

ЭКОНОМИКО-МАТЕМАТИЧЕСКИЕ МОДЕЛИ

УДК 330.101
ГРНТИ 06.03.07

Model of Economic Growth with Information Asymmetry and Inequality

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Abstract

The subject of the paper is the model of the economic growth of the system is proposed, taking into account the asymmetry effect of information in this system, as well as the level of income inequality between the elements of the economy. *The purpose* of the study is to obtain a model of the influence of asymmetry of information and income inequality on economic growth. And the asymmetry of information can be considered as a kind of inequality, only from information. *Methodology of the study.* The method of econometric modeling and analytical derivation of the relevant relationships describing the relationships by the parameter of the considered model is used, proceeding from the problem of determining the influence of asymmetry of information and inequality on economic growth. *Results of the study and main conclusions.* Changing the information structure affects the search for sellers and buyers. Agents are very scrupulous looking for information where you can buy a good at the lowest possible price. Information asymmetry is proportional to the ratio of information completeness of two agents. The presented analytical dependencies give results in the form of conditions for the effect of information asymmetry on the information system by comparing the system without asymmetry and with the presence of asymmetry, simplified by two agents or groups of agents. The obtained analytical dependencies allowed within the framework of the model to draw conclusions that the rate of change of inequality at different time intervals varies in different ways, and this also affects the rate of economic growth.

Keywords: *economic growth, information, inequality for income, information asymmetry, modeling of the growth*

1. Introduction

Emergence of the “economy of knowledge” was proclaimed in the economic theory of information (Marc Porat, Fritz Machlup, George Joseph Stigler, Joseph Stiglitz, etc.) [1-6] as a new form of economic relations and production of knowledge acting as a separate good. Market prices were considered as information signal to the agent defining its choice. There appeared different kinds of information sectors. Information obsolescence was considered as the reason of the prices range in the market, information asymmetry as the reason of adverse selection of decisions, opportunism and high transactional costs, and etc. It is necessary to notice, that economists have been paying much attention to information provision of management with information for a long time, in particular, to accumulation, preparation, processing and use of data (information) about various system elements and structural units of management. The main problem not solved in the information economy, which is of great importance for the knowledge economy, is the problem of the relationship between economic growth and the asymmetry of information in the system and the level of inequality. Below we propose a model for such a connection. The information factor is not taken into account in many known models of economic growth, while information has a strong influence on economic dynamics [7-8, 9-16].

2. Influence of asymmetry on the growth of the system

Information asymmetry can increase or reduce the volume of the relevant information, thereby defining information growth of the considered system which consists of two or many agents differently informed.

Let us formally write down the condition of information asymmetry influence on increase of information possibilities of the system of any level. Let us introduce a number of signs: N - number of the agents operating in the system, possessing and producing the volume of information Q . Each of the agents equally possesses the information (total volume and the relevant information $q = k Q$, where k is a share of the relevant information in the total volume, or norm of knowledge). The second situation is when the same number of agents N is presented by the number of agents N_1 who possesses the volume of information Q_1 and the relevant information (knowledge) $q_1 = k_1 Q_1$, and a group of agents N_2 possessing information Q_2 and the relevant information volume $q_2 = k_2 Q_2$, where norms of knowledge are k_1 and k_2 accordingly, and, $N = N_1 + N_2$, and $Q = Q_1 + Q_2$. General information in the system is equal to the sum of information of each of the agents groups and the structure of the groups defines the general value of the agents of the system – N [7-8].

This can be referred to two agents and to two groups of agents, for example, the most and the least informed. In particular, the agents of the first group (index one) are the most informed, and the agents of the second group (index two) are less informed.

It is also characteristic for knowledge, that $q = q_1 + q_2$, and if $q_1 > q_2$, then the first agent or group possesses greater volume of the relevant information. We will introduce designation of the specific information in the system which is the share of one agent: $a = Q/N$ and $b_1 = Q_1/N_1$ and $b_2 = Q_2/N_2$ accordingly. Then the value of information asymmetry is:

$$\varphi = Q_1/Q_2 = (b_1 N_1) / (b_2 N_2).$$

It is possible to write it down in a different way:

$$\varphi = \frac{k_2 q_1}{k_1 q_2}$$

And size Q_1 can be found:

$$Q_1 = \frac{q}{k} \left[\frac{k - k_2}{k_1 - k_2} \right]$$

Then we will define theoretical value of information asymmetry φ^* at which broadening of the relevant information will be observed in the case with arising asymmetry (q_1 and q_2 , q_1 not being a part of q_2 , and q_2 not being a part of q_1) relative to the situation when there is no asymmetry (q).

Two cases are interesting, when $q_1 + q_2 > q$ and $q_1 + q_2 < q$. Using introduced above proportions, we will write down:

$$k_1 b_1 N_1 + k_2 b_2 N_2 > k a N,$$

$$a N = b_1 N_1 + b_2 N_2,$$

$$k [b_1 N_1 + b_2 N_2] < k_1 b_1 N_1 + k_2 b_2 N_2.$$

Having divided the right and the left parts of the inequality by N , we will have:

$$k \left[\frac{b_1 N_1}{N} + \frac{b_2 N_2}{N} \right] < \frac{k_1 b_1 N_1}{N} + \frac{k_2 b_2 N_2}{N},$$

$$\frac{b_1 N_1}{N} [k - k_1] < \frac{b_2 N_2}{N} [k_2 - k],$$

$$\varphi = \frac{b_1 N_1}{b_2 N_2}.$$

Whence we have:

$$(q_1 + q_2) / q > 1$$

at

$$\varphi > \frac{k - k_2}{k_1 - k}$$

By analogy we have:

$$(q_1 + q_2) / q < 1$$

at

$$\varphi < \frac{k - k_2}{k_1 - k}.$$

Asymmetry does not influence information changes of the economic system presented by two or more agents at $\varphi = (k - k_2) / (k_1 - k)$, at $k \neq k_1$, $k \neq k_2$. Through the parameter of information provision u and the parameter of information completeness c , we can express the value of asymmetry:

$$\varphi = \left[\frac{uc_2 - u_2c}{u_1c - c_1u} \right] \frac{c_1}{c_2}$$

или

$$\varphi = \alpha \frac{c_1}{c_2}.$$

Thus, information asymmetry is proportional to the relation of information completeness of two agents (groups of agents) participating in information exchange and transaction.

The presented computation within the limits of the elementary method of the structural analysis¹ yield analytical result in the form of influence conditions of information asymmetry on the information system by means of comparison of the system with and without asymmetry on two agents or groups of agents. Sometimes the similar technique is used estimating the level of inequality on economic growth of the system, linking growth and the amount of investments, and assuming $I = I_1 + I_2$, and expressing investments through the norm of accumulation as a part of income sY . In essence, it is a priori considered, that investments on any group of agents are equal to the accumulation part of the income. Certainly, the rate of savings and norm of accumulation do not generally coincide, but also investments into the economy are larger, than simply accumulated part of the income. If to introduce the parameter of the system inequality as the relation of the income of the rich part of the agents to the poor, it is possible to receive a similar condition, when inequality should increase more, than some value in order for the investments of the system presented by the dichotomy to increase. Firstly, it will not mean economic growth with higher rate yet, because it is not inequality that provides investments growth. And gross domestic product according to the expenses is presented not only by investments, but also by internal consumption, governmental expenses and pure export. Redistribution between these factors of growth is possible that such simple computation does not reflect. Secondly, the economic system development is influenced not simply by the equity parameter as the relation between the income of the richest and the poorest [15-16]. It is influenced by the degree with which the income is distributed. The conclusion as if the inequality (between the rich and the poor) will increase growth is absolutely incorrect. The result depends on the starting point and many factors. The outcomes, when inequality increases, are possible, and absolute recession is observed as it was in the Russian economy of 1990s. And when the growth rate increases, the inequality is smoothed as it was in the Russian economy in 2000s. By the way, Kuznets

¹ I have been applying the similar block diagrams for a long time to demonstrate the elementary correlations which are important for further economic analysis.

effect describes the epoch of industrialization of the western countries [10], when the accelerated growth of the economy was simultaneously accompanied by the inequality growth. (We do not assert that it is because of inequality). The meaning of this effect is: when the growth dynamics slackened, the inequality level also decreased. Then this effect was not observed at all. With reference to asymmetry estimation there are less such reservations, as the direct parameter of the information system is considered. It is the relevant information (knowledge) and not one of the growth factors of the product/income – investments as when using the known approach to the problem having different formulation. But that problem has many reservations which should be considered when the researcher tries to formulate the relevant conclusions.

As it was shown, information asymmetry can promote the relevant information gain, probably creating motives for information search, or involving combinatory ways of getting of additional information at the agent's level and to expand information production in the system. However, there is the condition when information in the system is not increasing and even is not reducing. This function of information asymmetry to reduce the relevant information is somehow co-ordinated with the idea of the markets/systems destruction due to the asymmetry effect.

Technological changes (the progress in the field of means of information processing) expand the agents' possibilities at processing of increasing data volumes, and also in getting of the relevant information (knowledge). Firms also receive additional benefits as costs reduction for search and processing can operate in the direction of increase of labour productivity in the work with information and the firm's overall performance [17-19].

The Internet acts as the technology, which blurs geographical borders between the markets, reduces transactional costs for the search of buyers and sellers. However, it does it everywhere with the adjustment for the fact that various agents can use the advantages of the Internet depending on how they are adapted for it and how their propensities allow them working with great information volumes. It is this nuance regarding the Internet, which is not considered by the supporters of information economy. The Internet in itself is not a panacea, despite specially created search systems (software) facilitating the search. When search (not the information, which is presented chaotically enough) is regulated, of course, it reduces the search costs, but when the information volume grows, at the excess of a certain critical volume for the given system, it can sharply increase the search costs despite special search software ('finder'). The problem of getting of the relevant information from the found information, the so-called general relevance, is not solved here too. Thus it is impossible to do without human brain. It is only human brain who will carry out the selection and will generate a certain completeness of the relevant information for the information agent, rejecting all other information of the search, or as original information garbage. The agent should repeat the search if he did not take into account any detail in the first search, considering the increasing volume of general information in the Internet. Problem statement of the search can also appear rough, approximate, i.e. the agent does not always know precisely what he searches. This reason can also essentially increase transactional costs for search.

With the growth of information sector, the general volume of transactions and transactional costs increases all the same. Specific costs, i.e. transactional costs per unit of the found information or per agent can decrease. And with the growth of the sector and increase of its productivity, the specific costs per agent can even increase in connection with the relative reduction of the number of the agents occupied in proportion to the growth of the sector. As for the specific costs per unit of the information found, they can decrease due to the growth of productivity or efficiency coefficient of the information system. Transactional costs can be presented with the following transactional function:

$$Tr = \frac{Tr_0}{I^a},$$

$$a = f(t, Tr_0, i, Q),$$

where Tr – transactional costs; Tr₀ – initial level of transactional costs in the system; I > 0 – the volume of the relevant information (knowledge); a – the function dependent on the processing time (t) of the initial

transactional costs TrO , speed of information processing (information productivity) – i and dynamically changed total information volume – Q . Theoretically this function can be more or less than zero. The positive value of this function should mean increasing speed of information processing and getting of the relevant information (knowledge) and the negative value means the similar decreasing speed.

When $a > 0$ and $I > 1$, reduction of transactional costs will be observed. When $a < 0$, $I > 1$, increase of transactional costs will be observed. The type of function $a = f(t, TrO, i, Q)$ will define the dynamics of costs.

At small information volumes $0 < I < 1$, we will have different character of transactional costs dynamics. At $a > 0$ we have increase of costs, at $a < 0$ transactional costs reduce.

The agents very scrupulously search for the information where to get the blessing at lower price. Costs of the Internet use for them are the time spent for the search, because the agent pays a user charge for the Internet which includes not only the search but its use for other purposes, including rest (games, communication with other agents, and etc.). However, the basic expenses of time are the expenses for the search in the Internet. To compensate such expenses modern agents reduce their sleep, i.e. they actively use the night time for search and work in the Internet. Budgetary restrictions are the most significant for the agent. They allow him thinking about expenses of time for search differently. If the expected information is valuable for the agent, or in the course of search of one information (low price for the blessing) he finds a set of useful interfaced data about the given blessing or about its substitute, the efforts for search will not be vain.

It is improper to consider, that costs for the search of low price in the Internet are zero. Being the resource of general access, the Internet is limited in application as the sellers can understate the price announced in the Internet which in fact will be higher than the announced price at purchasing. The purchase process itself assumes additional costs, and the buyer has already bought the product as additional costs are connected with the purchase. By this time to cancel the purchase is problematic, if the costs for purchase plus cancellation costs plus search of the new seller will exceed the difference between the price announced in the Internet and actual payment.

It would seem that transactional costs should increase competition, especially in the Internet. However, differentiation of the blessings, knowledge for their creation, the possible development variant connected with the growth of these costs and the fact that the Internet is a common resource will preserve the competitive process on the given kind of the blessings. Of course, competition in the sphere of information possession in the Internet due to availability of this network intensifies, and its main characteristic is not information search, but selection of exclusively relevant data from the found volume. The agent who does it quickly and qualitatively will win in the competitive struggle in information sphere. It is not the fact, that the victory in the information field will result in the victory in the market of blessings creation as this information should be used skillfully. And this should be manifested in more efficient production. This frame presents the next, not less important part of the competitive process.

The growth of the total information volume and the relevant information (knowledge which demonstrates accumulation effect) on longer interval can increase costs for information search, including the Internet. Besides volume increase, the reason is in the fact that information becomes more specialized and differentiated. It means such qualitative parameters of information as, for example, data on the subcontractor which cannot be found or identified with the network. Personal contact is necessary, and this demands 10 times bigger costs. It can fail depending on the behaviour models of contacting agents. Certainly, growth of information volume can lower the efficiency of the search if the growth rate outstrips the rate of information search and processing in the same way as the rate of the personal income increment lags behind the growth rate of population size of poor countries, generating demographic trap and resulting in a trap of permanent poverty.

As we see, the technologies of work with information, including the Internet, reduce only a part of transactional costs, but they do not exclude the necessity of creation of additional techniques of information selection. The firms combine the activities, including marketing and executing a part of the

procedures within the limits of classical marketing, and a part of them is fulfilled in the field of electronic marketing².

Change of information structure taking place under the influence of many factors, determines the search of sellers and buyers. Often this search fails. It is paradoxical (as it breaks Metcalfe's law), but the speed of the network does not depend on the number of objects. To be more precise, it can decrease at growth of such number, and the speed of information processing can for certain decrease at growth of the agents number and total volume of information for the same technological processing level. However, the importance of the network is not reduced to the speed for the objects of the network. It is connected with the network habituation effect, so the agents do not worry about the loss of sleeping hours. They only aspire to solve certain problems in the Internet. Sometimes these problems are not necessary and speculative. There appeared a blessing which in technological sense becomes the continuation of the person, increasing dependence on the blessing without the dependence from the speed of information processing (in any case the speed is higher, than the processing speed of the same information by the individual) and network importance. The estimation of network importance will be completely defined by the applied criterion of importance. However, it is always necessary to think, whether this criterion reflects the original value or not, like whether Pareto criterion reflects the efficiency and which efficiency it reflects.

3. The impact of inequality on economic growth is the general model

Now we will discuss the problem how information asymmetry [24] and income inequality can affect economic growth of the system. Computations presented earlier demonstrated the influence on the information change in the system, in other words, on 'information growth'.

Let us imagine the economic system consisting of two groups of agents possessing different information (information asymmetry in the system [24-25]) and creating different product/income. We will consider the problem of influence of information asymmetry and inequality on economic growth of each of the groups and the system as a whole.

Let's introduce the following designations: k, k_1, k_2 – efficiency coefficients (the relation of the relevant information/knowledge to the total volume of the available information) of the system and on each group of agents; z_1 and z_2 – knowledge, the relevant information of group 1 and 2 accordingly with composition N_1 and N_2 and $N = N_1 + N_2$ the total number of the agents in the system; $Y = Y_1 + Y_2$ ($Y_2 < Y_1$),

² For more in detail see the monograph: Sukharev O.S., Kurmanov N.V., Melkovskaya K.R. *Functional Marketing and Internet Marketing*. M: Kurs (Course), Infra-M, 2013. and the works of Sukharev O.S., Kurmanov V.V. (2013- 2014) where the models of choice between transaction within the limits of electronic marketing (Internet) and classical marketing are described and compared. By the way, such comparison is useful from the point of view of the criticism of R.Coase's position on the question: what economic processes occur in the firm and what processes demand the market as an intermediary. I described the illegitimacy of such statement in a number of works, in particular, Sukharev O. S *Methodology and Possibilities of Economic Science* (2013) and *Theory of Efficiency of the Economy* (2009). Besides, the blueprints of such objections can be found in the work *Institutional Theory and Economic Policy*, Book 1 (2001). As a matter of fact, electronic marketing is the areas outside the firm, and classical marketing is procedures of intra-firm organization. The problem is that it is possible to consider the Internet as the firm's element, as its massive part located in computers of the given firm. They are densely bound and serve each other, so there is an additional argument of the critical attitude of the specified oppositions of different processes – in the firm and out of it. It is interesting to notice, that internal processes draw the data from external sources, the Internet, and the Internet transfers only the result of internal processes – the created blessing and its price. Good intellectual tricks in the form of the similar problems in the spirit of R. Coase are periodically invented by economists. Honestly, it gives a little for cognition, to be more precise, for understanding of economic life and its changes and for decision-making. Cognitive process widens because of this. It requires studying of 'dead' problems, oppositions, conclusions which are picked up and absolutized by many economists, like domino effect at economic crisis. Such position can be found in M. Spence's lecture, given when he received high award [20-21].

the product/income of the system and created product/income of the groups of agents³ accordingly; g , g_1 , g_2 – the growth rate of the product/income of the economic system created by each group of agents, $g = dY/dt$, $g_1 = dY_1/dt$, $g_2 = dY_2/dt$, $g = g_1 + g_2$. Let $Q = Q_1 + Q_2$ be information volume in the system, and at each group of agents. Then it is possible to introduce two kinds of information asymmetry: 1) general asymmetry $\varphi_0 = Q_1/Q_2$; 2) specific (or relevant) asymmetry $\varphi = z_1/z_2$. It is possible to consider conditionally, that the first agent/the first group is more informed and rich agent/group. However, for further computations this assumption is not obligatory. We will designate the value of inequality as $\eta = Y_1/Y_2$, the rate of inequality change as $d\eta/dt = g\eta$. The relevant information (knowledge) is the function of income, time and the total volume of information, i.e. $z_1 = z_1(Y_1, t, Q_1)$, $z_2 = z_2(Y_2, t, Q_2)$. The total volume of the relevant information in the system is $z = z_1 + z_2$. It should be noted that information efficiency coefficient in each case will be: $k = z/Q$, $k_1 = z_1/Q_1$, $k_2 = z_2/Q_2$.⁴

Further, on at model formation it is necessary to make two important assumptions. Firstly, efficiency coefficients of information systems make up a certain share from the growth rate of the system. Secondly, the relation of the rates of two singled out subsystems (or rates of well-being change of two co-operating agents) is proportional to the difference of the relevant information between them. We will write down these two assumptions in the following way:

$$k = \alpha g; k_1 = \alpha_1 g_1; k_2 = \alpha_2 g_2,$$

$$\frac{g_1}{g_2} = \beta[z_1 - z_2] = \beta[\varphi - 1]z_2.$$

where α , α_1 , α_2 are the parameters which can eventually change depending on institutional conditions and technological effectiveness of information processing (behaviour models of the agents). On short interval it is possible to accept, that they do not change. β is also time-dependent parameter, as well as α . It reflects the influence of institutional conditions and technological effectiveness. These parameters are inherently the ratios of reduction reducing the difference in knowledge (the relevant information) to the exceeding of the growth rate of one subsystem over another within the limits of the economic system (β), or growth rate to efficiency coefficient of the information system (α).

Considering all introduced above correlations and parameters of the system, it is not difficult to calculate:

$$k = \alpha \frac{k_1 \alpha_2 + k_2 \alpha_1}{\alpha_1 \alpha_2},$$

$$\frac{k_1}{k_2} = \frac{\varphi}{\varphi_0},$$

$$k = \frac{\alpha}{\alpha_1} k_2 \left[\frac{\varphi}{\varphi_0} + \frac{\alpha_1}{\alpha_2} \right].$$

Then, provided that inequality in the system does not change, we will have:

$$Y = (\eta + 1)Y_2,$$

$$g = (\eta + 1)g_2$$

$$npu$$

$$\frac{d\eta}{dt} = 0.$$

³ These computations are true for two co-operating agents as well, concerning the system of two agents, or to contracting process

⁴ All introduced parameters are function of time.

And the relevant information for each group of agents will be:

$$z_1 = \frac{\eta\varphi}{\beta(\varphi-1)},$$

$$z_2 = \frac{\eta}{\beta(\varphi-1)}.$$

Thereby, it turns out that the value of inequality does not influence the knowledge volume accumulated by different groups of agents. To be more precise, proceeding from the received correlation, if inequality does not grow and does not reduce, then its value is greater and the volume of the relevant information at each group of the agents is greater, other things being equal.⁵

However, other things being equal, the greater the value of ‘concrete information asymmetry’, the less the volume of knowledge in the second group. And in the first group it will also be less (we will rewrite $z_1 = \eta / (\beta [1 - 1 / \varphi])$, whence it is evident, that with the growth of φ the volume of knowledge will decrease). The value of inequality does not affect the volume of relevant knowledge, and the value of asymmetry reduces it under conditions of the given model. But for the first group of agents the value of reduction is less. Hence, the less the knowledge asymmetry, the better the system works at knowledge increment.

If we take into account the influence of the general asymmetry for the case when inequality does not change, the expressions will be as follow:

$$z_1 = \frac{\eta k_1 \varphi_0}{\beta(k_1 \varphi_0 - k_2)},$$

$$z_2 = \frac{\eta k_2}{\beta(k_1 \varphi_0 - k_2)}.$$

In this case there is similar conclusion, that greater value of general information asymmetry in the system will lower the value of the relevant information (knowledge) of the agents for the given inequality value, which does not change. On the contrary, the less value of general information asymmetry will increase the relevant knowledge, which as we see, depends on ‘technological effectiveness’ of each group of agents, i.e. on efficiency coefficient of information processing.

Now we will consider the situation, when inequality level changes in the economic system. We will write down:

$$\frac{g_1}{g_2} = \beta(\varphi-1)z_2,$$

$$g = g_1 + g_2,$$

$$Y = Y_1 + Y_2 = Y_2(\eta + 1),$$

$$\frac{dY}{dt} = \frac{d\eta}{dt} Y_2 + \frac{dY_2}{dt} (\eta + 1).$$

Thus, we will have:

$$g = g_\eta Y_2 + g_2 (\eta + 1).$$

After transformations, we will have:

⁵ It is necessary to understand, that it purely model solution, within the limits of introduced assumptions and properties of the model.

$$g_2 = \frac{g}{1 + \beta(\varphi - 1)z_2},$$

$$g = g_\eta Y_2 + \frac{g(\eta + 1)}{1 + \beta(\varphi - 1)z_2}.$$

Whence it follows that

$$g = g_\eta Y_2 \frac{1 + \beta(\varphi - 1)z_2}{\beta(\varphi - 1)z_2 - \eta},$$

$$g = g_\eta Y_2 \frac{1 + \gamma}{\gamma - \eta},$$

$$\gamma = \frac{g_1}{g_2} = \beta(\varphi - 1)z_2.$$

The growth rate of the economic system depends on parameter γ , which can be presented through the kinds of information asymmetry and reduction coefficient as follows:

$$\gamma = \frac{\alpha_2}{\alpha_1} \frac{\varphi}{\varphi_0}.$$

Thus, the economic growth rate of the system is defined by the amount of the created product of one of the agents groups (according to our condition it is the least provided group of agents), rate of inequality change, the value of inequality and the relation of various kinds of information asymmetry. Proceeding from the received correlation it is possible to draw the following conclusions:

For the same amount of the product of the agents group, the correlation of the kinds of information asymmetry and constant reduction coefficients α_1 and α_2 , growth of inequality will mean increase of the growth rate ($d\eta/dt > 0$), inequality reduction ($d\eta/dt < 0$) and decrease of the rate of economic growth of the system. In the denominator there is value η , which increase will operate in the direction of increase of the growth rate of the economy at $d\eta/dt > 0$, and its decrease will operate in the direction of rate decrease.

2. Income increase of the group of agents (without income reduction of the other group) can increase the growth rate. Other things being equal, the growth of the value of 'concrete asymmetry' in comparison with the general information asymmetry, and the set correlation on the reduction coefficients (information changes occur on the same interval faster, than the structure of the economy, technological effectiveness of information processing and behaviour models of the agents change) will mean increase of value γ , that will result in increase of the growth rate. Its decrease will accordingly result in decrease, other things being equal.⁶

3. The received formula has a property: the economic growth rate is connected not only with the value of inequality and presence of information asymmetry, but also with the change of inequality. That is an integral condition of application of this formula, because if there is no change, i.e. $d\eta/dt = 0$, then mathematically it turns out that rate $g = 0$. Of course, the situation is quite different in reality.

Let us receive the expressions for the growth rate of the product of the singled out elements of the economic system. We have:

$$g_1 = g_2 \beta(\varphi - 1)z_2,$$

$$g_1 = g_\eta Y_2 + g_2 \eta.$$

Whence,

$$g_1 = \frac{g_\eta Y_1 \gamma}{\eta(\gamma - \eta)},$$

$$g_2 = \frac{g_\eta Y_2}{\gamma - \eta}.$$

⁶ It is easy to show, that $(1 + \gamma) > (\gamma - \eta)$, at $\eta > 0$, as $(1 + \gamma) > (1 + \gamma) - (\eta + 1)$. The probability, that the relevant information asymmetry is greater, than the general information asymmetry, is rather large. In practice any outcomes are possible in proportion to arising situation.

Thus, upward dynamics on the inequality will operate in the direction of increase of the growth rate of the income in each group (of each agent). It is not obvious for the first group, as in essence there is a square of the value of inequality in the denominator. Most likely, it will give the reduction of the growth rate of the income of the first group if inequality increases. The rate is defined by the income of each group, and as for value γ , reflecting excess of concrete asymmetry over the general information asymmetry, with its increase the growth rate of the second group will decrease, and the income of the first group can increase or also decrease depending on the difference ($\gamma - \eta$).

In public system the income level between groups always changes, therefore inequality constantly changes from a year to year (it is observed according to Gini coefficient on different countries and according to the so-called stock ratio), therefore the given model is true, when inequality changes. If it does not change, $d\eta/dt = 0$, and the growth rate of the system is zero. In case of equal distribution of income $\eta = 1$, $Y_1 = Y_2$, inequality change is equal to zero, the gradient of income redistribution is absent due to the absolute equality. Such situation is exclusive and in modern society it is unfeasible (impossible)⁷.

The value of the created income on the groups and for the economic system will be defined as follows:

$$Y_1 = \int \frac{k_2}{\alpha_1} \frac{\varphi}{\varphi_0} dt + C_1,$$

$$Y_2 = \frac{1}{\eta} \int \frac{k_2}{\alpha_1} \frac{\varphi}{\varphi_0} dt + C_2,$$

$$Y = [1 + \frac{1}{\eta}] \int \frac{k_2}{\alpha_1} \frac{\varphi}{\varphi_0} dt + C.$$

As we see from the presented dependences, the product/income of the system and its elements, presented by the agents (groups) with different information and income, depends on the efficiency coefficient of one element (group of agents). According to our condition it is the least provided agents $Y_2 < Y_1$, and $k_2 < k_1$. Then they have worse technological effectiveness of information processing. The more the value of the efficiency coefficient and the more the superiority of the relevant asymmetry over the usual one, the more the product of the first group. The product of the second group depends on the value of inequality. The more it is, the less is this product. The product/income of the economic system depends on the same parameters. But this dependence is more smoothed because of the value of inequality, i.e. when the value of inequality grows, the general quantity of the product will decrease by smaller value, than the product/income created by the second group of agents.

Conclusion

This analytical result is subject to correction with empirical data. However, it accurately reflects that the product/income depends on the value of inequality, and if the inequality is more, the product is not absolutely necessary to be more. But the change of inequality influences the product change (growth rate), the speeds having the same direction. At the same time it should be noted, that due to its formulation the model does not give any constraints from above, i.e. it is not clear to what extent the economic growth rate will increase, and at what rate the inequality will change. In practice, the rate of change of the inequality usually changes differently on various time intervals. That will affect the rate of economic growth as well. The similar results are characteristic and for the change of information asymmetry. That's another matter, that asymmetry in relation to a complex economic system requires evaluation which is rather problematic to make, though it is possible to do for the subsystems of microeconomic level within the framework of economic researches.

⁷ Even under conditions of the Soviet system Gini coefficient was not equal to unit, and there was population differentiation according to incomes, that set a certain inequality level and led to its change in this or that direction on various population groups.

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Модель экономического роста с информационной асимметрией и неравенством

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Аннотация

В статье рассматриваются элементарные модели экономического роста системы с фактором асимметричной информации. Даются различные режимы функционирования экономической системы по трансакционной функции. Асимметрия информации трактуется как неравенство, что сближает модель роста с информационным фактором с моделью роста с учётом неравенства по доходу, сложившегося в данной экономической системе. Предметом статьи является модель экономического роста системы, с учетом влияния асимметрии информации в этой системе, а также уровня неравенства доходов между элементами экономики. Целью исследования является получение модели влияния асимметрии инфляции и неравенства доходов на экономический рост. Для достижения цели используется метод эконометрического моделирования, получения соотношений в аналитическом виде. Основные результаты. С использованием теоретических моделей показано, что изменение информационной структуры влияет на поиск продавцов и покупателей. Агенты тщательно ищут информацию, где можно купить товар по максимально низкой цене. Информационная асимметрия пропорциональна соотношению полноты информации. Представленные аналитические зависимости дают результаты в виде условий влияния информационной асимметрии на информационную систему путем сравнения системы без асимметрии и с наличием асимметрии, для различных групп агентов. Полученные аналитические зависимости позволили в рамках модели сделать вывод о том, что скорость изменения неравенства по доходу на разных временных интервалах различна, что также влияет на темпы экономического роста. Поэтому кривая Кузнеца может как соблюдаться для таких экономических систем, так и не соблюдаться, либо принимать иной вид.

Статья подготовлена в рамках государственного задания ИПР РАН, тема НИР "Макроэкономическая и промышленная политика роста: институциональные, структурные и технологические изменения".

Ключевые слова: экономический рост, информация, неравенство по доходу, информационная асимметрия, моделирование роста

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