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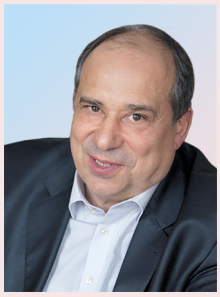
Production and Circulation in a Simple Exchange Economy



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Abstract. The article is methodological: it does not seek to analyze new economic phenomena; rather, its major aim is to study how these phenomena were formed and developed and how the market system was formed and developed with them. The actual subject of the study is a simple exchange economy model at the stage when production begins to be considered as its endogenous factor. This makes it possible to smoothly introduce the social division of labor into the analysis, to consider in the simplest form its combination with the differentiation of production functions in the framework of an individual household. We pay considerable attention to the analysis of socio-economic implications of the deepening of the social division of labor manifested in the transformation of the production of objects and means of labor into its independent links. We show why at this very stage of the study it becomes possible to provide a well-grounded substantiation for the mechanisms that form the market exchange value of consumer durables and means of labor, and, as a consequence, the interest rate. The introduction of the resource limitation factor into the analysis makes it possible to substantiate the need for the institution of ownership of such resources, the importance of absolute and differential natural rent for the normal functioning of the market economy, and to identify the specifics of formation of the market exchange value of land. We emphasize the importance of making the spatial dimension of the economy a full-fledged subject of analysis for pure economic theory. We touch upon a possible approach to the formulation of an initial model that would take into account the influence of space on the general parameters of economic activity. The main conclusion is that the model of a simple exchange economy helps to form a holistic view of all

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key categories (albeit in embryonic forms) reflecting the action of the market mechanism. At the same time, it becomes clear why further institutional transformations are required to realize all the potentials available in this form of economic activity organization.

Key words: simple exchange economy, social division of labor, comparative advantages, spatial dimension of general equilibrium, natural rent, interest rate, objective function of individual producer.

Transformation of production into an endogenous factor in a simple exchange economy

The analysis of the "pure exchange" economy (Nekipelov, 2021b) allowed us to determine the reasons that encourage free individual economic agents to engage in exchange relations with each other, and helped us to obtain an initial, essential understanding of such important phenomena and features of the market economy as current and trans-temporal exchange, exchange value, general equilibrium, competition, systems (including transaction) costs. The transformation of the sphere of production from an exogenous to an endogenous factor in an economy model based on in-kind exchange seems to be a natural next step in the framework of the research based on the "pure economic theory" paradigm (Nekipelov, 2019a).

At this new stage of analysis it becomes possible to clarify the factors leading to the formation and continuous deepening of the social division of labor, reveal the features of production relationships arising on this basis, and add to the idea of the phenomena and features of the exchange economy identified at the previous stage.

The starting point of the analysis is a model in which individual economic agents produce all the consumer goods necessary for their existence, and then use commodity exchange as a tool to further increase welfare. The analysis itself begins with a question of whether these economic agents can achieve even greater results if, at the stage of forming their production program, they will take into consideration the opportunities offered by exchange relations?

The nature of the social division of labor

Fundamentals of the social division of labor

Thus, we proceed from the fact that the economy under consideration has m economic agents, each of which autonomously produces all consumer goods in a certain amount $x_i \geq 0\ (i = 1, \ldots, n)$. The assumption means that their production activity covers all links of the technological chain from mining to the production of final consumer goods.

Generally speaking, to each of the links in any such chain corresponds its own production function. However, for simplicity, we will initially assume that all the mentioned chains are single-link chains, i.e. that there is a single production function linking the output of a consumer good to the natural resources used and the labor of an economic agent. For the same reason, we will initially assume that the factors of production used include only labor and natural resources, and the latter are unlimited.

Our first task is to identify the forces leading to the formation of the social division of labor, based on the results obtained while analyzing the Robinson Crusoe model and the pure exchange model.

Naturally, we will proceed from the fact that the objective function of the subject of economic activity is to maximize his own welfare:

$$\max U(x_1, \ldots, x_n) \qquad (1)$$

In this case an economic agent must reckon with the fact that the exchange value of the goods $y_1,\ldots,y_n$ must be equal to the exchange value of the goods produced $x_1,\ldots,x_n$, which he will possess after

the exchange, and the total amount of time $\sum_i t_i$, spent on the production of each good must be equal to the total duration of the work period:

$$\sum_i [y_i(t_i) - x_i] \cdot EV_i = 0 \quad (2)$$

$$T - \sum_i t_i = 0, \quad (3)$$

where EV_i is the exchange value of the i-th good.

In order to find the necessary conditions of the maximum of the objective function, we equate the first partial derivatives of the Lagrange function to zero:

$$\frac{\partial \Im}{\partial x_i} = \frac{\partial U}{\partial x_i} - \lambda_1 \cdot EV_i = 0 \quad (4)$$

$$\frac{\partial \Im}{\partial t_i} = \lambda_1 \cdot \frac{dy_i}{dt_i} \cdot EV_i - \lambda_2 = 0 \quad (5)$$

$$\frac{\partial \Im}{\partial \lambda_1} = \sum_i [y_i(t_i) - x_i] \cdot EV_i = 0 \quad (6)$$

$$\frac{\partial \Im}{\partial \lambda_2} = T - \sum_i t_i = 0 \quad (7)$$

It follows from the equations (*4*) that in the optimal position the marginal rate of substitution of one good for the other must be equal to the inverse ratio of their exchange values: $\frac{\partial x_j}{\partial x_i} = \frac{EV_i}{EV_j}$.

However, the equations (*5*) deserve special attention. Considering them, first of all, we can conclude that the output should be organized in such a way that the marginal value product of labor $\frac{dy_i}{dt_i} \cdot EV_i$ turns out to be equal to the ratio of Lagrange multipliers λ_2 (represents the marginal utility of the time of production activity) and λ_1 (represents the marginal utility of an exchange value). At the same time, the principle of forming the output structure, which allows an economic agent to achieve this result, boils down to the following.

In an effort to maximize the total exchange value, the agent should start with the type of activity characterized by the highest marginal value product of labor, or, what is the same, the smallest ratio of the unit time spent on production to the exchange value $\frac{a_i(t_0)}{EV_i}$, where t_0 is the zero moment of time.

If labor productivity for all the goods remains unchanged throughout the entire period of work T, that is, if $\frac{dy_i}{dt_i} = \frac{1}{a_i} = const$, then the economic agent should concentrate entirely on the production of the good chosen from the very beginning and continue this activity until the indicator is equal to the marginal utility of leisure. We note that in this case we achieve a result corresponding to the famous Torrens – Ricardo theory of comparative advantages (costs) (Torrens, 1808, p. 37; Ricardo, 1817, pp. 160–162), which, as is known, was developed for the conditions of international trade.

The situation turns out to be more complicated if the functions of the marginal products of labor used to produce different goods are variable – for example, decreasing due to fatigue accumulating in the producer. In this case, it is possible that at certain points in the working period, comparative advantages will shift from one good to another. Then and only then the economic agent will have to distribute working time on the production of more than one good.

Anyway, the solution of the system of equations (*4*) – (7) allows us to obtain vectors of output (vector y), consumed (vector x), and, consequently, exchanged (vector $z = x - y$) goods.

Let us return to the situation in which there are fixed levels of labor productivity in the output of all goods. Let the specific time spent on the production of consumer goods of the k-th subject of economic activity be given by the vector $(a_1^k, \ldots, a_n^k)$, and the exchange values of goods formed during the previous acts of "random exchange" – by the vector $(1, EV_2, \ldots, EV_n)$ (the first good is a good used as the counter). Then, as we have seen, the

economic agent in question should specialize in the production of a good that is characterized by the smallest ratio $\frac{a_i^k}{EV_i}$: in this case, the alternative ("roundabout") costs[1] of obtaining any other good will be lower that direct costs:

$$a_{j'}^k = a_i^k \cdot \frac{EV_j}{EV_i} < a_j^k, \quad (8)$$

where $a_{j'}^k$ – alternative costs, a_j^k – direct unit costs of obtaining the j-th good by the k-th producer.

It is clear that in this model, where the only limited factor of production is labor (more precisely, the time allocated for labor activity by an economic agent), in an equilibrium position, the ratio of specific alternative (labor) costs of obtaining goods through exchange to direct (labor) costs of production of the good that the economic agent specializes in are equal to the ratio of exchange values of the goods:

$$\frac{a_{j'}^k}{a_i^k} = \frac{EV_j}{EV_i} \quad (9)$$

A specific type of labor spent on the production of the good i, from the point of view of the producer k, acquires a special property in the conditions of the exchange economy. The product of this type of labor activity turns out to be any good: directly – the one that is produced, and indirectly – through exchange – any other good. In this regard, an analogy with abstract labor, as defined by Karl Marx, suggests itself (Marx, 1961, p. 47). However, this analogy has significant limitations. According to Marx, abstract labor is what all types of labor of all economic agents have in common. Such labor in the labor theory of value is considered as the basis of a special social substance inherent in any commodity – value, which, in turn, finds external manifestation in the proportions of exchange. Within the framework of our approach, each producer, figuratively speaking, has his own "abstract labor" and, accordingly, his own "cost" of goods. Moreover, this individual and abstract labor turns out to be such only due to the fact that the proportions of exchange (exchange values) already exist.

Dynamics of the social division of labor: causes and implications

Transformation of the subjects of labor into commodities

Let us now return to our assumption that natural resources are separated from consumption by only one technological processing stage. In fact, this assumption corresponds to the situation when one's production activity is reduced to "gathering" – collecting consumer goods provided by nature. The transition to independent production of consumer goods presupposes the existence of at least two technological links. The first one consists in separating certain elements from the natural environment (for example, wood, coal, ores). The second and possible subsequent links are connected with the processing of raw materials obtained at the first stage into final products.

Continuous complication of the structure of social production – first as a result of the formation of a two-tier technological structure, and then due to its continuous differentiation manifested in the emergence of new processing stages – is an inevitable consequence of the emergence of new and more advanced technology. But then the question arises: should an individual subject of economic activity continue to take on all the work aimed at producing a consumer good, or would it be wiser for him to focus on individual stages of technological processing?

In fact, this question has long been of interest to theoretical economists. Thus, Karl Marx noted internal production functions naturally turning into independent links of the social division of labor (Marx, 1961, pp. 363–372), and R. Coase put

[1] That is, the costs associated with obtaining the good j through exchange rather than as a result of its production by the k-th economic agent.

forward the idea that the boundary between the intra-company and social division of labor is where the marginal transaction costs associated with the reduction in the area of the company's production activity are equal to the marginal management costs associated with its expansion (Coase, 1937).

At the level of a simple economic model under consideration we must first of all reveal a mechanism governing the participation of the objects of labor in exchange transactions. The fact is that this type of product does not directly satisfy human needs, and therefore the proportions in which the corresponding goods are exchanged for others cannot be based on marginal utility estimates.

Microeconomic theory has formed a clear viewpoint on this issue: the participation of the factors of production (including the objects of labor) in the exchange is associated with the demand of producers, which, in turn, is derivative in relation to the demand for consumer goods produced with the use of these factors of production. This conclusion is substantiated with the help of a model of maximizing the objective function of an economic agent (usually a firm). We have only to apply this approach to the model of a simple exchange economy.

Let an individual economic agent specializing in the final stage of technological processing leading to the creation of a consumer good be able to obtain the necessary object of labor through exchange. At the same time, due to the desire for the highest possible level of satisfaction of his own needs, he is interested in choosing such a combination of factors of production (we mean labor services and objects of labor) that ensures his maximizing the net exchange value of the goods produced (gross exchange value minus the exchange value of the subjects of labor used in production):

$$Max\ NEV = Y\left(x_L^0, x_{RM_1}, \dots, x_{RM_q}\right) \cdot EV_{CG} - \\ - \sum_{q=1}^{Q} x_{RM_q} \cdot EV_{RM_q}, \quad (10)$$

where NEV – net exchange value, x_L^0 – labor services that act as a parameter in the production function of an individual producer, $x_{RM_1}, \dots, x_{RM_q}$ – raw materials (objects of labor) used in the production, $Y\left(x_L^0, x_{RM_1}, \dots, x_{RM_q}\right)$ – production function, EV_{CG} – exchange value of the consumer good, EV_{RM_q} – exchange value of the q-th raw material.

A necessary condition for the existence of the maximum of this function is the equality of the marginal value product of labor to its exchange value: $\frac{\partial Y}{\partial x_{RM_q}} \cdot EV_{CG} = EV_{RM_q}$. In relation to a given production function this means that the demand of an economic agent for an object of labor is a function of the own exchange value of the latter, the exchange value of other raw materials, and the exchange value of the final product (consumer good):

$$x_{RM_q}^* = x_{RM_q}^*\left(EV_{RM_1}, \dots, EV_{RM_q}, EV_{CG}\right) \quad (11)$$

As for the "penultimate" stage of technological processing, the demand for the objects of labor will be directly determined by the demand for its products from the "final" processing stage and, indirectly, by the demand for a consumer good produced at the final processing stage. In other words, as we move away from the final link of a technological chain, the demand for intermediate products will depend more and more indirectly on the demand for consumer goods, but this connection will remain under any condition.

Since there is a clear mechanism for the formation of demand for intermediate products, the decision of an economic agent acting within the framework of the economic model under consideration regarding the sphere of specialization can be thoroughly explained using the theory of comparative costs. The difference in comparison with the algorithm described earlier is only that

the scope of choice is noticeably expanding for an individual producer: now he can specialize not only in the production of individual consumer goods, but also the objects of labor.

We should note that the supply of intermediate products (and it is the reverse side of specialization) always comes from the previous link of the technological chain, in relation to its scope of application. It is known that the corresponding function is obtained by replacing the factors of production as independent variables in the production function with their demand functions (this ensures that the output value invariably corresponds to the task of maximizing the objective function of the economic agent):

$$Y^* = Y\left[x_L^0, x_{RM_1}^*, \dots, x_{RM_q}^*\right], \qquad (12)$$

where Y^* is the supply function (in this case, of an intermediate product).

The question arises: does the thesis on the applicability of the theory of comparative costs to the solution of the issue of specialization of an individual producer imply that the labor activity of the latter should be limited to only one link in the technological chain? This problem can be formulated in another way: how, within the framework of the approach under consideration and with the restrictions adopted within it (in particular, when analyzing the problem in relation to the conditions of complete certainty), can one explain the fact that in practice economic agents almost never limit their production activity to performing one technological operation? It is clear that with any formulation, we are talking about defining the boundary between the social division of labor and the intra-economic division of production functions.

Let there be m types of consumer goods and Q types of intermediate products that are the result of homogeneous technological processes; accordingly, the total number of goods produced is $n = m + Q$. We proceed further from the fact that the number of economic agents N exceeds the number of produced goods n, and each of the producers has a fundamental ability to produce any type of goods. Accordingly, the production function of the k-th producer in the j-th type of activity is as follows: $Y_j^k = Y_j^k\left(x_L^0, x_{RM_1}, \dots, x_{RM_q}\right), j = 1, \dots, n$.

Obviously, in accordance with the principle of comparative costs, the output of more than one good is justified only when the unit time costs[2] spent per unit of "net exchange value"[3] are the same for several types of goods. At that we should take into account that the very value of unit costs is under the influence of the forces caused by the process of specialization, moreover, the forces that are oriented in the opposite direction. The positive effect of a higher level of specialization is due to the fact that the producer gets an opportunity to increase the level of professional skill in selected activities and minimize the time spent on the transition from one of them to another. At the same time, both in the production and in the institutional area, we reveal the action of opposite forces. The first are associated with the spatial dispersion of production in the conditions of specialization and, as a result, with an increase in transportation costs[4]. The second are associated with an increase in transaction costs – the time spent on concluding market transactions due to an increase in the number of the latter. As always happens in the presence of such "costs", the producer should strive to ensure that the marginal benefits of increased specialization are equal to the marginal costs accompanying this process.

This conclusion is obviously consonant with Coase's idea. But there is a difference. A firm, unlike an individual economic agent, has a

[2] In the case of variable cost coefficients, the adjustments discussed at the beginning of the section should be made.

[3] This refers to the exchange value of the good placed on the market minus the exchange value of the objects of labor acquired elsewhere and used in production.

[4] More details about the role of the spatial factor will be given below.

fundamental ability to attract the factors of production of required quality (including workforce) for any production processes. Under these conditions, the value of the comparative advantage factor is largely leveled. At the same time, if we ignore the question of the availability of capital, a firm, unlike an individual producer, has the ability to scale output in any direction almost indefinitely. And in these conditions, the question of the costs of managing large production structures inevitably comes to the fore. Its peculiar analogue in the conditions of individual production – the losses associated with the need to switch from one type of activity to another – is significantly less important.

We should note that these differences are important from a methodological point of view: after all, they confirm how important it is to analyze not only the state in which the economic system is in a particular period, but also its development.

Transformation of consumer goods of durable use and means of labor into a commodity

In the world of goods, a special place belongs to consumer durables and means of labor: their beneficial effect (respectively in the sphere of consumption and production) extends for a more or less long time in comparison with ordinary goods. Due to this circumstance, such goods are carriers of two exchange values – the exchange value of the services they provide during a single period of time (current exchange value), and the exchange value of the flow of services for the entire period of their operation (trans-temporal, or commodity, exchange value). The first type of exchange value is realized within the framework of a lease relationship, and the second – in the framework of an exchange transaction accompanied by a change of ownership of the corresponding good.

The current demand is for the **services** provided by durable goods. Let us consider the features of such demand first in relation to consumer durables ("capital goods"), and then – in relation to the means of labor.

The demand function for the services provided by the durable good $m + 1$ will be as follows: $x'^{*}_{m+1} = x'^{*}_{m+1}(EV_1, \dots, EV_m, EV'_{m+1}, NEV)$, where x'^{*}_{m+1} – demand for the services of the $(m + 1)$-good (capital good), EV'_{m+1} – exchange value of the services of the capital good, NEV – net exchange value of the goods (good) in the production of which the economic agent[5] in question specializes. As in the case of ordinary goods, this function is formed in such a way as to maximize the utility function of the consumer. Accordingly, the desired value of the services of such goods will be set by the consumer at such a level that the marginal rate of their substitution with a good used as the counter is equal to their exchange value (rental value).

The demand for the services of the means of labor, like the demand for the objects of labor, is formed in such a way as to maximize the objective function of the individual producer. The function in the conditions under consideration will be as follows[6]:

$$Max\ NEV = Y_i\left(x_L^0, x_{RM_1}, \dots, x_{RM_q}, x'_K\right) \cdot EV_i - \\ - \sum_{q=1}^{Q} x_{RM_q} \cdot EV_{RM_q} - x'_K \cdot EV'_K, \quad (13)$$

where Y_i – output of products that the economic agent specializes in, EV_i – exchange value of a unit of goods produced, x'_K – value of services of the applied means of labor (physical capital), EV'_K – factor exchange value (exchange value of services) of capital. Accordingly, one of the necessary conditions for the maximum of this function is the equality of the marginal value service of the means of labor to its exchange value: $\frac{\partial Y_i}{\partial x'_K} \cdot EV_i = EV'_K$. The very same function of demand for the services provided by the means of labor is as follows:

$$x'^{*}_K = x'^{*}_K\left(EV_{RM_1}, \dots, EV_{RM_q}, EV_i, EV'_K\right) \quad (14)$$

[5] This indicator is an analogue of the consumer's income in the monetary economy.

[6] For simplicity, we assume that an economic agent specializes in the production of one type of good.

An economic agent chooses a capital consumer good or a means of labor as an object of specialization in exactly the same way as any other good: it is important for him that the ratio of unit costs of production to its **commodity** exchange value should be the smallest. In other words, the economic agent will produce the durable K only if $\frac{a_k}{EV_K} = min\left\{\frac{a_1}{EV_1}, \dots, \frac{a_n}{EV_n}, \frac{a_k}{EV_K}\right\}$. Accordingly, the individual supply function for such goods will be as follows:

$$y_K^* = y_K^*\left(EV_{RM_1}, \dots, EV_{RM_q}, EV_i, EV_K\right) \quad (15)$$

A seemingly contradictory situation has developed: the demand is for the services of durable goods (see formula *(14)*), and the supply is formed in relation to the goods themselves (see formula *(15)*). But we must keep in mind that the magnitude of the services of a durable good is derived from its quantity. In other words, in order to receive the services of such a good x'_K during the period under consideration, it is necessary to have it in the amount x_K. Taking this into consideration, we see that the process of forming the commodity exchange value of durable goods becomes clear.

The market function of the supply of such goods consists of the individual supply functions of economic agents; similarly, the market function of the demand for their services consists of the corresponding individual functions. Since the satisfaction of demand for services x'_K implies the availability of supply $y_K = x_K$ of these goods themselves, then in the process of market interaction of economic entities, equilibrium levels of demand for their services, production (supply) of these goods, as well as the exchange value of their services and their commodity exchange value are **formed simultaneously**. At the same time, the exchange value of capital goods services, based on a relative marginal assessment of their utility, is **logically primary** in relation to the commodity exchange value: the former is introduced into the analysis at the stage of analyzing the pure trade model, and the latter – only when taking into account the conditions prevailing in the sphere of production.

The problems associated with analyzing the process of production and circulation of durable goods do not end there. The reasons why an economic agent assumes the functions of an investor, which are inevitably required in connection with the production and circulation of such goods, demand an explanation. The investor turns out to be a manufacturer if he agrees to transfer durable goods to the consumer on the basis of a lease for the entire period of its existence. The roles will change if the consumer agrees to a transaction in which the good becomes his property.

This problem is resolved on the basis of credit relations, and the lender can be either an economic agent external to the exchange participants, or one of them. If a third party provides a loan to the manufacturer of durable goods, then the latter can, without prejudice to himself, establish rental relations with the consumer. And, on the contrary, if a loan is provided to the consumer, then he is ready to purchase the good into ownership. In the absence of an external creditor, his functions will inevitably be performed by one of the exchange participants.

If the manufacturer agrees to transfer a durable good to the consumer on the basis of a lease for the entire period of its existence, then he *de facto* becomes a creditor: after all, this case is equivalent to concluding two transactions – granting a loan to the consumer and acquiring ownership of a durable good by the latter. If the consumer agrees to purchase a durable good, then he turns out to be the actual creditor. In this case, the same result can be obtained with the help of two interrelated transactions: the provision of credit by the consumer to the manufacturer when the latter leases durable goods out (in both cases, loan servicing deliveries are repaid by deliveries against lease obligations).

Of course, so far we have simply transformed the "investment problem" into a "lending problem". However, such a transformation does not resemble "ploughing the sands". The fact is that we have at our disposal the opportunity to build a model that allows us to determine the amount of net credit that each economic agent will be interested in providing (obtaining) at different values of the exchange value of the service provided by a capital good, its commodity exchange value and interest rate (Nekipelov, 2021a, p. 16). The most important conclusion suggested by this model is that the value of the loan provided (attracted) is optimal when the ratio of the commodity exchange value for each durable good to the relative marginal valuation of its services is equal to the sum of discounts during its operation:

$$\frac{EV_K}{MRS'_{1/K}} = S, \qquad (16)$$

where $MRS'_{1/K}$ is the marginal rate of substitution of services of the capital good with a good used as the counter, $S = \sum_{t=1}^{T} \frac{1}{(1+r)^t}$ is the amount of discounts for T periods during which the "capital good" provides services (r is the interest rate for the period, t is the period number).

Since in the equilibrium position the relative marginal valuation of durable goods services $MRS'_{1/K}$ is equal to the exchange value of these services EV'_K, insofar the ratio of two exchange values of such goods – EV_K and EV'_K – uniquely identifies the value of S, and, consequently, the value of the equilibrium interest rate.

The equilibrium levels of exchange values of individual goods, exchange values of durable goods services, their commodity exchange values and interest rates are formed **simultaneously**. However, the **logical sequence**, as evidenced by the analysis, is represented by the following chain: exchange values of non-durable goods and exchange values of services of durable goods – commodity exchange values of durable goods – interest rate. Of course, in the current plan, there may be non-equilibrium levels of these important indicators, but it is important that then forces aimed at bringing the economic system into a state of general equilibrium come into play.

Thus, the development of the social division of labor associated with the transformation of durable goods into a commodity is inevitably accompanied not only by the usual (current) exchange, like in the case of non-durables, but also by credit transactions that service trans-temporal exchange occurring simultaneously with them. The total amount of credit flows turns out to be derived from the total exchange value of durable goods produced, and the current and trans-temporal exchange values of durable goods are logically primary in relation to the interest rate. The mechanism of direct and inverse relationships between the interest rate, production and, accordingly, credit, current and trans-temporal exchange values ensures the achievement of an equilibrium state.

General equilibrium in a simple exchange economy

General changes related to the transformation of production into an endogenous factor in an exchange economy

In the conditions of the social division of labor, the problem of general equilibrium undergoes certain modifications. Within the framework of pure trade, as shown by L. Walras (Walras, 1874), its most important feature was the equality of the relative marginal valuations of all goods for all economic agents to their social exchange values expressed through the exchange value of a good used as the counter. This requirement turns out to be insufficient for an economic system whose participants are not only consumers, but also producers. In such a situation, it becomes fundamentally important that each producer should specialize in the type of activity in which he has a comparative advantage.

The second most important feature of the general equilibrium in conditions when production becomes its endogenous factor is associated with the need to take into account the possibility of existence of limited natural resources. The analysis of the influence of this feature, which may be inherent in a larger or smaller number of resources, on economic decision-making was started in the framework of the Robinson Crusoe model (Nekipelov, 2019b). It was shown that in an optimal situation, the marginal return of time allocated to those types of production where such resources are used will be higher than in other types of activity. This circumstance manifests itself in a specific way in the conditions of a simple exchange economy.

The availability of limited resources leads to the fact that the second of the above-mentioned conditions of general equilibrium is violated – the opportunity for each economic agent to choose the type of activity that provides the greatest return on the labor efforts. A natural question arises: can access to limited resources in forms that do not contradict the basic conditions of a market economy be provided in such conditions?

The answer to this question has long been known to economic theory: see, for example: (Ricardo, 1817), (Marx, 1961). The solution to the problem is connected with the emergence of the institution of ownership of land and, accordingly, the arrival of the owner of natural resources. As a result, access to resources becomes paid, and the amount of corresponding payments is formed during the interaction of owners and potential users of resources and is set at a level at which the production of goods using scarce resources is equal to the public demand for such goods.

Payment for access to limited natural resources, which is an economic form of the realization of land ownership, has been called resource rent. Taking into account the fact that natural resources may differ from each other in qualitative terms, it becomes necessary to distinguish between absolute and differential resource rent. The former represents the amount of payment for access to the worst-quality natural resources, the use of which is a prerequisite for achieving market equilibrium; the latter characterizes the value of the "premium" that the market gives to owners of natural resources of higher quality.

Special attention should be paid to the analysis of the mechanism of formation of commodity exchange value for natural means of labor (land). The fact is that the approach from the standpoint of comparative costs, which was used in constructing the supply function of means of labor, which are the product of human activity, cannot be applied here. Therefore, it turns out that the emergence of transactions accompanied by a change of ownership of a natural means of labor is logically possible only when the conditions for credit relations have already been formed in the economic system and the interest rate formation mechanism is in effect. In this case, we naturally come to a well-known conclusion that the price (in our case, the commodity exchange value of land) is determined by capitalizing the flow of rent payments (in our case, the exchange value of rent deliveries). In other words, the commodity exchange value of land turns out to be derived not only from its factor exchange value (rent), but also from the interest rate.

The role of the uncertainty factor

In the framework of a Robinson Crusoe economy, possible deviations of the results of production activity from those that were planned by the economic agent were explained primarily by the unpredictability of the conditions of the natural environment surrounding him. When shifting to the study of a simple exchange economy, the problem of uncertainty undergoes some modifications. Here, the impossibility for an economic agent to accurately anticipate the behavior of other

economic participants comes to the fore. It becomes clear that uncertainty and the risks associated with it are a trait inherent in a market economy[7].

An economic agent who does not have all the information inevitably has to face the risk of the changing proportions of exchange (both current and trans-temporal). The ways in which such risks affect the behavior of a market economy agent, in particular, the amount of output he sets, are well described in standard courses on microeconomics. Here, taking into account the specifics of a simple exchange economy (individual nature of production activity and the specifics of the motivation of economic agents associated with it; in-kind exchange), it is necessary to make only a small and routine adjustment to the corresponding model apparatus.

After the Crusoe model, the focus on the uncertainty of economic activity helps to expand the idea not only about the spheres of its manifestation, but also about the possibilities of adaptation to the risks that economic agents face in a simple exchange economy. The accumulation of stocks which was the only risk reduction tool for an isolated economic entity is supplemented by the diversification of the goods produced: after all, in this case, the unfavorable dynamics of the proportions of exchange for one of the goods can be compensated by beneficial changes in the exchange value of other goods.

It is also obvious that the situation of uncertainty inherent in an exchange economy, while influencing the behavior of economic agents, directly affects the specific parameters of the state of general equilibrium.

On the spatial dimension of a simple exchange economy

The classical way of studying general equilibrium issues typically avoids the question concerning the role of the spatial factor[8]. That is why W. Isard, the renowned American scientist in the field of regional economics, stated that the corresponding models, in fact, describe the "one-point world" (Isard, 1956, p. 26). It is unlikely that such a state of affairs can be considered normal for general economic theory: after all, space, like time, sets the coordinate system in which all economic activity takes place. Therefore, the neglect of spatial problems, which M. Blaug described as "one of the great mysteries in the development of economic science" (Blaug, 1994, p. 58), causes serious damage to its integrity.

The spatial dimension of the economic system is already evident in the analysis of the Robinson Crusoe model. In (Nekipelov, 2019b), a model was formulated for an isolated economic agent to choose the optimal place of residence, taking into account the location of natural resources he used in his work. In the conditions of a simple exchange economy based on the social division of labor, the spatial problem becomes much more complicated: now the decision of each economic entity is influenced not only by the location of natural resources, but also by the location of the other members of the community. It is for a reason that problems begin to emerge already when trying to determine which model should be used as a basis in analyzing the role of the spatial factor in the conditions of the social division of labor.

It is quite natural for the general economic theory to rely on the idea of an "ideal space (state)" by von Thünen (Thünen, 1895). But here, too, an important question arises: how homogeneous should such a territory be? In other words, do we assume that this quality concerns not only the terrain and climate, but also the location of natural resources? The problem here is that the assumption of an absolutely uniform distribution of resources in the territory under consideration will inevitably lead

[7] This means that when we analyze the situation in the conditions of certainty, which is a completely justified technique, then, strictly speaking, we go beyond this economic system.

[8] It is noteworthy that the fundamental monograph (Katzner, 2006) written from the standpoint of the Walrasian theory of general equilibrium bypasses this problem completely.

us to the conclusion that any point in such a space is suitable for accommodating all producers.

In this regard, we immediately come across the following question. Is it justified to assume the possibility of a "point" location of natural resources and economic agents, that is, in fact, to assume that their localization does not require any land area. The negative answer, of course, fully corresponds to the real state of affairs, but at the same time generates intractable problems associated with the need to supplement the abstract analysis, typical of the general theory, with assumptions about the area occupied by various natural objects and economic agents. In this sense, the assumption of "point" location seems very attractive. But what about those types of activity, for example, agriculture, in which the area of land used is a key feature of the main factor of production for the relevant field of activity?[9]

With regard to the territory, the question also arises whether we should somehow limit it from the very beginning or not. Von Thünen's "ideal state", as we know, was a circle with a city in its center. But, perhaps, if we assume that natural resources necessary for production activity have a fixed location, then such a restriction is not required. In this case, the task will not be to show how economic agents are located in a given territory, but to identify the boundaries of the territory where the particular community of people live and conduct production activities. The advantage of this approach is that it can help to identify both the forces acting toward the concentration of population in a certain territory, and the forces aimed at eliminating the isolation of individual communities.

But, of course, it is not only about these purely spatial problems. From an economic standpoint, the key change associated with the inclusion of the spatial factor in the analysis is the emergence of transport costs accompanying the movement of goods between producers and consumers. The consequences of this circumstance are very diverse.

First of all, attention should be paid to the fact that the mechanism of comparative advantages undergoes serious modification in these conditions: transport costs increase the "roundabout" (alternative) costs of goods received through exchange, and therefore act as a force restraining the development of the social division of labor[10]. This very circumstance allows us to talk about the existence, at a given level of technological development, of economically rational boundaries of the territory for conducting economic activity based on available natural resources.

The most serious attention should be paid to the fact that due to the different position in space, the "final" (taking into account transport costs) exchange value of the same goods will not coincide among different consumers[11]. Moreover, it is almost inevitable that individual consumers will have to purchase the goods they need from various producers. And this means that the "final exchange value" of the same good received from producers located at unequal distances will be different.

[9] Having encountered this problem, von Thünen (Thünen, 1895) found a completely reasonable solution combining "point" and "spatial" localization of economic agents. In his model, as we know, the city in which all consumers are concentrated is located at the central point of the circle, and farmers occupy its entire area.

[10] Thus, the third reason is revealed that explains why the specialization of the producer, as a rule, is not absolute, that is, it is not reduced to the implementation of a single technological operation. The first one is the possible dynamics of comparative advantages of two or more goods; the second one is related to the influence of the abovementioned uncertainty factor.

[11] On this basis, M. Blaug actually concludes that taking into account the spatial factor "kills" perfect competition: "Classical location theory was posited on the assumption of perfect competition but if firms compete spatially by f.o.b. pricing, the market structure is one of monopolistic, not perfect competition". The consequences of this state of affairs, according to Blaug, are very serious: "Unfortunately, monopolistic competition theory offers few unambiguous implications about firm behavior and, indeed, to this day there is little agreement about what is implied by monopolistic competition models of spatial differentiation" (Blaug, 1994, pp. 582–583).

Finally, we should bear in mind that the results of the analysis will significantly depend on institutional assumptions. Apparently, at the first stage it is reasonable to proceed from the fact that economic agents have all the information concerning both their production capabilities and their systems of individual preferences, as well as the ability to draw accurate conclusions from this information. Based on the study of such a model, it is possible to come to important conclusions concerning the role of the spatial factor in the formation of general equilibrium in the complete absence of "friction" accompanying the process of formation of commodity flows between members of society. In turn, if the abovementioned assumption of the absolute rationality of economic agents is abandoned at the second stage of the study, then it will be possible to substantiate the causes of the emergence of a localized market (the so-called marketplace), within which there is direct interaction between producers and consumers. This will make it possible to introduce such an important economic category as location rent into the analysis.

A special study of the features of the formation of general equilibrium, taking into account the spatial dimension of the economic system, goes beyond the scope of the subject of this article. At the same time, it seemed absolutely necessary to draw attention to the importance of introducing this factor into the analysis already at the stage of a simple exchange economy.

Social division of labor and the objective function of an individual commodity producer

The formation of an exchange economy, the limited amount of certain types of natural resources, the transformation of objects and means of labor into commodities – all this leads to the transformation of the objective function of the actor of economic activity. Let us summarize the changes taking place in this regard.

The natural aspiration of an isolated economic agent, Robinson, was to maximize his own utility function in the conditions of limitations set by both the duration of the period under consideration and the material factors of production at his disposal.

The emergence of exchange relations and then the development of general division of labor between previously isolated economic agents lead to a certain change in the situation. Granted, even under these conditions, every economic actor is interested in maximizing his own welfare. However, now the condition for solving this problem is the choice of a production program that helps to obtain a good with the maximum net exchange value. The economic agent associates the value of the latter with his own labor contribution to the results of production activity.

Under all conditions (they will be discussed below), the search for such a production program is carried out in two stages. At the first stage, the producer calculates the net exchange value which he can obtain if he specializes in the production of each of the existing goods. At the second stage, the producer determines the sphere of activity in which, with the exchange values of goods prevailing on the market, the ratio of his labor costs to the net exchange value is minimal. The corresponding good (or any of a number of goods – if of each of them has the minimum level of the corresponding indicator) and should be selected as an object of specialization.

In conditions when the object of the division of labor is exclusively consumer goods and services, when natural resources are unlimited, and when there are no means of labor, the value of the net exchange value coincides with the (gross) exchange value of the good produced, and it is this value that the producer's labor efforts should comply with.

The presence of limited natural resources leads to the emergence of the first element of economic costs – the exchange value of the services they provide (rental deliveries). The latter represent the actual current costs for economic agents who, in the production process, use scarce resources that do not

belong to them, and the opportunity costs for the owners of these natural factors of production who conduct independent production. In both cases, the net exchange value subject to maximization, which the producer associated with his own labor contribution, will be expressed by the formula (17).

$$NEV_i = TEV_i - \sum_j Rent_j \cdot Z_j = TEV_i - Rent, \quad (17)$$

where NEV_i is the net exchange value of the good i, TEV_i is the total exchange value of the good i, $Rent_j$ is the exchange value of rental deliveries for the right of access for a single period of time to the unit of resource j, Z_j is the amount of the resource j required for the manufacturer of the good i, *Rent* is the total exchange value of deliveries against rental payments.

The situation undergoes further changes when the objects of labor become the object of exchange. Under these conditions, it is necessary to subtract from the total exchange value of the goods produced, along with rent, the exchange value of the objects of labor acquired through exchange and used in production. Accordingly, the cost of purchasing the objects of labor becomes the second element of current economic costs.

The transformation of the means of labor into an object of the social division of labor leads to further modification of the objective function of an individual producer. Now the normal return on physical capital corresponding to the exchange value of the services of the used means of labor (the exchange value of lease deliveries when renting the corresponding factors of production) should be included in the composition of economic costs. This element of economic costs, in turn, is divided into two parts – the interest return on the means of labor and depreciation:

$$\sum_i KY_i = \sum_i \left(r \cdot K_i \cdot EV_{K_i} + A_i \cdot K_i\right) = \sum_i K_i \cdot \left(r \cdot EV_{K_i} + A_i\right), \quad (18)$$

where KY_i is the normal return of the i-th means of labor, r is the interest rate, EV_{Ki} is the commodity exchange value of the i-th means of labor, A_i is the depreciation rate per unit of the means of labor.

The net exchange value with which the producer associates his labor contribution is now determined for each type of activity by the formula *(13)*, in which the normal return of the means of labor $(x'_K \cdot EV'_K)$ can be represented, as follows from the formula *(18)*, by the expression $\sum_i K_i \cdot \left(r \cdot EV_{K_i} + A_i\right)$

The metamorphoses that the objective function of an individual economic agent is going through along with the development of the social division of labor are projected onto the structure of the exchange value of the produced good. Ultimately, the exchange value of a unit of any commodity breaks up into parts, each of which is associated with the contribution of the corresponding factor of production: the exchange value of rent deliveries $\frac{Rent}{Y}$ – with the contribution of natural factors of production, the exchange value of the objects of labor used in the production $\frac{RMC}{Y}$ and the normal return of the means of labor $\frac{\sum_i K_i \cdot \left(r \cdot EV_{K_i} + A_i\right)}{Y}$ – with the contribution of physical capital, and the residual (net) exchange value $\frac{LY}{Y}$ – with the contribution of labor[12].

Conclusions

The material presented in the paper is a result of the efforts aimed at building such an intellectual model of a market economic system that would not only reflect the set of existing functional dependencies between its various parameters and describe the state of the institutional environment at a certain point in time, but also give an idea of enriching the content of economic concepts alongside the transition from simple forms of the

[12] $LY = TEV - TEC$, that is, the amount of the net exchange value associated with the labor contribution of the producer is the difference between the total exchange value *TEV* of the produced good and the total economic costs *TEC*.

object under consideration to increasingly complex ones. This approach is designed to solve not only the logical problems faced by empirical economics, but also to overcome its static nature (Nekipelov, 2019a). The task, therefore, is not to discard the knowledge accumulated during the development of our science, but, first of all, to reformat it in accordance with the principles of "pure theory".

The transformation of production from an exogenous into an endogenous factor in an exchange economy, in which individual economic entities participate, becomes an important step on this path. The exchange is still in-kind, but it becomes possible to take into account the action of forces leading to the development of the social division of labor. The latter makes the exchange relations systematic and, in this sense, promotes the transition of the economic system into a new state. It is significant, from the viewpoint of the thesis on the reformatting of economic knowledge, that a tool to justify the emergence of the social division of labor is the Torrens – Ricardo theory of comparative costs (advantages) used for addressing a more specific task – to demonstrate the benefits of international trade for countries with different levels of development.

It is important not only to see the reasons for the specialization of producers, but also to identify the dynamics of this process. Such a formulation of the question urges us to consider the technological organization of the economy, and on this basis – to search for a boundary between the division of production functions performed by an individual economic agent and the division of labor in society. The article shows that this boundary in the conditions of a simple exchange economy will gravitate toward a position in which the marginal benefits of increasing the specialization of an individual producer will be equal to the marginal costs accompanying this process. Of course, this conclusion is consonant with the one made by R. Coase regarding the issue of the boundary between the intra-firm and social division of labor. However, it is made in relation to a simpler economic system and with a different "filling" of the general principle of equality of marginal benefits to marginal costs.

Mainly due to the improvement of production processes, the shifts in the boundary between the division of functions implemented by an individual producer and the social division of labor determine the changes in the composition of the commodity world. Initially, objects of exchange include consumer goods; in the future they are joined by the objects and means of labor. As a result, the exchange value of a commodity produced by an individual economic agent splits into a part that compensates for its current costs, and a part that represents its "labor income" (net exchange value).

The analysis of the consequences of the transformation of consumer durables and means of labor into a commodity deserves special attention. When analyzing the net exchange model on the example of consumer durables, it was shown that the initial form of involvement in the turnover of such goods is rent rather than the classic exchange associated with the change of ownership of the corresponding goods. Such goods can be provided on credit, but at the same time the exchange value of deliveries for credit servicing is determined by the exchange value of the services of the corresponding goods, and not by their "market exchange value". As a result, the terms of pure trade do not have prerequisites for the formation of the market exchange value of "capital goods", on the one hand, and the interest rate, on the other (Nekipelov, 2021b, p. 44).

The transformation of production into the model's endogenous factor leads to important changes: the costs of producing durable goods become the basis for their "market exchange value", and the presence of two exchange values for such goods (current and trans-temporal) becomes the basis for the market interest rate. Due to the latter circumstance, it becomes possible to represent the

return on the means of labor used in production by an individual producer in the form of a part compensating for their "market exchange value" and a part corresponding to interest income[13].

The model of exchange economy under consideration allows us to enrich our ideas about the state (states) of general equilibrium. Now that production is an internal condition of the model, we get the opportunity to introduce the limited resources factor into the analysis and show that the formation of ownership of such resources is a necessary prerequisite for the normal functioning of the market mechanism. As a result, the concepts of absolute and differential rent are naturally included in the conceptual framework and the specifics of the mechanism of formation of the "market exchange value" of land become clear. There is also an opportunity to adapt the sources of uncertainty of economic life to the conditions of the model under consideration, to show the expansion (in comparison with the Robinson Crusoe model) of the tools available to economic agents to reduce the level of risks.

The article emphasizes that it is very important for the pure economic theory to make the spatial dimension of the economy and its influence on the parameters of general equilibrium a full-fledged subject of analysis. We show serious problems that stand in the way of solving this problem, and express considerations regarding a possible approach to the formulation of the initial model that makes it possible to take into account the influence of space on the general parameters of economic activity.

Perhaps the main result of our research consists in a holistic view of almost all key categories (albeit in embryonic forms) reflecting the action of the market mechanism. There arises a reasonable question: do we really believe that such a primitive economic system based on individual labor and lacking the most important tool of the market economy – money – can provide a deep social division of labor, multilaterally balanced in-kind exchange of goods, and developed rental and credit relations? There can be only one answer: of course not! But, from the point of view of the pure economic theory, it does not matter. After all, the results of the study indicate no more than those potentials that can (and therefore should!) be detected already in a simple exchange economy. The main reason that does not allow these opportunities to be realized in any mature form is also clear – enormous transaction costs that accompany in-kind exchange. And hence the obvious conclusion: the next stage of the study is designed to demonstrate whether these transaction costs can be drastically reduced and, if they can, what will be the implications of the corresponding changes for the economic system as a whole? It is easy to guess that the next step of our research should consider a monetary economy based on individual labor.

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[13] This conclusion is not as trivial as it may seem at first glance. Among theoretical economists, and by no means only those supporting Marxism, it was a very common idea that in a primitive economy, similar to the one we called a simple exchange economy, the exchange value of goods is determined solely by labor costs. A. Marshall writes: "In this case the cost problem is very simple. Things are exchanged for each other in proportion to the labor spent on their production" (Marshall, 1993, p. 211).

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