МЕЗОУРОВЕНЬ ЭКОНОМИКИ: ТЕОРЕТИЧЕСКИЕ ОСНОВАНИЯ И МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ¹,²

КРУГЛОВА МАРИЯ СЕМЕНОВНА,
младший научный сотрудник
Центра эволюционной экономики
Института экономики РАН,
e-mail: mashakruglova999@gmail.com;

ВОЛЫНСКИЙ АНДРЕЙ ИГОРЕВИЧ,
младший научный сотрудник
Центра эволюционной экономики
Института экономики РАН,
e-mail: ava3003@hotmail.com;

КИРИЛЮК ИГОРЬ ЛЕОНИДОВИЧ,
младший научный сотрудник
Центра эволюционной экономики
Института экономики РАН,
e-mail: igokir@rambler.ru

В статье представлен ретроспективный анализ развития мезоэкономической идеи от первого упоминания этого термина в научной литературе (Wittfogel, 1962) до опубликованных в настоящее время исследовательских работ. Выделено три основных направления понимания мезоуровня в современной англоязычной неортодоксальной экономической литературе: неошумпетерианская интерпретация, эволюционный подход и неоинституциональная трактовка. Нами рассмотрены все три направления, показаны взаимосвязи, сходства и различия между ними. Выявлено основное различие между англоязычными и русскоязычными традициями мезоэкономических исследований. Для англоязычных авторов характерной особенностью является внимание к задаче преодоления принципов методологического индивидуализма в экономических исследованиях, что необходимо для понимания процессов институционализации правил взаимодействия между экономическими индивидами. Напротив, рассмотрение российскими или, точнее, постсоветскими экономистами мезоэкономических тем было обусловлено историческими реалиями перехода от советской плановой экономики к рыночной экономике постсоветской России, характеризовавшимся эффектом распада связей между экономическими субъектами.

¹ Исследование выполнено в рамках государственного задания для ФБГУН Института экономики РАН по теме «Феномен мезоуровня в экономическом анализе: новые теории и их практическое применение».
² Доклад был представлен на 30-й конференции Европейской ассоциации эволюционной политической экономии (EAEPE) в рамках совместной сессии «Экономика и мезоэкономика сложности: решение проблем и противоречий современного сложного мира (Special JAES and RA Q)», Ницца, 6–8 сентября 2018 года; и на XII Международном Пущинском Симпозиуме на сессии «Актуальные проблемы мезоуровня экономики». Пущино, 21–23 сентября 2017 года. Авторы благодарны доктору В. Эльснеру и доктору Т. Хейнриху за критику и ценные комментарии.
In the paper we will present a retrospective analysis of the development of the mesoeconomic idea from the first mention of the term in research literature (Wittfogel, 1962) to research papers now being published. Three main trends of meso level understanding in modern English language heterodox economic literature can be identified: the Neo-Schumpeterian Interpretation, the Evolutionary Approach and Neo-Institutionalism. The paper will consider all three trends with a consistent approach, showing the interrelations, similarities, and differences between them. The analysis shows the main difference between the English-speaking and Russian-speaking traditions of mesoeconomic research. For the English-language work a typical feature is reflection on the need to overcome methodological individualism in economic research, to better understand the emerging processes and the institutionalization of the rules of interaction between economic individuals. The consideration by Russian or, more precisely, post-Soviet
economists of mesoeconomic topics has been conditioned by the historical realities of transition from the Soviet planned economy to the market economy of post-Soviet Russia. We will also consider the mathematical models developed by Russian scientists as applied to mesoeconomic research. There are four main groups. The first group of models is based on Econophysics ideas. The second group develops agent-based models. The third group is based on the Optimal Multisectoral Interregional Models. The fourth group considers economic systems differentiated by the age of fixed capital. This fourth group includes math models based on the theory of the shifting mode of economic reproduction.

**Keywords:** mesolevel of economic analysis; heterodox economics; economic orthodoxy; institutional mesoeconomics.

**JEL:** B15, B25, P16, P 51

**Introduction: mesoeconomics in the world and in Russia**

The beginning of the formation of the binary model of the structure of the economy, with the micro and macro levels, was laid by J.M. Keynes in his classic work «The General Theory of Employment, Interest and Money» (Keynes, 2007). It is a key concept for modern mainstream economic theory. However, one can often find statements about the need to recognize a third, intermediate level between the micro- and macro-levels, the meso level. The idea of a transition from a binary to a trinary model of the economic hierarchy, where the meso level should be located between the micro and macro levels, periodically becomes an object of discussion. Its supporters often face “neoclassical” criticism. At the same time, it can be stated that “the present stage is characterized by a greater willingness of heterodox directions to focus on the meso levels of analysis” (Dopfer, 2012, p. 142). The increasing complexity of scientific knowledge about the socio-economic processes taking place in society and the parallel transformation of the structure of society induce us to talk about the need to recognize the meso level as an independent object of economic research. The development of formal and informal supra-individual institutions, not normally observed within the framework of the “micro-macro” paradigm, prompts the conceptualization of the meso level as a separate social and economic hierarchy level (Hodgson, 2000; Ayres, Martinas, 2005). “In general, evolutionary and institutional theories, modeling, clusters, network structures and all sorts of group associations may require their own theoretical space – meso” (Chen, 2008, p. 121).

The first meso level reference found by us is dated in 1962: Karl A. Wittfogel used the term “mesoeconomic” to describe the regional level of governance (Wittfogel, 1962). Arthur Cole gave a different understanding in his monograph “Meso-Economics: A Contribution from Entrepreneurial History”, published in 1968. He defined the meso level as a space between micro- and macro-economics, manufacturing companies and economic aggregates, such as the industrial sectors, in which the phenomenon of the “business system” is formed (Cole, 1968, p. 11–16).

In the 1980s Yew-Kwuang Ng, a Singaporean researcher, attempted to carry out a neoclassical synthesis of micro- and macro-level research, proposing to approve the concept of mesoeconomics (Ng, 1982; 1986). He understood mesoeconomics as a synthesis of macro- and micro-analysis. In parallel with Ng, the English economist and politician Stuart Holland also turned to mesoeconomic research. In the monograph «The Market Economy. From micro- to meso-economics» (Holland, 1987), he outlined the trend of a modern market economy, in which oligopolistic competition and network forms of industrial coordination play an increasingly important role, which interpretation requires a transition from a micro- to a meso- paradigm in economic research (Ozawa, 1999). In our opinion both works represent mesoeconomics in mainstream concepts: these studies consider the meso level in isolation from evolutionary theory, which will be emphasized in our analysis.
In 1992 Francis Stewart defined the level of analysis between a country’s overall economy and the level of individuals, companies and households with the notion of “meso”. According to the concept, the meso-level characterizes the depth of the impact of the macro-level structures, determining, for example, which property, gender groups and industries bear the brunt of macro-level reforms (Stewart, 1992, p. 37; Rodgers, Cooley, 1999, p. 1401).

The Russian-speaking meso-level study tradition is younger than the European: according to RSCI, the first publication in Russian devoted to mesoeconomics was the article “Competitiveness in Micro, Meso- and Macro-Level Measurements”, published in 1998 (Gelvanovsky, Zhukovskaya, Trofimova, 1998). Classical works in this area are the two monographs: «Mesoeconomics of the transition period ...» (Mesoeconomics of the transition period, 2001) and «Mesoeconomics of development» (Mesoeconomics of development, 2011), edited by G. Kleiner.

The purpose of this paper is to show the main threads of mesoeconomic theory, and to make a comparative analysis of how mesoeconomics is considered by Russian authors against the backdrop of other worldwide mesolevel descriptions. The first part of the paper is devoted to the study of «English-speaking» mesoeconomic works. In the second part, we describe the main directions of mesoeconomic research in Russia. In conclusion, we compare the English-language and Russian works on mesoeconomics, pointing out their similarities and differences.

1. Mesoeconomics and meso level: English-language studies

Modern European meso-level studies can be divided into three main directions: neo-Schumpeterian, neoinstitutionalist and evolutionary but which, however, do not exist separately from each other.

The neo-Schumpeterian understanding of the meso level uses Schumpeter’s idea of the entrepreneur as the starting point of the theory and as the main source and engine of innovation processes. The meso level in this concept is understood as a definite ontological category, the space for the formation, adoption and dissemination of social norms and institutions, of which the latter are regarded as a meso-level phenomenon (Dopfer, 2004). Within the mesospace, one idea (general rule, or generic rule) is accepted and implemented by many agents (the population). A rule turns into a qualitatively different state of the general rule that transforms the customary interactions order of both micro-level agents and interactions between macro and microlevels (Elsner, Heinrich, 2009). In the trinary “micro-meso-macro” concept, the macrosystem is the aggregate of mesoobjects, and it reflects changes in the mesostructure. Microeconomic analysis involves considering the behavior of individual rule carriers and their local operations. It is assumed that economic development is the result of the emergence, adaptation, dissemination and institutionalization of meso-rules at micro and macro levels (Dopfer, 2004).

The Neo-Schumpeterian interpretation to define the mesolevel as a space of institutionalization of rules is close to the theories of proponents of evolutionary institutional economic theory. For example, Wolfram Elsner refers to the meso level, understanding it as the level of the economic hierarchy in which the observed processes of social and economic evolution occur, resulting in the emergence of new institutions (Elsner, Heinrich, 2009). The endogenous process of rule formation at the meso level is the result of an attempt to collectively overcome the uncertain economic conditions of economic agents with the aim of economic coordination and minimizing losses. The groups of emerging rules carriers in the process of co-evolution of complex systems raise them to a new institutional quality, transferring the rules from the level of micro- and meso interactions to the level of the macroeconomic space (Elsner, 2007).

Supporters of this trend (Elsner, Heinrich, 2009; Elsner, 2010) refer to the game theory about the well-known dilemma of the prisoner, for describing endogenous processes modeling the emergence and institutionalization of rules. The prisoner’s dilemma illustrates processes
about how the mesolevel agents, through the desire to minimize costs and to overcome collectively the conditions of uncertainty, establish the rules of interactions, institutionalized as a result of their repeated actions.

In addition to game theory, mesoeconomics in the works of English-speaking researchers uses such mathematical and methodological approaches as system dynamics, network analysis, graph theory, computer simulation, models describing the market of imperfect competition and models of successive oligopolies of Stackelberg and others, as originally used in the mainstream.

2. Mesoeconomics in Russia

The range of Russian-language studies of meso-level problems can be conditionally divided into three main trends: the system approach, in which the meso level is understood as the process of intra-industry interactions between economic agents with the goal of harmonizing the economic system; a regional-spatial approach that considers regional economic structures as part of the meso-level, and a theoretical approach to methodological institutionalism that addresses interdisciplinary intersections of economics and sociology.

1. Two collective monographs prepared and published, with an interval of 10 years between them, under the leadership and with the participation of the Corresponding Member of the RAS, G. B. Kleiner, are classics for the system approach: «Mesoeconomics of the Transition Period...» 2001 and «Mesoeconomics of Development» 2011. (Mesoeconomics ..., 2001; 2011), as well as several articles written by co-authors of the monographs (Braginskii, 2012; Dementiev, 2002; Kleiner, 2003). The objects of study in these works are called network structures or just networks, defined as “flows of goods and money, information transfer channels, established relationships, etc., that is, a set of economic objects (not necessarily precisely defined), viewed from the point of view of paired and group interrelations” (Mesoeconomics ..., 2001, p. 7). It is emphasized that “Under the mesoeconomic level or mesoeconomics, we mean not only the aggregate socio-economic subsystems of the middle level of the economic hierarchy, but also the aggregate subsystems that lie at lower levels, in particular, the enterprises and their groups.” (Mesoeconomics ..., 2001, p. 10). Four components of the meso-level are distinguished: sectoral mesoeconomics; interindustry mesoeconomics (interindustry vertical complexes and sub-sectoral complexes of the type of agroindustrial complexes and military industrial complexes); regional mesoeconomics (regions, territorial groups of enterprises); interregional (territorial socio-economic entities) (Mesoeconomics ..., 2011, p. 9). Reflecting on the methodology of mesoeconomic research, the authors emphasize the need to consider the “generic” features of the domestic economy” (Mesoeconomics ..., 2011, p. 10) and the inability to adapt directly the macro- and microeconomic research methods based on perceptions of a perfect market and rational behavior of the subject in making economic solutions.

2. The idea of mesoeconomics as a phenomenon that includes the regional economy, we can see in the works of E. V. Popov (Popov, 2007, p. 70) and T. R. Gareev (Gareev, 2010 (a); 2010 (b)). The authors suppose that the problems of the regional economy are often on the periphery of the mainstream economic discourse because the object of the study of the regional economy is at an intermediate level between macro- and microeconomic levels (Gareev, 2010 (b), p. 28). It is natural that regionalists appeal to the meso-level theory. For example, T. R. Gareev emphasizes the nonidentification of the concepts of the region, meso level and institutions, but reveals a fuzzy although traceable connection between mesoeconomic systems, institutions and the boundaries of the local distribution of both institutions and mesoeconomic systems (Gareev, 2010 (b), p. 30). Based on this, he proposes the theory of regional institutionalism, with the study object being the mesoeconomic systems that have economic, social, cultural and spatial dimensions (Gareev, 2010 (b), p. 36), whose consideration is possible through the study of their institutional changes (Gareev, 2010 (a), p. 57).

According to G. Kleiner, the main reason for the unsuccessful experience of market reforms in post-Soviet Russia was the failure of economic regulation at the meso level: regional
and sectoral aspects. The Soviet institutions of economic planning ceased to function. At the same time, market coordination institutions were not yet available. This "led to a weakening of horizontal links, both between business entities and territorial entities" (Mesoeconomics ..., 2011, p. 10). Institutional failure, according to G. Kleiner, provoked a crisis of the era of transition from post-Soviet Russia to market institutions. The described historical context pushed Russian researchers to study mesoeconomics. In mesoeconomics they saw a way to develop an adequate institutional environment for meso-economic strategies for institutional reforms.

3. The main methodological framework and the subject field of Russian-language studies on mesoeconomics can be outlined in the so-called “Kleiner’s formula”: “In fact, the study of mesoeconomic structures is equivalent to the study of institutions ... Mesoeconomics is a natural field of formation and action of economic institutions” (Kleiner, 2003, p. 16). Such an understanding is like the world tradition of meso-level studies, but the historical realities of post-Soviet Russia have identified a somewhat different, more practical direction of development.

In the context of methodological institutionalism meso level is considered in the works of S.G. Kirdina (Kirdina, 2013; Kirdina, 2015; Kirdina, 2016), where it is described as an opportunity to pass between the Scylla and Charybdis of two methodological extremes, characteristic of both economics and sociology: methodological individualism and methodological holism. In a similar vein, the above-mentioned T.R. Gareev reflects, the goal of meso-level research is formulated as “identification of the area in which ascending processes of new rules formation and downward processes of stabilizing constitutive rules collide” (Gareev, 2010 (a), p. 45), which is impossible with the use of classical micro-macroeconomic study methods.

3. Mesoeconomic models

According to different versions of the theoretical understanding of the meso-level of the economy, various classes of mathematical models can be distinguished, which can in some aspects be considered as meso-economic (Kirilyuk, 2017; 2016).

If we consider both mesoeconomic models describing the economy with detailed levels of industries and regions, then these mesoeconomic models include the intersectoral balance developed by the Nobel laureate V. V. Leontiev (popular in the Soviet planned economy) and economic geography models. Both directions are taken into account in the optimized interregional interindustry models (OIIM) proposed by Academician A.G. Granberg, currently used and improved in Novosibirsk at the Institute of Economics and Industrial Engineering of the Siberian Branch of the Russian Academy of Sciences. These models are sometimes referred to as the Russian equivalent of the direction in the west called New Economic Geography, which development brought to P. Krugman a Nobel Prize. Calculations for these models are used in forecasting by the Ministry of Economic Development of the Russian Federation. The OIIM consider both the balance between the branches of each region, the interests of the regions, and the balance of interests between the regions. It also takes into account the interests of the country as a whole, including the interest of the country to equalize living standards in the regions. In simple cases, these models are linear, but there are nonlinear generalizations in some cases (Suslov, 2011).

Mathematical modeling of strategies to achieve personal and group subjects interests, including economic ones, is the subject for the study of mathematical game theory, which is considered as a mathematical tool suitable for describing the problems of institutional economics (a direction close to mesoeconomics, sometimes even identified with it). It is important to study the possibility of establishing such "game rules" that are optimal from the point of view of the functioning of the system as a whole. Developments in this field, called the theory of mechanisms, were recognized by the award of a Nobel Prize (Izmalkov, Sonin, Yudkevich, 2008). In the USSR similar studies were carried out in parallel within the framework of the “theory of active systems”, which continues to evolve, for example, at
the Trapeznikov Institute of Control Sciences of the Russian Academy of Sciences (Burkov, Novikov, 2009).

In addition to disaggregating the economy by industry and region, other forms of its disaggregation are possible in the models. For example, with the participation of the Nobel laureate L. V. Kantorovich, models were developed that were disaggregated by the age of the fixed capital (Kantorovich, Zhiyanov, Khovansky, 1978). This method of disaggregation was also used in the works of I.G. Pospelov, N.N. OIenev from the Computing Center of the Russian Academy of Sciences (Olenev, Pospelov, 1989) and in a number of studies by other authors. It also underlies the models of the shifting mode of reproduction (SMR) theory proposed by Academician of the Russian Academy of Sciences V. I. Mayevsky. Mathematical models of this theory are developed at the Center for Evolutionary Economics of the Institute of Economics of the Russian Academy of Sciences with the participation of S. Yu. Malkov, A. A. Rubinshtein and others. The theory describes the development of a population of competing enterprises that differ in the age of fixed capital used. They work alternately in two different modes - in the mode of releasing a product for consumption in the system and in the mode of updating equity capital (Mayevsky, Malkov, 2013). The mathematical basis of the theory is a system of ordinary differential equations with discrete time-varying coefficients. It is shown (Kirilyuk, 2016) that in the simplest cases the model can be represented as a system of nonlinear discrete mappings. Depending on the values of the parameters and initial conditions, this model class can generate both random and regular dynamics (even though exogenous random influences are not used in modeling). The basic version describes the competition between enterprises, which also corresponds to a group of households, the influence of the financial sector and other clarifications which have been added to more advanced versions. From the models of the economic mainstream, the SMR model differs in the fundamentally non-equilibrium dynamics of indicators, which allows us to consider in detail the cash flow dynamics over time, as well as taking into account the heterogeneity in the characteristics of enterprises. The ability to interpret the dynamics of a population of enterprises, as an effect known in evolutionary theory as the “run of the black queen” when it is necessary to make efforts for development just in order not to drop out of the system, is one of the arguments to consider models as referring to the direction of evolutionary economics.

A mathematical adequate for describing collective processes of self-organization at the mesoeconomic level, which are the object of researchers interest in the field of institutional and evolutionary economics, is proposed in the framework of the direction called econophysics (which also includes the SMR model). The expediency of considering the meso-level of economics with the concepts of econophysics (or in other words, synergistic economics) can be characterized using the concepts of nonequilibrium and non-linearity. For a two-tier mainstream economy, it is typical to postulate an economic equilibrium, and the only one is the application of linearization procedures in the equilibrium neighborhood. In nonlinear ordinary differential equations systems the equilibrium conditions are determined by the properties of the system, along with nonequilibrium dynamics. Nonlinear systems are characterized by a violation of the property of superposition, which researchers associate with the concepts of methodological individualism and reductionism. The concept of dynamic chaos, implying the sensitivity of the system to small impacts, also changed the scientific community's view of the relationship between the micro level and the macro level, showing in mathematical language the mechanisms of how small effects due to instability in the system can lead to significant changes at the macro level (just as in studies by J. Schumpeter and his followers of economic processes, ideas spread from one innovator to the whole society).

Econophysics originated in the west but found its followers in Russia. D. S. Chernavsky, a Russian scientist, proposed a dynamic theory of information and developed a mathematical model for the struggle between conditional information. This is a universal approach, used, for example, in studies of the interaction of languages, currencies, ideologies, etc., which
are interpreted as conditional information - a set of implemented and reproducible ways of comparing certain conditional phenomena when they are in competition with alternative ways. He also developed a block-hierarchical approach in the economy, which implies considering detailing, for example, consumer goods (when describing it, the author directly mentions his attitude to the mesoeconomic level (Chernavsky, Starkov, Shcherbakov, 2016, p. 29). The basis for D. S. Chernavsky’s diverse topics of work are the concepts of synergetics. An important role in his economic work used the application of nonlinear ordinary differential equations which, in contrast to the well-known modern models of general equilibrium, can lead to the presence in the models of many alternative equilibrium states of economic systems. Thanks to his works, as well as to other scientists involved in this field, synergetics and the use of nonlinear dynamics methods have become popular in the scientific community. It led to the formation of the Russian school in the field of econophysics. In the works of S. Yu. Malkov, A. A. Akayev, A. V. Korotaev, and other researchers, there is a variety of dynamic systems that describe the interaction between countries, considering the possibility of increasing returns to production factors in production functions. Econophysics works are also the works of G. G. Malinetsky, A. V. Podlazova about the phenomenon of self-organized criticality, leading to changes of different scales in the systems (Malinetsky, Podlazov, 1997), including in social systems, etc. The importance of these approaches in econophysics allows them to describe the processes of self-organization at the meso-level of the economy and are more adequate than, for example, simple econometric models for describing the crisis phenomena in the economy, which unfortunately so far are characteristic of Russia. More information about econophysics can be found, for example, in (Romanovsky, Romanovsky, 2012).

If in synergetics research it is enough to have simple non-linear systems of small dimension to identify and study unusual phenomena, then the simulation modeling of economic agents often aims to consider as much real data as possible while modeling the system. Agent-based modeling is a modern approach that actively uses computing power and allows flexibility to consider the individual characteristics of economic objects, their heterogeneity, the interaction between themselves and the influence of each on the aggregate properties of macroeconomic systems. In Russia, this area is actively developed, for example, at the Central Economics and Mathematics Institute of the Russian Academy of Sciences under the guidance of Academician of the Russian Academy of Sciences V. L. Makarov and corresponding member of the Russian Academy of Sciences A. R. Bakhtizin (Makarov, Bakhtizin et al., 2016). They are also developing hybrid models where agent-based models are combined with a general equilibrium modeling approach or use neural networks. Agents are a rather abstract concept, and they can represent different levels of economics. Of course, when modeling their behavior, previous achievements of economic theory are considered. However, this approach does not imply a rigid link to the division of the economy into the macro and micro levels. An overview of agent-based modeling of the meso-level economic systems is presented, for example, in the article (Chekmareva, 2016). In Russia, agent-oriented models exist and are used both for Russia as a whole and for individual municipalities.

While identifying types of mesoeconomics mathematical models, it is necessary to consider that the models listed above are developing interrelatedly, the various mentioned groups of authors influence each other, borrow successful findings and resulting in a joint improvement of modeling methods. Experience shows that not all promising areas are universally recognized and promulgated immediately.

The conclusion: the comparative analysis of Russian-speaking and English-speaking researches of the meso level and prospects of development

As can be seen from the analysis, there are many similarities between English-speaking and Russian-speaking researchers of mesoeconomics. Many of the authors who write about
Meso-level of economy: theoretical approaches and math modeling

mesoeconomics consider the problem from the point of view of the evolutionary-institutional approach. From an evolutionary-institutional point of view, the meso level is the space in which the processes of the rules and institutions emerge. It is assumed that the meso level in this case will help to describe these processes, since the available micro-macro models, from the point of view of the task of describing the processes of the formation of institutions are not applicable. Similar theoretical constructions can be found in the works of Russian-speaking and English-speaking authors. Moreover, we believe that the scientific community in Russia is ready to accept the evolutionary-institutional interpretation of the meso level.

In many studies of the meso-level as a space for the formation and functioning of institutions, the synergetic theoretical paradigm treats it as the level of the system in which the mechanisms of its self-organization are formed. The meso-level is methodologically described as a development “from the microscopic level to the macroscopic level” (Haken, 2014). The reason for the identification of a separate meso level is that the structures of the main characteristics of the complete system are formed at this level.

However, a comparative analysis of publications shows that there is a difference between English-speaking and Russian-speaking meso-level studies, the origin of which is determined by historical circumstances. If the meso-level for evolutionary and institutional researchers of mesoeconomics in the West is a means of overcoming the limitations of the mainstream micro-macro model, the initial interest of Russian-speaking authors was determined by the crisis in the Russian economy, a failure in the functioning of the entire economic system. Initially, G. Kleiner and his co-authors turned to mesoeconomics, understanding the level of regions and industries in the meso level. For them, mesoeconomics seemed to be a way to study the problems of the transition of the Russian economy from the planned system to the market. In those conditions, descending regulatory processes disappeared, while the downward processes of economic coordination have not shown themselves yet (Volynskii, 2017; Kruglova, 2017; Kirdina-Chandler, Maevsky, 2017).

We highlight four main groups of Russian models. The first group of models is based on Econophysics ideas (D. S. Chernavskii’s Scientific School with A. A. Akayev, S. Yu. Malkov, and others (Chernavsky, Starkov, Shcherbakov, 2002; Korotaev, Malkov, Khalturina, 2007; Akaev, 2000; Malkov, Kirilyuk, 2013)). The second group develops agent-based models (V. L. Makarov, A. R. Bakhtizin at the Central Economics and Mathematics Institute of the Russian Academy of Sciences (RAS), etc.). The third group is based on the Optimal Multisectoral Interregional Models developed at the Institute of Economics and Organization of Industrial Engineering of the Siberian Branch of the RAS within the framework of A. G. Granberg’s scientific school of Economic Geography. The fourth group considers economic systems differentiated by the age of fixed capital by developing the approach of the Soviet Nobel laureate L.V. Kantorovich (and a team at the Computing Center of the RAS) (Kantorovich, Zhiyanov, Khovansky, 1978). This last group comprises the math models based on the theory of the shifting mode of economic reproduction, developed under the leadership of V. I. Maevsky in the Institute of Economics of the RAS (Maevsky, Malkov, 2013).

However, there is still the problem in mesoeconomic analysis, being the problem of linking mathematical modeling with ongoing theoretical developments and the development of terminology.

СПИСОК ЛИТЕРАТУРЫ


Гареев Т. Р. (2010a). Институты и экономическое развитие на субрегиональном (мезо-) уровне // Общественные науки и современность, № 5, с. 45–58.


Кирдина С. Г. (2013). Методологический индивидуализм и методологический институционализм // Вопросы экономики, № 10, с. 66–89.

Кирдина С. Г. (2016). Между макро и микро: методологические проблемы анализа мезоуровня в экономике. Монография / Отв. ред. В. И. Маевский, С. Г. Кирдина. М.: ИЭ РАН.


Киршлюк И. Л. (2016). Дискретная форма уравнений в теории переключающегося воспроизводства с различными вариантами финансовых потоков // Компьютерные исследования и моделирование, Т. 8, № 5, с. 803–815.


Клейнер Г. Б. (2003). Мезоэкономические проблемы российской экономики // Экономический вестник Ростовского государственного университета, Т. 1, № 2, с. 11–18.


Суслов В. И. (2011) Анализ и прогнозирование пространственного экономического развития России с использованием межотраслевых моделей // Управленческое консультирование, № 3, с. 93–105


REFERENCES


