

V. V. Popkov^{a)}, D. B. Berg^{b)}, E. A. Ulyanova^{b)}, N. A. Selezneva^{c)}

^{a)} International A. Bogdanov Institute

^{b)} Ural Federal University named after the First President of Russia B.N.Yeltsin

^{c)} Institute of Economics, Ural Branch of the Russian Academy of Sciences

COMMODITY AND FINANCIAL NETWORKS IN REGIONAL ECONOMICS¹

The article discusses the relationship between commodity-production and financial network structures in the regional economy as dual conjugate systems. Material flows (raw materials, goods and so on) circulate in the commodity network as shown by Leontiev's input-output balance model. Nonmaterial flows of property rights, money, and so on circulate in the financial network and reflect the movement of material objects in commodity networks. A network structure comprises closed and open circuits, which have fundamentally different characteristics: locally closed circuits meet local demand by supplying locally produced goods, thus ensuring self-reproduction of the local economy; open (or transit) circuits provide export-import flows. The article describes the mechanism of 'internal' money generation in closed circuits of commodity-production networks. The results of the theoretical study are illustrated by the calculations of closed and open circuit flows in the municipal economy model. Mutual settlements between the population and manufacturing enterprises are given in matrix form. It was found that the volume of the turnover in closed circuits of the municipal economic network model is about 28.5 % of the total turnover and can be provided by 'internal' non-inflationary money. The remaining 71.5 % of the total turnover correspond to the flows in the network's open circuits providing export and import. The conclusion is made that in the innovation-driven economy, main attention should be given to the projects oriented towards domestic consumption rather than export supplies. The economy is based on internal production cycles in closed circuits. Thus, it is necessary to find the chains in the inter-industrial and inter-production relations which could become the basis of the production cycle. Money investments will complete such commodity chains and 'launch' the production cycle.

Keywords: regional economy, commodity network, financial network, dual systems, closed financial flows, local currency, self-reproduction of economy

Introduction

Modern development of the means of communication, systems which can process enormous data bulks very fast and provide their immediate analysis, creates new opportunities for prompt decision-making and capital transfer between different areas and industries. What caused this change of economic reality was mainly the development of information technologies, the emergence of the Internet, the permanent growth of e-trade involving different types of virtual currencies. The world is rapidly transforming into one global information space with practically limitless opportunities for communication. The subjects of these communications are not only people (social communications), but also the economic structures generated through economic communications. All this presents to new challenges which economics has to deal with.

The dynamics of the communications development in the last thirty years has led Castells to the following conclusion: 'As a historical trend, dominant functions and processes in the Information Age are increasingly organized around networks'. It does not mean that network structures did not exist before. It just means that the phenomenon of networks has now come to the fore, reshaping the established, geographically organized systems of social and economic relations. Efficiency and competitiveness of more and more economic agents started to depend on their knowledge and skills acquired through networks. It was through these networks that this knowledge and these skills

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converted into commodities and services and spread across vast areas. Moreover, here we are dealing with technological but also with marketing knowledge acquired by processing huge amounts of data about the specific acts of communication between the agents.

Model and empirical studies based on system techniques and tensor analysis of networks have shown that relations between economic entities (regional, municipal) can be represented as an assemblage of networks of two types of economic exchange:

- locally closed circuits, which meet local demand by supplying local production;
- open or transit circuits (relations with other regions and municipal entities), which are orientated towards meeting the internal (import) and external (export) demand.

This division by itself seems almost trivial. However, modern economics pays a lot of attention to studying open (transit) circuits orientated towards money (monetarist approach and commodity-based economy). Closed circuits of economic exchange are considered to be the most interesting type of self-organization. They are de facto targeted at the mutual satisfaction of the network participants' needs through the equivalent exchange of commodities and services. This type of self-organization is related to the ability of individual microscopic open systems to form macro-systems and to their capacity for progressive evolution. A major flaw of some studies of regional macroscopic systems is that they ignore such kinds of self-organization, which makes them incomplete and, therefore, less productive.

It is important that functioning of locally closed circuits of economic exchange (internal market) mostly rely on small and medium-sized businesses, which provide most employment opportunities, supply a significant part of the essential services and commodities, and determine the social and economic climate in the region in general.

Networks of economic exchange have a commodity and a financial component. A commodity network is a place where raw and semi-processed materials, consumer goods, services, and so on circulate, as shown in Leontiev's input-output balance model [6]. The geographical location of economic agents, volumes of supply, delivery dates, and so on are particularly important for such networks [7]. A financial network reflects each act of communication when this or that commercial product is transferred, although it deals only with property rights [12], money, and other purely ideal (non-material) objects. The transfer speed depends neither on the volume nor the geographical distance between the agents. Moreover, the direction of communications in a financial network is opposite to that of commodities' movement in a commodity network. Both commodity and financial components are described in the theory and practice of economics by using the universal language of money. This being the case, it is important to point out that money in networks is a means of communication with a discreet code ('yes' — 'no'; 'bought' — 'didn't buy'), while money records in financial accounting reflect something of a different, continual nature, that is, of material flows. Money in a cash register or money in the company's bank account, as well as delivered goods or semi-processed goods, are all recorded in the appropriate columns as roubles but this is just a technical recording system going back five hundred years. Representation of material flows (raw materials, component parts, energy, labour costs, and so on) in the value form (money) is confusing and does not show the fundamental difference between money and commodities: it neglects not only the difference between money and commodities as such but also the differences in the structure of their circulation.

If this fundamental difference in the nature of communications objects in commodity and financial networks (material and ideal respectively) is not taken into consideration, then the risk of wrong decision-making will increase, for example, in decisions concerning the organization of product manufacturing. As a rule, decision-making is based on the analysis of financial (ideal) indicators, according to Friedman's monetarist approach, which prevails in modern economic practice [13]. This approach leaves out material features of specific production, particular characteristics of the region, peculiarities of the national economics, and other factors.

Without acquiring a proper understanding of how the material and ideal flows conjugate in the economy, it is impossible to make sufficient progress in studying the 'network community' phenomena. This research work applies the economic constructivism theory [11] as a methodological tool. This theory is based on the analysis of dual self-referential systems and describes such new economic phenomena as autopoetic systems, circular and transit processes, communications networks.

Networks in Economics: Closed and Open Circuits

The concept of economic systems in the form of networks allows researchers to see the so-called hierarchical levels of the economy (municipal, regional, national) in a new light. Since economic systems on all hierarchical levels are networks, it is possible to consider economy as a network in which separate systems (or more specifically, the ones selected by researchers) interact as hubs with other similar systems (hubs) according to the same network principle.

Each hub of such networks is a ‘viable’ system: being visually enlarged, it will turn out to be a network itself, and so on. In other words, economic systems consist of networks within other networks: on each level, after being considerably ‘enlarged’, network hubs turn out to be smaller networks. Researchers tend to incorporate these ‘small’ systems into larger ones and apply the hierarchical principle by putting larger systems above smaller ones in the form of a pyramid. However, it is just a man-made construction. In the economic network world, there is no ‘above’ and ‘under’, there are no hierarchies. There are only networks embedded into other networks. The features of the network parts are not their inherent characteristics: they can be understood only in the context of a larger single whole.

An economic system can be schematically represented as a network with the hubs corresponding to enterprises and their links to the connections between them. In spite of all the diversity of networks, their structure is made of only two types of elementary networks (Fig. 1), open and closed circuits, random combinations of which create the diversity of the mixed type circuits we observe.

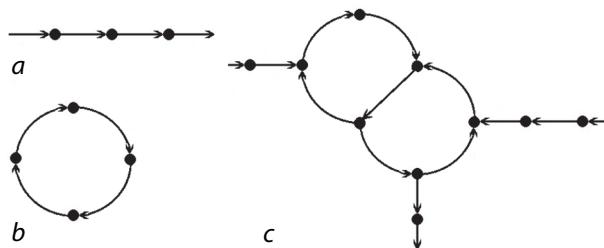


Fig. 1. Two main types of circuits, open (a) and closed (b), form mixed circuits of any randomly chosen circuit (c)

Let us consider a random open circuit of a network of enterprises. Each enterprise is a ‘black box’, a linear operator converting one set of goods (resources) into another in accordance with consumption indices. An enterprise is a classic hero of all balance models. Operators compete with each other for access to limited resources: they minimize their inputs and maximize their outputs, which provides equilibrium prices on the market. The only motive of such ‘transit’ production processes is added value, the difference between input and output (hub) prices. The concept which can be called an ‘input-output paradigm’ has become ingrained in the minds of economists, together with linear balance models.

As a result, chains of enterprises and production programs are constructed in order to provide the maximum effect within the framework of the ‘input-output’ system under the given restrictions on the inputs. The subjects of market economy used to focus primarily on resources, products, goods, exchange of goods, markets, prices, added value, and profit. This trend was also reflected in the mainstream economic theory.

However, at present, this narrow perspective is actively broadened by the institutional theory, which accepts that the moment of goods exchange is of course ‘the moment of truth’ but also points out that it is preceded by a number of important conditions and relations between operators which cannot be reduced to a simple ‘funfair’ act of purchase and sale. Moreover, the continuing relations and the contracts which secure such relations play a more important role than ‘single-point’ exchanges of commodities. It is particularly obvious in the developed core of micro-economics where contractual relationships and services are considered to be not only one of the most promising economic sectors but also the fundamental one. For instance, in 2012 aggregate services in the British GDP accounted for 77 %, while the aggregate production together with construction, 22.4 %². It is the marginal development of commodity markets that has brought to light the significant flaws of their theoretical description and led the institutional theory to distinguishing contractual relationships as a separate sphere.

² The Structure of the UK’s Economy. URL: <http://spydell.livejournal.com/487902.html>.

The exchange establishes connections between commodities, with the operator in the commodity market performing the function of a seller and a buyer. However, as a manufacturer, the operator's function is to transform some goods into others. The contract formalizes the relationship between the operators in the aspects in which they can only function together, serving each other. As a matter of fact, the contract confirms not the commercial result of the operators' economic activities (for this they can use a simple exchange) but the specific desirable operating standards, important parameters of the counter-parties' activities. These counter-parties are unwilling to 'bend under' the external conditions, rather they prefer to fit this commodity world to their own needs.

When a chain of enterprises forms a closed circuit, balanced in all its hubs, a closed structure is formed, which doesn't depend on any external price conditions. If the production in all the circuit hubs continues, these flows are determined by other, non-cost-related motives, not the hub prices or added values but other sources embedded into the production links themselves. Here the merchantability of production recedes into the background; what comes to the front is such an almost forgotten category as the need, mutual need each other's work.

Moreover, in the space of transit (open) circuits, enterprises get a market sanction for the movement of commodities irrespective of each other, since the number of enterprises (operators) in this space is by one less than the number of independent pairs of markets (at the entry, purchasing raw materials; at the exit, selling finished products). On the contrary, in a closed circuit, enterprises (operators) are heavily dependent on each other since there are by one more enterprises than independent pairs of markets. The closed circuit emerges in the network regardless of commodity and price sanctions. It is initiated exclusively by internal flows and internal stimuli of its participants. In the network's closed circuit, production to a great extent resembles a work contract or a service: this is how consumers prefer it to be and this is how the local 'service' production can compete with large commodity-producing 'monsters'. This is the way that various 'internal markets', national, regional or local, reproduce themselves.

Duality of Commodity and Financial Networks

In all versions of the quantitative theory of money (including the monetary theory), conclusions are drawn on the basis of balance or imbalance of money and commodities. These theories ignore the fundamental difference between money and commodities and the structure of their circulation. According to Marx's classical economics, the value is not material, it has an ideal nature, in the Hegelian meaning of the word. In economic positivism, the sphere of value was reduced to the monetary sphere and was studied as a kind of a commodity flow using balance methods (this is where all monetary theories come from). The optimization, marginalist model, considered cost performance as coefficients which determine the target function of an economic system.

The dual, optimization problem of linear programming [3] to some extent reveals the specific character of value-based processes in economics: this specificity is in the appearance of the dual problem itself, in which the minimal target value of the target function equals the maximum value of the target function of the original problem. By solving the original problem, the process maximizes its inertial-kinetic function within the given restrictions: in our economic problem it is the function of sales maximization. This task is addressed on the basis of the input-output model and, therefore, does not take into consideration the internal structure of the system and does not make it possible to track deeply how price and commodity processes interact within the economic system. The economic system 'throws out' internal flows in closed circuits, aggregating them. However, these are the factors which have a most significant impact on the economy.

According to the topological theory [2], any integral system structures some kind of closed surface, which, speaking generally, is multidimensional. For instance, a network of biogeocenoses structures the biosphere while a network of cyclones and anticyclones structures the atmosphere. Networks of enterprises, correspondingly, structure the economic sphere. Let us consider an enterprise E_1 (Fig. 2), which forms a production flow with a price variation at the ends, thus creating added value. The difference between the entry prices and the exit prices is provided by the communications of the enterprise E_1 , the consumer of its production E_2 , and the raw material supplier E_3 , Fig. 2.

For the enterprise E_1 to start functioning, either of the following plans should be realized:

— the system should have the bank B_1 , which will grant a loan to the enterprise E_1 to buy raw materials from the supplier E_3 , Fig. 2a;

— between the enterprise E_1 , its client E_2 , and its supplier E_3 there should be a closed circuit of the production-commodity network, Fig. 2b.

Topologists also maintain that for each network there is always a dual network [10]. The dual network is constructed automatically, according to the following rule: in a pair of two mutually dual networks, each open circuit in the first network corresponds to a closed circuit in the second one, and vice versa: each closed circuit in the original network corresponds to an open circuit in the second network.

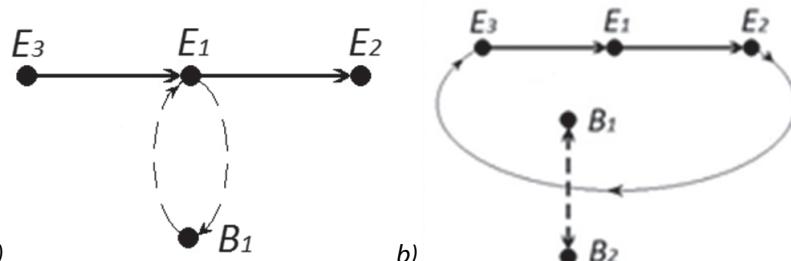
In Fig. 2a the open circuit $E_3 \rightarrow E_1 \rightarrow E_2$ of the commodity network is supplemented by the dual closed circuit $B_1 \rightarrow E_1 \rightarrow B_1$ of the financial network. This closed circuit is nothing else but cash flow, and it closes in on the creditor (it can be the bank B_1 or any other partner interested in the operations of the enterprise E_1). In case of the bank (B_1), the latter lends a certain sum of money to the enterprise E_1 at a certain rate in order to get this money back at the same time absorbing a part of the enterprise E_1 's added value.

In the Fig. 2b, a closed circuit $E_3 \rightarrow E_1 \rightarrow E_2 \rightarrow \dots \rightarrow E_3$ of the commodity network, is supplemented by its dual open circuit $B_1 \rightarrow B_2 \rightarrow B_1$ of the financial network, with the bank B_1 located inside the closed commodity circuit and B_2 being outside it. This situation means that an open financial circuit, being dual to the closed production-commodity circuit, connects a certain settlement bank (B_1), which is internal to the closed circuit, with an ordinary external bank (B_2). Therefore, 'internal' money circulates inside the closed circuit $E_3 \rightarrow E_1 \rightarrow E_2 \rightarrow \dots \rightarrow E_3$ but it can be converted into 'conventional' money and back. Internal money, according to Harris [15], is not an asset, since the condition of its existence is the balance of claims and liabilities. However, it is true only for a static case but as soon as a new commodity cycle is launched within a closed circuit and so is its dual circulation of finance, then the profit will start to generate on each element of the closed circuit corresponding to a certain enterprise. That is, if a balance of claims and liabilities is formally maintained, each element of the closed circuit will be generating assets.

Although the banks B_1 and B_2 are connected by the forward and back arrows, the financial circuit is open, that is, the corresponding links have different nature. The connection $B_1 \leftarrow B_2$ means that 'internal' money of the closed production and commodity circuit is secured by 'external' money received from the external bank B_2 . This is how the emission of the Russian roubles is implemented by the Central Bank: the Central Bank as an 'internal' bank buys US dollars in the external market (as a rule, from energy export) and they enter the gold and foreign currency reserves. Then the Bank emits the corresponding number of roubles, which ensure settlements between the subjects of the national economy within the closed production and commodity circuits of the network. A similar scheme was realized in the Austrian town of Wörgl in the 1930s: the national currency served as security for the so-called 'stamp scrips' issued by the municipality.

The connection $B_1 \rightarrow B_2$ implies that there is 'internal' money in the form of taxes and investments which flows out into the external environment from the 'inside' of the closed production and commodity circuit. The same principle applies to those parts of the profit which were not used to fulfill the needs of the closed circuit.

The interconnection of the dual circuits of the commodity and financial networks shown in Fig. 2b is meaningful and very important. F. Hayek pointed out that there is no clear boundary between money and non-money [14]. This boundary is drawn by the state law stipulating the obligatory use of the national currency in financial settlements and by the established practice. This analysis can be made



a — open circuit of a commodity network and a closed circuit of a financial network;
b — closed circuit of a commodity network and an open circuit of a financial network

Fig. 2. The simplest examples of dual pairs of circuits of a commodity (—) and financial (- - -) networks.
 E_1, E_2, E_3 are enterprises sharing one production cycle; B_1 and B_2 are banks

more and more complex by increasing the number of enterprises in closed circuits. However, the picture will stay pretty much the same: the dual open circuit of a financial network will connect the ‘internal’ settlement bank generating ‘internal’ money with an ordinary external bank.

Usage of the same payment instruments (‘external’ money) in circuits of both types eliminates the difference between the ‘external’ and ‘internal’ money but it is brought to light by the topological analysis, as described above. Taking into account the experience of the non-payment crisis, this ‘internal’ money might share some properties with debt securities, which are used in the internal turnover to measure the needs, their importance, and weight. Once it is ‘outside’, this ‘internal’ money joins the general cash flow.

This open financial branch is an important institutional component of an integrated economic system. Open commodity circuits always use only one monetary unit, while in each closed commodity circuit there can be its own payment unit and its own ‘hub-bank’ to provide the financial component of the closed commodity flow, in particular, with the help of the alternative settlement medium (ASM). The current monetary system unit (for instance, the national currency) can be used as such payment unit, too, but its meaning will be different, even if the subjects using it are unaware of this fact.

It is not a mere coincidence that the structures of the so-called vertically integrated holdings and economically self-sufficient areas always include their ‘own’ bank. Sometimes these banks are disparagingly called ‘pocket banks’ but their existence ensures the cyclical character of self-reproduction inside the production complex and the social complex linked to it. Building the network of such local banks is an essential pre-requisite for full-fledged functioning of an integral economic system.

Commodity and Financial Networks in Municipal Economy

The municipal economy’s model was based on the average statistical data per 10,000 residents, with the following age distribution: 55 % (5,500 people), working age (18 years and older); 27 % (2,700 people), retirement age; 18 % (1,800 people), below working age (under the age of 18 years)³. The industry-specific structure of the municipal economic model was constructed in accordance with the following assumptions:

- diversification of the economy, which provides production of different commodities and services without the so-called ‘city-forming enterprise’, which turns a municipality into a ‘monotown’;
- production and market relations between specific enterprises within the municipality; enterprises without such relations were not included into the model.

The population in the model is identified as a separate ‘sector’ which consumes the production of local enterprises and provides them with the key resource, the workforce. The sectors of industry and the volumes of consumption of their products and services by the local population were determined by analyzing the consumer basket⁴. The annual financial statements of enterprises similar to the ones in the model were used as source data for calculating commodity flows between the municipal enterprises, for example, the overall production of the main product, the average salary, and the average staff number. The industry-specific structure of the municipal economy [4] is shown in Table 1.

Thus, there are 4,119 people employed by the enterprises given in Table 1. The rest of the employable population work either outside the municipality or at enterprises which do not have close production and market ties with the enterprises given in Table 1 and which are orientated towards the external market. Internal production meets the population’s needs by 32 %: people can buy local bread, meat and dairy products, furniture; use the car services and the services of the local vehicle companies (transportation).

In this model of the municipal economy, there are 28 significant internal relations between the enterprises (non-zero cells in Table 2), which form various closed circuits of the municipal commodity network. These closed circuits, aggregated at the inter-industrial level, are shown in Figure 3.

To estimate the significance of the internal production and market relationships between the enterprises, it was necessary to consider their need in each other’s products in accordance with the structure of their operating costs. The average prices of the Ural region were used in the calculations of commodity flows. The matrix of the commodity flows aggregated this year (Table 2) between the

³ Federal State Statistics Service. URL: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/population/demography/#.

⁴ O potrebitel'skoj korzine v celom po Rossijskoj Federacii [About the consumer basket in the whole Russian Federation]. Available at the site of the reference-law system “ConsultantPlus”: <http://base.consultant.ru/cons/cgi/online.cgi?req=doc;base=LAW;n=138547>.

Table 1

Industry-Specific Structure of Municipal Economy

Nº	Industries	Enterprise (firm)	Business area	Average staff number
1	Crop farming	Agricultural production cooperative	Grain growing, growing of industrial crops	170
2	Cattle and poultry breeding	Farm	Beef and dairy cattle farming	200
3		Poultry farm	Poultry farming, egg production	427
4	Food manufacturing industry	Meat factory	Meat and poultry products manufacturing	500
5		Dairy factory	Dairy production	1800
6		Bakery	Bakery production	290
7		Flour milling plant	Flour manufacture	185
8		Fodder plant	Fodder manufacture	357
9	Cabinetry	Woodworking shop	Cabinetry	100
10	Services	Car service	Technical maintenance and repair	40
11		Vehicle company	Cargo and passenger transportation	50
12	Population (households)		Human resources Consumers of goods and services	4 119 10 000

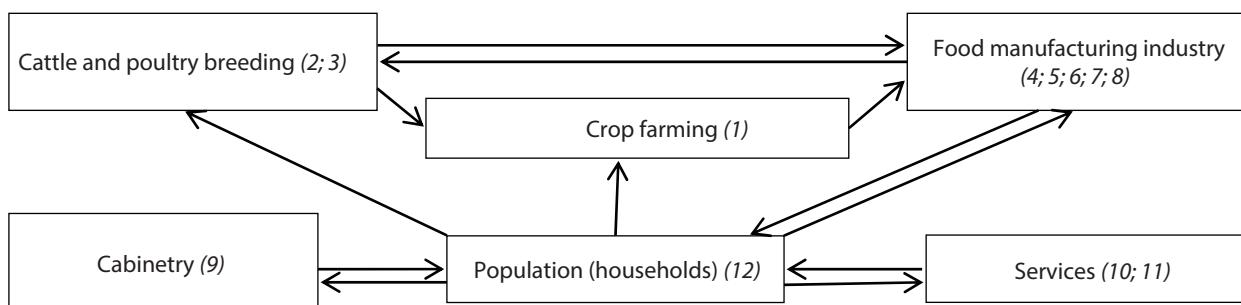
**Fig. 3.** Scheme of closed circuits in the commodity network of the municipal economy. Figures in brackets show the ordinal number of enterprises in Table 1

Table 2

The matrix of the commodity flows between the municipal enterprises per year, thousand roubles

Nº	1*	2	3	4	5	6	7	8	9	10	11	12	D (debit)	Δ (balance)
1	—	0	0	0	0	0	496000	1340680	0	0	0	0	1836680	1822275
2	405	—	0	53993	590322	0	0	0	0	0	0	0	644720	618994
3	0	0	—	79100	0	0	0	0	0	0	0	0	8227	87327
4	0	0	0	—	0	0	0	0	0	0	0	0	109460	-82633
5	0	0	0	0	—	0	0	0	0	0	0	0	79389	79389
6	0	0	0	0	0	—	0	0	0	0	0	0	27514	-23306
7	0	0	0	0	0	4081	—	0	0	0	0	0	4081	-507919
8	0	8726	419318	0	0	0	0	—	0	0	0	0	428044	-942636
9	0	0	0	0	0	0	0	0	—	0	0	0	2352	-16848
10	0	0	0	0	0	0	0	0	0	—	33	9000	9033	2033
11	0	0	0	0	0	0	0	0	0	—	16280	16280	8517	
12	14000	17000	40450	59000	170300	48000	16000	30000	19200	7000	7730	—	428680	175196
C (credit)														
	14405	25726	459768	192093	760622	52081	512000	1370680	19200	7000	7763	252223	3673560	—

* Columns and rows numbers are conform to the enterprises numbers in the table 1.

municipal enterprises, as shown in Table 1, was made by drawing on the statistical data and the actual economic data of similar enterprises. These flows, denominated in roubles, visualize the municipal financial network and reflect the movement of commodities and services between the enterprises located in the municipality area, including the population. Commodity flows between the municipal enterprises, and the external enterprises were not included in this model.

The lines of Table 2 reflect the commodity flows which this industry (enterprise) or the population 'gives' to other enterprises in the internal market. For example, annually, the fodder plant 8 supplies the farm 2 with fodder to the amount of 8,726 thousand roubles and the poultry farm 3 to the amount of 419,318 thousand roubles. In the table column 'Debit', the total values of both flows are calculated. The debit value for the fodder plant 8 is $D_8 = 428,044$ thousand roubles.

The Table 2 columns reflect the commodity flows which the industry (enterprise) or the population consumes in the internal market. For instance, the bakery 6 buys flour from the local flour milling plant 7 to the amount of 4,081 thousand roubles and pays wages to its workers to the amount of 48,000 thousand roubles annually. In the line 'Credit', the total values of both these flows are calculated. For the bakery 6, the credit value is $C_6 = 52,081$ thousand roubles.

The total value of the commodity flows and, therefore, the money exchanged by all the municipal economic actors included in the model (internal commodity turnover, in roubles), W_{total} is calculated by adding up all the values in Debit D (in modulus they equal the values of Credit C) and makes $W_{total} = 3,673,560$ thousand roubles.

The internal turnover of the commodity weight W_{total} evidently aggregates two financial flows: one is related to the open circuit of the municipal financial network (W_{open}), while the other, to its closed circuits (W_{closed}), see Fig. 1c.

$$W_{total} = W_{open} + W_{closed} \quad (1)$$

This being said, the financial flows generated by commodity supplies in closed circuits W_{closed} will be fully balanced within the framework of the municipal economy. The rest of the W_{total} will belong to the open circuit and form W_{open} . This is the part of the internal turnover which participates in manufacturing the product within the closed production and market circuit but the finished product itself 'leaves' the municipality or is transferred to other participant enterprises of the open circuit.

To distinguish between these two commodity flows it is necessary to calculate the balance Δ of each enterprise as the difference between its debit D and its credit C :

$$\Delta_i = D_i - C_i, \text{ where } i \in \overline{1, n}. \quad (2)$$

The value of each enterprise's balance is given in the right column of Table 2. The total of the column 'Balance' is zero, since the debit and the credit are equal.

The values of unbalanced financial flows in the internal turnover of the municipal economy are at the intersection of the lines, in which $\Delta_i > 0$ (in Table 2 these are the lines № 1, 2, 10, 11, 12), and columns, in which $\Delta_i < 0$ (№ 3, 4, 5, 6, 7, 8, 9) [1]. The corresponding cells in Table 2 are highlighted by gray colour. The sum of the balance values in these cells equals $W_{open} = 2,628,277$ thousand roubles.

Then there will be the following volume of commodity flows, fully balanced in the closed circuits of the commodity network of this municipal economic model:

$$W_{closed} = W_{total} - W_{open} = 3,673,560 - 2,628,277 = 1,045,283 \text{ thousand roubles.}$$

1,045,283 thousand roubles, annually used in the balanced internal turnover in national currency, is quite a substantial sum of money for a municipality of ten thousand people. Given that the velocity of money turnover in the Russian economy is about five times per year, then it will take not less than 209 million roubles to provide the estimated balanced turnover. Taking into consideration the constant lack of working assets and the existing practice of lending money for these purposes, debt servicing of this sum, even at the refinancing rate of the Russian Central Bank of 8.25 % per annum, will require interest payments of 17 million roubles. These expenses are added to the production costs of commodities, which leads to growing prices and the loss of the competitive edge.

In the analyzed model, the cooperation coefficient of the municipal enterprises involved into the closed circuits of the commodity network is calculated the following way:

$$C_{coop} = W_{closed} / W_{total} \times 100 \% = 1\,045\,283 / 3\,673\,560 \times 100 \% = 28,5 \%.$$

Thus, 28.5 % of the internal commodity turnover in this model of the municipal economy is provided by the fully balanced internal financial estimates. In accordance with the theory of dual networks and the corresponding flows of commodities and money, a closed commodity flow should generate a transit (open) financial network consisting of two banks: a source bank ('internal' in relation to the closed commodity chain) and a stock bank ('external' bank).

The first of these banks provides mutual settlements between the subjects of the closed commodity network. Its role can be performed, for instance, by a municipal clearing centre or by an issuer of alternative settlement medium (ASM). ASM is not money in the full (common) sense of this word since it does not have the function of accumulation. At the same time, ASM cannot be called a monetary surrogate since it maintains a fundamentally different type of economic relations: those of cooperation, ensuring self-reproduction of the municipal economic system. As the international [7] and Russian practice⁵⁴ shows, ASM functioning can be organized within the existing legal framework with the payment of all the required taxes.

By introducing the sufficient amount of its own alternative settlement medium (ASM), the municipality will not only release financial resources of over 200 million roubles from the non-productive turnover (according to the model calculations) but will also avoid paying taxes for them and will 'saturate' the closed circuits of the commodity chain with the sufficient amount of liquidity. The negative interest rates applied to such ASM allow to increase the commodity exchange manifold and to enhance the production output and consumption inside the municipality [2, 8].

The second bank is an 'external' bank or a stock bank absorbing the taxes, investments, and the spare profit acquired from operations within the closed commodity network. This closed commodity network reproduces itself autopoetically [9] in each production cycle. However, it can always produce more than it is necessary for mere self-reproduction (the so-called clear balance in Leontiev's input-output model). In this case, the surplus of products is either spent on expanding the network's self-reproduction or is transferred to the 'external' environment through the open circuit: $B_1 \rightarrow B_2$ (Fig. 2). It is transferred not in the 'external' but in the 'internal' currency, which is secured by the products manufactured within the closed circuit.

Conclusion

The economy is based on internal production cycles in closed commodity circuits; the viable economy is always based on the mutually supportive and mutually enhancing internal production cycles. Since closed commodity cycles are provided with commodities and services, they function as engines and produce non-inflationary money. This also leads to other surprising practical conclusions concerning the popular innovation-driven economy: 1) when selecting innovation-enhancing measures, one should not get too excited about export projects but, on the contrary, develop projects targeted at internal consumption; 2) the crucial factor for innovation growth is not just the profit or the payback period, as it is commonly believed, but also the fact that innovation is 'embedded' into the cyclical process which maintains itself and generates high-quality money. Experts should be checking inter-production and inter-industrial relations to find chains which are capable of becoming the basis of a production cycle but for some reason fail to do so. These chains should be provided with sufficient funding to complete the commodity circuit and 'launch' this production cycle.

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References

1. Astafyev, N. M. (2010). Matrichnyy instrumentariy analiza balansovoy modeli i zadachi lineynogo programmirovaniya [Matrix tools of the balance model analysis and problem of linear programming]. *Trudy IMM UrO RAN* [Works of the Institute of Mathematics and Mechanics, UB RAS], 16, 3, 3-11.
2. Gezel, S. *Yestestvennyy ekonomicheskiy poryadok* [Natural economic order]. Available at: <http://www.demandandsupply.ru/gesell.html> (date of access: 18.05.2014).
3. Yeremien, I. I. (2001). *Dvoystvennost v lineynoy optimizatsii* [Duality in the linear optimization]. Yekaterinburg: UB RAS, 179.

⁵ Potapova O.V. In the moments of crisis they will be looking for something new and might choose our method. // T-Vlast. URL: <http://kommersant.ru/doc/2134930>.

4. Ignatova, M. A., Selezneva, N. A. & Ulyanova, Ye. A. (2014). Munitsipalnaya ekonomika. Model finansovoy seti vnutrennego rynka [Municipal economy. Model of financial network of domestic market]. *Sovremennyye problemy nauki i obrazovaniya* [Modern problems of science and education], 2. Available at: <http://www.science-education.ru/116-12901> (date of access: 08.05.2014).
5. Kastels, M.; Inozemtsev, V. L. (Ed.). (1999). Stanovlenie obshchestva setevykh struktur [New post-industrial wave in the West. Anthology]. *Novaya postindustrialnaya volna na Zapade. Antologiya* [New post-industrial wave in the West. Anthology]. Moscow: Academia, 494-505.
6. Leontyev, V. V. (2006). Obshcheekonomiceskie problemy mezhotraslevogo analiza [All-economic problems of the interindustry analysis]. *Izbrannyye proizvedeniya v 3-kh t. T.1. [Selected works in 3 vol. Vol. 1]*. Moscow: Economika, 407.
7. Lesh, A. (2007). *Prostranstvennaya organizatsiya khozyaystva: per. s nem.* [Spatial organization of economy: trans. from German]. Edited by Academision A. G. Granberg. Moscow: Nauka, 663.
8. Lietar, A. Bernar (2007). *Budushcheye deneg* [Future of money]. Moscow: KRPA Olimp; Astrel, 493.
9. Maturana, U. & Varela, F. (2001). *Drevo poznaniya. Biologicheskie korni chelovecheskogo ponimaniya* [Tree of knowledge. Biological roots of human understanding]. Translated from English by Yu.A. Danilova. Moscow: Progess-Traditsiya, 224.
10. Novikov, S. P. (2002). *Topologiya* [Topology]. Moscow — Izhevsk: Institute of Computer Science, 336.
11. Popokov, V. V. (2014). *Ekonomicheskiy konstruktivizm. Uskolzayushchaya realnost: chto kroyetsya za obektivnostyu ekonomicheskoy nauki?* [Economic constructivism. The elusive reality: what is behind of objectivity of economic science?]. Moscow: Lenand, 200.
12. Titov, L. Yu. (2009). Printsypry formirovaniya innovatsionnykh setey v realnom sektore ekonomiki [The principles of the innovative network development in real sector of economics]. *Problemy sovremennoy ekonomiki* [Problems of modern economics], 1, 64-67.
13. Fridman, M. (2002). *Osnovy monetarizma* [Principles of monetarism]. Moscow: TEIS, 175.
14. Khayek, F. A. (1996). *Chastnyye dengi* [Private money]. Moscow: BAKOM, 112.
15. Kharris, L. (1990). *Denezhnaya teoriya* [Monetary theory]. Moscow: Progress, 728.

Information about the authors

Popkov Valerian Vladimirovich (Ekaterinburg, Russia) — Doctor of Economics, Professor, Head of International A. Bogdanov Institute (105, Malysheva St., 620002 Ekaterinburg, Russia; e-mail: president.ibi@mail.ru).

Berg Dmitry Borisovich (Ekaterinburg, Russia) — Doctor of Physical and Mathematical Sciences, Professor of the Department of System Analysis and Decision Making, Graduate School of Economics and Management, Ural Federal University named after the First President of Russia B.N. Yeltsin; Chief Research Associate of the Industrial Ecology Institute, Ural Branch of the Russian Academy of Sciences (19, Mira St., 620002 Ekaterinburg; 20, S. Kovalevskoy St., 620990 Ekaterinburg, Russia; e-mail: bergd@mail.ru).

Selezneva Nadezhda Alekseyevna (Ekaterinburg, Russia) — Post-Graduate Student, Institute of Economics, Ural Branch of the Russian Academy of Sciences (29, Moskovskaya St., 620014 Ekaterinburg, Russia; e-mail: nadegda-x@mail.ru).

Ulyanova Yelizaveta Andreyevna (Ekaterinburg, Russia) — Deputy Director of the Centre for Regional Economic Studies of the Graduate School of Economics and Management, Ural Federal University named after the First President of Russia B.N. Yeltsin; Research Assistant of the Industrial Ecology Institute, Ural Branch of the Russian Academy of Sciences (19, Mira St., 620002 Ekaterinburg; 20, S. Kovalevskoy St., 620990 Yekaterinburg, Russia; e-mail: uralsertif@inbox.ru).