Brandenburger and Nalebuff, 1998). The life cycle of these market structures is not so strictly defined by a comparison with the firm's life cycle anymore. Development of these structures is subjected to the logic and laws of evolution dynamics (Kleinknecht, 1986). At the heart of it a transition from simple to more complex forms lies, so the network structure's life cycle will not have a traditional pyramid-shaped trajectory but the signs of wave-like development.

MATERIALS AND METHODS

The theoretical base for studying of wave-like characteristics of a firm's innovative development is described within the G.B. Kleiner's approach. In this context, the institutionalization (prolongation) of innovative development, deceleration of degradation of innovative products in terms of market structures is a possibility for growth. In the network structures the potential of coherence occurring within an innovative system is high, so the focus company uses the resources of other innovative companies combined within the network (Moore, 1996; Shinkevich *et al*., 2015). Other firms are interested in development of the focus company because its low competitiveness will result in negative performance along the value added chain. Network interactions dump the negative effects of external environment preventing the firm's exit out of the network. Therewith, the network elements occupy key positions which should be stable; otherwise, the transaction costs for creation and recovery of an agent's functions which are higher in comparison with the network's additional costs for providing its prospective and

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complementary development trajectory. As a result, conditions for appearance of external network effects from transformation of the firm's life cycle and internalization of a firm-based development trajectorie's management has occurred. Transformation of an enterprise's reproduction technologies in network conditions results in new properties, first of all, increase in learning capacity (Kalenskaya *et al*., 2014). An enterprise's competitiveness within the new terms of business now more and more defined by the level of routinization of the new competence's creation process as far as resources poor setting, competitiveness increasing and crisis make actual the capabilities of the enterprise to use traditional resources at the new way and provide it's combinations with new resources resulting in addition value adding of a manufactured good. A capability to get, integrate, collect, save and apply knowledge is the most important approach to ensure the competitive advantage. Injections in such development are investment as far as it is accompanies by sustainable character of changes and the actives created within this process are unique and difficult for copying. Moreover, the knowledge synergy occurs which may be unavailable for the competitors. As a result the enterprise's actives become specific due to the integration of present knowledge with new solutions leading to new competences and knowledge creation.

RESULTS AND DISCUSSION

In comparison with investments into technological innovations, investments into knowledge are connected with capability of latter for accumulation and renewal. Such resources are subjected to obsolescence in a less degree flatting negative fluctuations of traditional cycle of firm's development. Therewith, network structures of business organization require adequate identification of network structures as economic systems in terms of a new typology of economic systems: object, environment, process and project systems. In terms of institutionalization technologies of innovative development, it is important to understand what kind of a product is incident for each type of system. Object systems provide manufacturing activity, so the products are goods and services intended for further exchange or sale. Environment systems intended to connection of object systems are oriented on providing services, transforming the quality of a created product also. For process systems the product is a synergy effect occurrence due to decrease of losses and increase in practicality for users. The product of project systems is the system's changes leading to the transformation of the product of three previous systems. Regarding to the adaptation of these approach for the system's typology for the purpose of network economy description, we conclude that the integrated form all the system's types existence is an innovative-industrial cluster.

In terms of Supply Chain Management approach which is considering economic processes as interrelation of centers of logistic activity through the flows ensuring the system's emergence principle in general, instead of independent functioning of suppliers, manufacturers and consumers. In actual fact this means the institutionalization (fixation at the branch-wise level) of movement directions of material's flow, information and technologies by the means of creation/intrusion of branch-specific innovative activity centers (clusters). Developing the typology of the market power, we should mention an alternative concept of SCM, stipulating so called "fasciculation" (variability of functioning scenario) of separate segments of supply chains and effectiveness of cross-sector flow of added value from stage to stage within the production process. Additionally, there are several modern management concepts, focused on the high level of innovative development: co-opetition model (Brandenburger and Nalebuff, 1998), entrepreneurial ecosystems and co-evolution (James F. Moore), a model of competing for the future (Gary Hamel, C.K. Prahalad).

The federal cluster initiative was adopted in 2012 by the Chairman of the Government of the Russian Federation. It comprises 25 innovation territorial clusters and five of them are focused on biotechnologies. Territorially, they belong to Moscow, Kaluga, Novosibirsk, Tomsk and Altay regions. Predominating sources of investment are federal and private funds.

Moscow and Kaluga regions are located in the European part of the country and others B in Siberia. The distance between those territories in 3500 km and it is a barrier on the way of diffusion of innovations. Within the present research, we study only two provinces in Central Russia with strong background in biotechnologies: Kaluga region (Cluster of pharmacy, Biotechnology and Medicine) and Moscow region (biotech innovation territorial cluster "Puschino).

Kaluga province hosts big assembling plants of Volkswagen, Volvo, Peugeot, Citroen, Mitsubishi and Samsung. In turn, its biotech cluster has a diversified and mature manufacturing base due to partnership with globally-acknowledged companies. Another benefit results from federal support by development institutions (Skolkovo, Russian Venture company and etc.). Among weaknesses of Kaluga's region are comparatively low number of universities and availability of qualified working force and early stage of several investment project's implementation. Kaluga region biotech cluster is quite mature and comprises >40 actors:

- 12 research organizations and 20 scientific centers
- Russian and international pharmaceutical corporates (Stada, Berlin-Chemie/Menarini, Novo Nordisk, Astra Zeneca and etc.)
- 4 industrial parks
- 2 universities and educational centers

The Moscow province sets up a transport and logistics hub stimulated by the central position in Russia and presence of transnational FMCG companies like PepsiCo, Coca-Cola, Danone and etc. Currently, the center of biotech development in Moscow region is located in Puschino City. It has favorable geographic location and reputation of strong scientific hub. Members of the cluster produce one third of all biotech products in Russia but the total volume of national output is extremely low by itself (in comparison with global corporates). The ecosystem of Puschino's cluster is performed by the following members:

- 4 big research institutions
- 7 key national pharmaceutical enterprises
- Mature educational base based on federal universities branches and
- sufficiently developed innovation infrastructure

The obvious weakness of Puschino's biotechnological cluster is in its orientation on internal linkages, so no international producers have localized manufacturing sites in this region. At the same time, Moscow city district and region historically play leading role in R&D.

Taking into account the present research's goal we would like to use Kaluga and Moscow regions as examples of vertical and horizontal models of diffusion of innovation processes described above. In turn, to illustrate matrix pattern of diffusion, we picked up the biotech cluster of Tatarstan Republic. This province is one of the most innovation-active regions in Russia. This object is also located in the Central part of Russia. Another important fact about Tatarstan is that there was the first ever biotechnological program in Russia adopted in 2010 (2 years before the national BIO-2020 started in 2012). The local Kamskiy petrochemical cluster is also included to the list of innovation territories receiving money from the Federal budget. Innovation ecosystem in Tatarstan is well-performed:

- 15 big industrial enterprises of federal importance exploiting biotechnological processes
- 5 research organizations
- 7 state universities with branches
- Special economic zone Alabuga, technolpolis Himgrad, 6 big industrial parks, 2 hi-tech IT B clusters and 2 industrial clusters-Kama petrochemical cluster and Naberezhnie Chelny automotive cluster
- Regional biotechnological program since 2010

Tatarstan's biotech cluster generally has similar weaknesses as Moscow and Kaluga's regions do. However, local administration provides organizing comfortable conditions for diffusion of innovation. Making linkages between university, government and business is understood as the most effective way for innovation growth, so we expect the growth of biotechnologies in the nearest future. To support our observation, a methodology of biotech clusters modeling was needed. The main issue was collecting data for analysis as available databases lack of sufficient data about biotechnologies in Russia. Describing clusters we agreed to use macrotechnological approach, so all necessary data could be downloaded from RNCEA database making the process easy and derived model reliable.

RNCEA-based methodology of cluster analysis: The hypothesis of our study is based on understanding diffusion of innovations as a process of knowledge exchange between well-and underdeveloped branches and regions, so it can be performed as the industrial hierarchy. It implies that every region has a specific pathway of development and industrial profile, so the study of its hierarchy (region-forming branches) would show up patterns of diffusion of innovations Cluster analysis was chosen to prepare hierarchic schemes. This instrument is provided by IBM SPSS Statistics 20.0 for Windows (Analysis→classification→hierarchic clusterization tool).

In Russia there is a special federal body aggregating all statistical data which may be used for mathematical modelling. The Russian economy is analytically performed by 27 general branches and each of them has a special alphabetic code at Russian National Classifier of Economic Activities (here and further-RNCEA):

- A Agriculture, hunt and Forestry
- A Fishery, pisciculture
- CA Extraction of fossil fuels
- CB Extraction of natural resources excluding fossil fuels
- DA Manufacture of food including beverages and tobacco

Table 1: Classificator of economic activities (RNCEA) codes describing biotechnology in Russia

Biotech's subtrajec-tory	Main activity within the international classification of biotecnology	RNCEA codes
Red	Medicine and pharma: drugs, diagnostics, vaccines, equipment	24.4 Manufacturing of pharmaceutical products within the DG Chemical industry
Green	Agriculture: genetically-modified plants and animals	A Agriculture, hunt and forestry DG Chemical industry
White	Chemical industry: enzymes, chemical substances, fuels, food and beverages	DA manufacturing of food including beverages and tobacco DG Chemical industry
Grey	Environment protection: soils detoxification, sewage treatment, used air and gases	A Agriculture, hunt and forestry DG Chemical industry
Blue	Marine technology: cultivation of aquatic organisms: technical application of processes and organisms of marine biology	B Fishery, pisciculture

- DB Textile and garment manufacture
- DC Leather manufacture, leather products and shoes
- DD Wood processing and woodworking
- DE Cellulose and paper industry
- DG Chemical industry
- DH Manufacture of rubber and plastic products
- DI Manufacture other inorganic mineral products
- DJ Metallurgy industry
- DL Manufacture of electrical equipment, electronic and optical devices
- DM Transport and equipment manufacture
- DN Other industries
- A Production and distribution of power, water and gas
- F Construction
- G Wholesale and retail trade
- H Hotels and restaurants
- I Transportation and communications
- J Financial activity
- K Real estate operations, rent and related services
- LA Municipal administration
- M Education
- N Health care and social services
- O Other services

The codes represent different kinds of economic activity and say almost nothing about its hi-tech component. In fact, the main issue we faced while data mining was pitting RNCEA classification for describing biotechnological macrotechnology because the database doesn't have a single code for biotechnology.

Before starting our research we suggested a hypothesis that hi-tech branches, (i.e., biotechnology) are based on traditional (historically) developed sectors of economy. More often than not it is true for countries, where the government initiates innovation-oriented activity. Back on cyclical nature of innovation development, (i.e., Kondratieff's waves, Glazyev's technological paradigms and etc.) we can distinguish developed countries which passed through consecutive stages of evolution during last 150 years and are moving towards knowledge-based economy. In less developed economies the lack of sufficient experience and competence in scientific and manufacturing spheres results in necessity to adopt foreign practices upon existing industries. Such activities may negatively affect normal flow of diffusion of innovations and make creative process less efficient. For example in developed countries chemical industry produces and sells substances with high value added while developing countries usually mine raw materials. This is exactly what is going on in Russia, so recommendations how to create the efficient innovation ecosystem and balance interests of all participants of the Triple Helix might be useful.

Analyzing practices of managing biotechnological industry, we figured out that the international 5-colour bases system of biotechnology codes has to be adopted for available statistics in Russia. After thorough study of RNCEA system, following codes were chosen:

- A Agriculture, hunt and Forestry
- DA Manufacturing of food, including beverages and tobacco
- DG Chemical industry
- B Fishery, pisciculture

We paired each biotechnological "color" code with corresponding economic activity (Table 1). However, there are some assumptions need to be mentioned. "Red" biotechnology is the most important "color" of biotechnology in developed countries (up to 50% of all output, Burril, 2011). However, it is underdeveloped in Russia and statistically described under a sub-sector 24.4. "Manufacturing of pharmaceutical products" within the general code DG AChemical industry. We also selected "DG" family for describing "grey" and partially "white" biotechnology, so this code is defined as the most important for future growth based on existing chemical industry in Russia. RNCEA's "A" code represents "green" biotechnology but additionally captures soil management within "grey" biotech. Turning back to "white" biotechnology we noticed that food and beverage

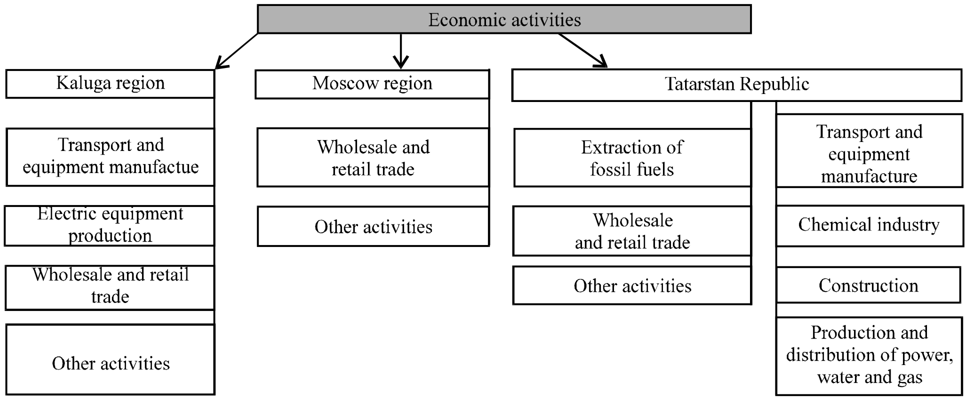

Fig. 1: An integtared scheme of industrial hierarchy in Kaluga, Moscow and Tatarstan provincein Russian Federation hosting biotech clusters

production fit to DA RNCEA code while enzymes, chemical substances, fuels are correctly put under "DG" code. The last one-"blue" biotechnology titulary corresponds to RNCEA code B Fishery, pisciculture but on practice this economic activity is not of the top priority in Russia due to cold climate. At the present moment, A (agriculture, hunt and forestry), DG (chemical industry), DA (manufacturing of food, including beverages and tobacco) are quite mature and fast-growing, so it is reasonable to consider them as acceptors of innovation in Russia. Systemizing abovementioned observations we emphasized those traditional manufacturing A, DA and DG industries to become a base for future growth of biotechnologies. As a result we create a statistical framework of Russian biotechnological complex suitable for further mathematical modeling. Moreover, through this model we moved from branch-wise to macrotechnology approach for understanding the biotechnological industry.

The methodology of hierarchic clusterization is based on selecting a pair of two closest objects forming the cluster. All input data pass through step-by-step combination of a cluster and an object or two clusters with each other. When grouping of all clusters and objects is done, a final model is derived combining clusters from previous stages. Clustering of the target object is done in squared Euclidean distances. Validity of this method is ensured by using the input data measured in similar units (A"revenue" measured in millions of rubles, year 2011, RNCEA base www.gks.ru) and have comparable order of internal values. All input values were valid and agglomeration was done in 26 steps. Results of analysis of economic linkages are performed by dendrograms.

The results of Russian biotech's clustering illustrate industrial profiles in Kaluga, Moscow and Tatarstan. Dendrograms outline several "leading" branches and a group of "other" activities with less impact on a given province's development. We put clustering results together into the scheme, where all the leading economic activities are presented (Fig. 1). The analysis revealed importance of machinery manufacturing for Kaluga region's economy; trade for Moscow region; natural resources extraction and chemical industry for Tatarstan. Thus, the ecosystem of Kaluga region could be used as examples of vertical; Moscow region-horizontal and Tatarstan Republic-matrix models of diffusion of innovations. Local producers are not ready to start manufacturing hi-tech biotechnological products. Some of them growth within multinational corporates (as Kaluga region does) or create knowledge internally (as Moscow region does). Tatarstan republic realizes another strategy by organizing comfortable conditions for diffusion of innovation. Making linkages between university, government and business is understood as the most effective way for innovation growth.

Kaluga has huge experience in automotive industry. It explains domination of "transport and equipment manufacture" and "Electric equipment production" activities in the region based on clustering results (Fig. 1). On the other hand, small and medium-sized companies provides services and outsource non-core functions which is generally covered by the "Wholesale and retail trade" category. However, we are aware of governmental initiatives to create a biotechnological cluster in the region. From the strategic point of view, it may be qualified as a transfer from the technological mode #4 to the mode #6 missing the fifth one (Mensch, 1979).

The second trade-oriented model of diffusion of innovations is applicable for the Moscow region as comes from clustering results. Thus, the province is referred as an example of the horizontal hype of diffusion of innovation. Within respect to experience in R&D and manufacturing of biotech products, it makes feasible transfer of regional biotechnology-related industries from the technological mode #5 to the stage #6. Based on clustering results, Tatarstan's economy is determined by oil-extraction and chemical industry as well as energy production, construction, equipment manufacture and wholesale. Thus, the province combines the traits of Kaluga and Moscow regions with technologies related to the modes 4 and 5. At the same time, local administration promotes innovations by investing R&D in petrochemistry, biotechnology, pharmacy and agriculture, stimulating hi-tech and innovations. In facts, the region has more chances to jump over #4 and #5 technological modes into the 6th one-technological obsolesce, low demand on R&D results and etc.

Cluster analysis on Central and Volga Federal districts outlined prospective regions for biotech industry in Russia. In fact, Moscow city and Moscow region together are heading three industry groups; Tatarstan Republic is presented in chemical and agricultural segments. Alternatively, Kaluga region does not show up within any of investigated groups due to its focus on automotive industry.

Forecasts on further development of biotechnologies in Russia are currently based on the program BIO 2020. In fact, it is expected that its output will make €5,000M in 2015 and €20 000M in 2020. Currently, it's too early to expect some real changes in products outputs after Pharma-2020, BIO-2020 and other federal initiative's implementation as they officially started 1-4 years ago.

CONCLUSION

There is a new model proposed and tested by the authors called "symmetrical market position" oriented on implantation of small and medium enterprise'ssegment into the global supply chain. At the global level this model reflects the specificity of "glocalization"-"think globally, act locally" (R. Robertson). The model is taking in account the important points: to begin with, existing asymmetry in position of transaction participants; secondly, appearance of so called "competitiveness paradox" on the global scale. A prototype of proposed "symmetric market position" concept is the dualism concept and dualistic model of market organization in the field of R&D developed by F.Scherer. Within the proposed model the author attempted to describe the initiation of the innovative process at two industrial poles, where one of them is created artificially as an institution, (e.g., a technological platform) and other is represented by an industry's leader. The symmetry is achieved by the compensation of transaction expenses and economy on scale for the competitive segment of an industry within the innovation process. The task of the created institution (a technological platform) is in providing an optimal structure to avoid a "transaction effect" (transition from investments into the "ready-to use" technologies to investments into innovations). While realizing the innovative process, innovations created by the competitive institution could be sold to the industry leader or the latter places an order on R&D. The high level of innovative activity within the created institution is a stimulating factor of industry's branch-wise development.

A modern economy should be able to continuously upgrade its dominating technologies. There are various cycle paradigms describing technology fluctuations and each of them represents a specific pattern of innovation process. Harmonized innovation ecosystems, since based on linkages between universities, government and businesses, are considered an important way for promoting innovation and economic modernization. However such ecosystems are more typical for the developed and globally competitive economies and much less for the emerging markets that are historically lagging behind. In fact, many countries including Russian Federation have a significant gap in innovation development level as compared to, say, the US or old EU-members.

In order to benefit the leaders and stimulate the weaker players, the innovation strategies for countries and regions should be locally specific with their innovation models matching the historical background and industrial structure of concrete localities. Knowledge of historical background and infrastructure features of local economies is important for elaborating customized hi-tech development programs. For those regions which lag in paradigm shifting, strong low-and medium-tech industries can serve as a basis for adsorbing hi-tech innovations through a diffusion process. Thus, diffusion of innovations occurs between leading and lagging systems, either industries or regions. In this connection, we have proposed a sectoral typology of diffusion which embraces vertical, horizontal and matrix patterns. And this typology corresponds with Glazyev's idea of different technological paradigms. We strongly believe that key traditional industries (so called "basic economic activities" in Russia) are not less important for promoting modernization and supporting economic growth than hi-tech ones.

Increased attention to health and environment protection during last decade results in rise of popularity of biomedicine and sustainable development concepts, so the knowledge-based economy is considerably dependent on biotechnologies. In the study a case of biotechnologies's support and promotion in Russian Federation has been presented. Three types of economic activities from the the national statistic RNCEA database, food, agriculture and chemical industries-were proved to be the most important ones for diffusion of biotech-related innovations. Those sectors are traditionally related to industrial modes #4 and 5 and generally may act as a base for hi-tech growth and transition to knowledge-based economy (technological mode #6).

Russian Kaluga, Tatarstan and Moscow provinces were additionally chosen to study sectoral patterns of diffusion of innovation in the sphere of biotechnologies. First of all, strong local scientific base and infrastructure are confirmed to be positively bound with promotion of diffusion. Based on clustering analysis on Central and Volga Federal districts, Moscow and Tatarstan regions are confirmed as leaders in agriculture, chemical and food products manufacturing. Based on presented observation and analysis we expect that Moscow and Tatarstan Provinces may become the first regions entering the 6th Technological mode in Russia. Unlike Tatarstan and Moscow, hierarchic analysis on Kaluga region's data revealed its competence automotive production dominates in with minor dependence on chemistry. In addition, Kaluga's companies belong to global corporates with strict internal standards and technologies. Practically, it means that there are just a few possibilities for diffusion of biotechnology-related innovations in Kaluga region.

In conclusion, Russian biotechnology still has minor position within national economy output. It is also true for global market. However, there are some opportunities for the growth of biotechnologies in Russian Federation determined by its scientific and industrial background. Based on proposed typology of diffusion of innovation and methodology of its modeling in different industries and regions, we expect biotechnology to become a key industry in Russia.

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