QUALITY OF THE ECONOMIC GROWTH UNDER THE TERMS AND CONDITIONS OF THE TECHNOLOGICAL PROGRESS

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Abstract: This Paper has a two-fold purpose: 1) to explore the abstract and theoretical principles of the classical and neoclassical economic theory to the notion of the economic growth under the terms and conditions of the technological progress; 2) to try to apply these provisions with national economic practice of modern Ukraine.

Keywords: quality, economic growth, technological progress, labor productivity, capital-employment ratio, and capital capacity.

JEL: O 30, O 40

1. Introduction to the Study and Formulation of the Problem

Problems of the economic growth quality have always been and still remain within the line of vision of the economic science.

The category of the economic growth quality itself reflects the specifics and target orientation of the process of expanded reproduction, its effectiveness at a given stage of economic development. The material basis for economic development is the rational use of the basic factors of production - labor and capital being at the disposal of the society. One of the main factors of qualitative changes in the economic system is a scientific and technological progress. That is it that has been recognized as the most important factor of economic development all over the world. "Scientific and technological progress, - noted V.I. Vernadsky, - this is the only process in the development of mankind, which, like time, is never interrupted and not back".[1]

Unfortunately, today Ukraine is faced with a significant reduction of the internal reproductive capacity, stipulated by the increase of the technological

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[1] **Вернадский В.И.** Научная мысль как планетарное явление. – М.: Наука, 1991, С. 64.

conservatism, low level of updating the material and technical base, a low level of investment in the development of the economy, low interest in the development of science and technology manufacturers, aggravation of the demographic situation and as a consequence - decrease in competitiveness in the global market. Such problems have a negative impact on potential capacities of the economic growth. The need to launch the economy on the path of positive growth and development provides the economic science with a problem of in-depth knowledge of the essence of the processes occurring in the economy today.

2. Theoretical Aspects of the Economic Growth Quality

The predecessor of the theory of economic growth was the theory of reproduction, whose task was to examine the essential problem - motivation, resources, sources, subjects, and dynamics of the extended reproduction. In contrast thereof, the theory of economic growth is away from social and economic problematics, thus concentrating on the quantitative and functional relations and production increment rate.

Thus, starting from the XVIII century the economic theory raised a question of the proportions of social reproduction, the maintenance of which is necessary for its smooth implementation. The first who attempted to answer the question was a French economist F. Kene, who introduced the theory of reproduction of social capital, as a system of quantitative relations under the conditions of the stationary economy without a technological progress.

However, since the beginning of the XIX century, the problem of reproduction of social capital takes on a different meaning. The attention of scientists is focused on changing the proportions of social reproduction under the influence of the technological progress. The first who formulated this problem in such a way was S. Sismondi. Then the authors (K.I. Rodbertus-Yagetsov, J.G. von Kirhman), which consider social reproduction necessarily under the terms and conditions of the technological progress, come into controversy. Nevertheless,

researchers have abstracted from the consumed fixed capital, identifying the reproduction with the volumes of the national income.

The theory of Karl Marx became a new stage in studying the social reproduction. Marx made an attempts analyze the internal relations between the parts of the annual product by cost and by natural and material form, showing their quantitative expression in his famous reproduction schemes by entering into the study missed by predecessors - the constant capital. The schemes showed what ratios are between the basic units of the economy (Unit I , producing investment goods and Unit II division, producing consumer goods) necessary for the continuous reproduction on an extended scale, i.e., for economic growth.

However, when considering the exchange between the basic units of social production Marx abstracts from technical progress (changes in the organic composition of the capital), noting thereby that "to implement the transition from simple to expanded reproduction, production of Unit I shall be able to create fewer elements of constant capital for Unit II, but in the same way more for Unit I"[2]. Thus, from the point of view of the development line Marx continued the study of Kene, and the theory of growth continued the line which goes from Sismondi.

The followers of Marx, developing his theory of reproduction of social capital, included the technological progress in the study. Using different approaches in this case, they came to the same conclusion about the leading role of the unit of the economy producing investment goods and the need for its priority development in comparison with the unit producing consumer goods that is the conclusion -about increasing the share of capital goods in the annual product of the society.

Why did not Marx take into account the technological progress in the reproduction of schemes? As it follows from Marx's schemes we can make a conclusion that these schemes represent a phenomenon which in the modern economy has been called a neutral impact of technological progress on the cost of

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[2] **Маркс, К. Енгельс, Ф**. Сочинения. М.: Политиздат, том 24. 1961. p. 565

weight of the means in case of increasing their production and increase of productivity. Neutral technological progress means that labor productivity and capital shall be increased at the same time that is, innovation, and labor-saving, balanced with innovations that save capital. However, technological progress efficiency cannot be constant throughout the entire period of the machine production.

But the problem is that there is some inconsistency in the Marxist classical theory: on the one hand, Marx says that the rate of return shows the efficiency of the total capital, the degree of increase, on the other hand - if it is to grow at a faster pace the capital goods production (production of investment goods) and as a consequence of capital intensity - it tells about the decreasing production efficiency. That is, in fact, Marx did not consider the problem of the effectiveness and quality of the economic growth. There were some grounds - ontological: the technological progress of that time was largely capital intensive. The methodological basis of "neglect" of this problem was the problem itself, which was directly in front of the scientist: creation of a comprehensive theoretical system of capitalism. Prior to solving the issue of the capital efficiency in general, it was necessary to reveal the essence, the nature of this system. Only then, in the process of the further ascent from the abstract to the concrete - to study the problems of more concrete levels of the theoretical system; Marx not only failed to solve that problem, but even did not put it.

A new impetus to the development of the theory of quality of the economic growth was given in the first half of the XX century. It was during this period when there was transition from the reproductive approach in understanding the economic growth to the functional and macro-economic, which in complete form was first presented in the works of J.M. Keynes and his followers and was further developed within the framework of the economic thought.

In presenting his theory, Keynes based on some assumptions. He considered all the economic processes within a short period, including in his model the main parameters, first of all, the capital stock was not changed in time that was ignored

by the inflow of net investment. This statement is of course quite reasonable in case of considering the short-term period. However, investments not only create revenue but also expand the capital, that is, in the long term perspective, increase the resources that the society may dispose of. Production should be expanded so as to ensure the use of the emerged additional resources. Otherwise, there is excess capital, which in the future may discourage entry of new investments and, consequently, the growth of income and employment.

Keynes's concept is statistical by its nature, it determines the equilibrium level of income for a short-term period, which can then either increase, due to the inflow of net investment, or reduce due to the formation of idle productive capital, which negatively affects the investment. This approach was largely stipulated by the peculiarities of depressive economy of the 30s, when the problem of long-term economic growth and economic dynamism was not in the first place. That time it was important for Keynes to respond a more urgent question: how to get the economy out of the state of a cyclical decrease.

The situation was radically changed in the post-war period when although there were high rates of growth in some developed countries, but they were unstable, slight character, so the problem of economic dynamics reached the first place.

Solution of issues of economic dynamics became a challenge of the time and first who have accepted that challenge (late 40-ies.) were a British economist R. Harrod and an American economist E. Domar. Due to the proximity of their views a single model of growth of Harrod-Domar is sometimes spoken about.

A special feature of this approach is the use of Keynesian assumptions and methods of analysis of the economic situation in the short-term period for describing long-term tendencies.

In general, the model of Harrod-Domar is based on two assumptions: 1) increase of the national income is only a function of capital accumulation. Such important factors as technological progress and its economic characteristics that have a direct impact on the growth of capital productivity are ignored. Thus, the

model of Harrod Domar is a one-factor model. It is supposed that the demand for capital with this capital intensity depends only on the rate of growth of the national income; 2) capital intensity does not depend on the ratio of the prices of production factors, and shall be determined only by the technical conditions of production.

The representatives of the neoclassical theory believe that social production is effective if the production volume of products is maximum possible using precisely defined volumes of the production factors, namely, capital and labor[3]. To evaluate the efficiency of production, the concept of the production function as a model of knowledge of quantitative dependences of the directly production process is introduced in the scientific turnover.

Determination of the volume of production factors depends on their prices. As a result of the price changes for one or another factor the ration of these factors in the production changes. The preference is of course given to the cheaper factor of production.

Constantly changing economic conditions have pushed neoclassicists to take into account other production conditions, including the technological progress. In particular, the Dutch economist J. Tinbergen in 1937 in his " Econometric Approach to the Problems of the Business Cycle"[4] made an attempt for the first time to include a third factor of the exogenous nature - technical progress absolutely independent of the economic system in the production function, as increasing the impact of costs over time.

Further the neoclassical theory of production, being used for the analysis of macroeconomic problems was transformed into a growth theory. The essence itself of this transformation can be characterized as a transition from the problem of the determination of prices of production factors and justification of the existing income distribution system to the study of the macroeconomic growth factors. A significant role in the development of macroeconomic growth models based on the

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[3] **Фишер, С. Дорнбнуш, Р. Шмалензи, Р.** Экономика. Пер. Со 2-го англ. изд. – М.: Дело ЛТД, 1995 р. 136.S.

[4] **Tinbergen J**. An Econometric Approach to Business Cycle Problems.// Paris, 1937. 73 p.

unit of production functions belongs to Nobel Prize winner Robert Solow. In 1956[5] he proposed a model that gave rise to the emergence of numerous studies on the basis of macro-economic production functions. The model of the economic growth of Solow the growth of total GDP is explained by the growth of employment, technological progress and capital accumulation. Scientific and technological progress in the Solow model is introduced as labor-saving; it increases the efficiency of capital use, but does not reduce the capital ratio during the growth of labor productivity.

Due to the fact from a great number of factors that affect the growth of the production volumes, it is almost impossible to isolate the impact of those directly related to the development of science and technology, in the majority of studies the so-called contribution of STP in the increase in the production volumes was identified with the overall effect caused by all factors except for labor and capital. However, the practical implementation in the macro model, intended for analytical and forecasting calculations, got the so-called simple approaches to identify the contribution of scientific and technical progress within the framework of the factorial analysis of the dynamics of production.

As the technological progress cannot be measured directly, Solow assessed its impact as the difference between the actual rate of growth of the volume of production and part of that growth, due to the growth of labor and capital (later a fairly conventional assessment became known as "Solow remnant". In its turn, the assessment of labor input and capital were determined taking into account the share of wages and profit in the total output volume.

Considering the growth of labor productivity as a function of capital intensity and technological progress in the US economy in the first half of the XX century, Solow made a conclusion that about 12.5% of labor productivity growth for the forty-year period is required to increase in the level of capital intensity, and 87.5% - "technical changes".

[5] **Solow R.M.** Contribution to the Theory of Economic Growth / Robert M. Solow // The Quarterly Journal of Economics, Vol. 70, No. 1. (Feb., 1956), pp. 65-94.

At different times, different economists evaluated the proportion of so-called "contributions" of capital, labor and technological progress in the economic growth (Table)

Table 1. Interpretation of the contribution of main factors of production in the US economic growth by different scientists[6]

Author	Analyzed period yy.	K	L	Of technical progress
Abramovitz,(1956)	1869-1953	22	48	33
Kuznets,(1971)	1889-1929	34	32	34
Kendrick, (1961)	1889-1953	21	34	44
Denison, (1962)	1909-1929	26	32	33
Solow (1957)	1909-1949	21	24	51
Denison, (1962)	1929-1957	15	16	58
Kuznets,(1971)	1929-1957	8	14	78
Kuznets,(1971)	1950-1962	25	19	56
Kendrick (1961)	1948-1966	21	24	56
Jorgenson, Gollop, and Fraumeni (1987)	1948-1979	12	20	69

The data of the Table shows that the technological progress is an important factor of the economic growth, which value increases according to the calculations of all the given authors throughout the XX century.

Thus, the Solow model shows that in the long-term period the production growth depends on the rate of the technological progress. It is this exogenous factor that can support the continuous growth of production, and hence the welfare of the population, expressed in the growth of output and per capita consumption.

However, numerous attempts to assess the qualitative component of the economic growth under the guise of NTP contribution using the unit of production function can be hardly considered successful. In general, as all the models used in micro- and macroeconomics the model of the production function is based on the methodology intended to be limited by the quantitative analysis of external relations without raising the question of quality content. From this point of view,

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[6] **Rosenberg, N., Landau R., Mowery D.** Technology and the Wealth of Nations Paperback. Stanford University Press – October 1, 1992. 460 p.

the only type of relations, existing between the production elements shall be the functional ratio. A distinctive feature is the extensive use of mathematical logic.

Next increased attention to the quality of economic growth coincided with the period of 70[-ies] of XX century, but this time a special interest in the problem was showed by Soviet economists, who by that time formed a sense of the gap between the rapid growth of labor productivity in the socialist economy, and low level of the intuitively understood production efficiency.

In the Soviet economic literature of that time the quality of the economic growth was often associated with the category of efficiency, sometimes talked about the intensification of production, while foreign economists talked about technological progress, total factor productivity, "Solow's remnant".

Despite a great number of publications on the issue of efficiency, the discussion is hardly complete. The reason for this is commitment to the concept of pre-emptive increase in the production of the production means (manufacturing producing investment goods), which was the basis for planning the Soviet economy since the 20s.

2. Quality of the Economic Growth in Ukraine

Having systematized different theoretical approaches about the quality of the economic growth, we can conclude that at the present stage of development of the Ukrainian economy, there are a lot of conflicting tendencies in the dynamics of the main indicators of the social production effectiveness. This concept is used in this paper to reflect the impact of all the quality parameters on the economic growth.

Table 2. Productivity and capital labor-ratio in 2000-2014

Year	Labour productivity, GDP / busy Thousand UAH / person	The rate of growth (decline) in productivity,% to previous year	Capital-labor plant and equipment / busy Thousand / UAH	The rate of growth (decrease) in capital-labor,% to previous year
2000	8,73	100	41,08	100
2001	10,57	121,1	45,83	111,5
2002	11,65	110,2	48,02	104,8
2003	13,75	118,0	50,89	105,8
2004	17,61	128,0	56,22	110,5
2005	22,11	125,5	61,71	109,8

2006	27,25	123,2	75,68	122,6
2007	35,93	131,8	97,93	129,4
2008	47,24	131,4	150,18	153,4
2008 р. в % до 2000 р.	541,1	-	365,2	-
2009	46,90	99,3	193,33	128,5
2010*	56,27	120	346,65	179,3
2011*	67,60	120,1	384,63	110,9
2012*	72,93	107,9	474,94	123,5
2013*	75,86	104,0	538,53	113,4
2014*	87,80	115,7	760,90	141,3
2014 р. в % до 2008 р.	185,9	-	506,6	-
2014 р. в % до 2000 р	1005,7	-	1852,2	-

Source: http://www.ukrstat.gov.ua.

The data of the Table shows that the productivity and capital-labor ratio grow in the dynamics. Usually, a sharp increase in the capital-labor ratio is characteristic of the stage of the NTP implementation, when new types of equipment with high unit power and technological systems contributing to the further mechanization of labor are implemented in the production on a large scale. In this case the capital-labor ratio shall exceed the rate of capital-labor, which eventually causes the growth of the capital productivity. The economy of Ukraine is characterized by high growth in capital-labor. In 2014 in comparison with 2000 it increased by 18.5 times, labor productivity - by 10 times. Alongside with that the given data certify the violation in rations between the growth in labor productivity and capital-labor ratio, when the latter is growing faster than productivity. Such growth has been especially observed since 2008. Such a tendency certifies declining efficiency and low quality of the economic growth.

Figure 1 is a proof of the fact that the capital-labor ratio may grow under the terms and conditions of the scientific and technological involution (reducing the rate of accumulation, degradation of fixed capital).

Figura 1. Gross Fixed Capital Formation in % to GDP and the Degree of Depreciation of Fixed Assets in 2000-2013[7]

Source: http://www.ukrstat.gov.ua.
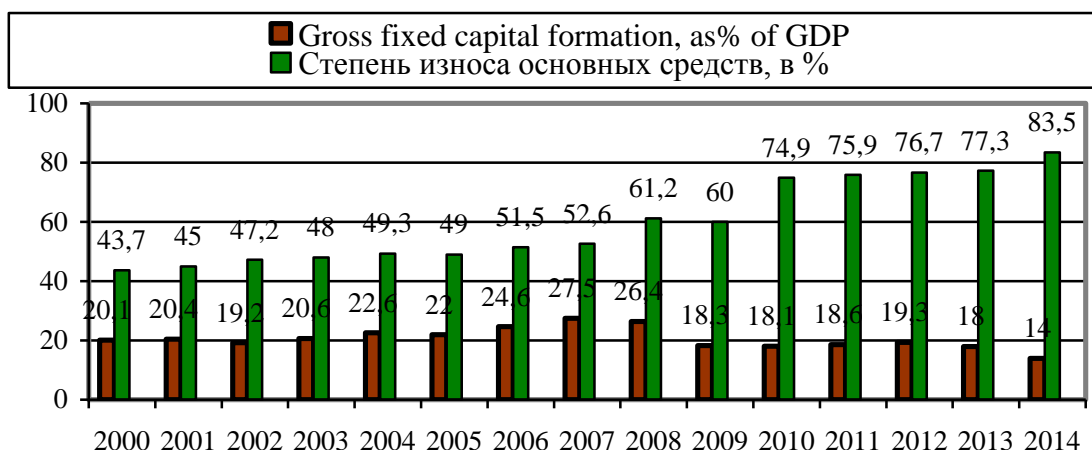
This indicates that the qualitative state and the effective use of the equity capital in the Ukrainian economy in most cases do not meet the requirements of the technical progress, and do not provide competitiveness. The result is a decline in the level of capital productivity and capital utilization. Capital productivity in Ukraine has been steadily declined since 60-ies of XX century, and capital intensity grew accordingly. This tendency continues up till now (Table).

Table 3. Changes in Capital Intensity as a Whole in the Economy of Ukraine

Year	GDP at current prices, mln. UAH.	GDP growth rate in% to the previous year	The cost of fixed assets (mln. UAH. at current prices)	The rate of growth of fixed assets as% of previous year	GDP for hryvnia fixed assets, cop.	The capital intensity of production, UAH
2000	176128	100	828822	100	21,3	4,71
2001	211175	119,9	915477	110,4	23,1	4,34
2002	234138	110,9	964814	105,4	24,3	4,12
2003	277355	118,4	1026163	106,3	27,0	3,70
2004	357544	128,9	1141069	111,2	31,3	3,19
2005	457325	127,9	1276202	111,8	35,8	2,80
2006	565018	123,5	1568890	122,9	36,0	2,78
2007	751106	132,9	2047364	130,5	36,7	2,73
2008	990819	131,9	3149627	153,8	31,5	3,17

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[7] State Statistics Service of Ukraine [E-resource] – Access mode: http://www.ukrstat.gov.ua.

2009	947042	95,6	3903714	123,9	24,3	4,12
2010	1079346	113,9	6648861	170,3	16,2	6,16
2011	1299991	120,4	7396952	111,2	17,6	5,70
2012	1404669	108,0	9148017	123,6	15,4	6,51
2013	1465198	104,3	10401324	113,7	14,1	7,10
2014	1586915	108,3	13752117	132,2	11,5	8,66

Source: http://www.ukrstat.gov.ua.

The ration between the growth of production, fixed assets and capital productivity in Ukraine was uniquely. In general, during 2000-2014, GDP growth amounted to 88.2%, the growth of fixed assets - 105.3%, and capital productivity was 53.9%. The reduced capital productivity had a negative impact on GDP growth and an increase in the volume of fixed assets. It can be concluded from the table that for 2000-2014 fixed assets outpaced the growth of production, and capital productivity declined, "eating" almost all of the growth associated with an increase in the fixed assets. In general, for the entire studied period the capital intensity increased by 2 times, amounting to UAH 4.7 in 2000 and 8.66 – in 2014.

Table 4 shows the calculations of the National Institute for Strategic Studies of Ukraine regarding the contribution of production factors to GDP growth. The calculations were made on the basis of the production function of Cobb-Douglas, identified on the official statistics of Ukraine and transferred to the measurement of the rate of growth when taking the logarithm and derivatives.

Table 4. Contribution of the Costs of Production Factors in the GDP growth of Ukraine, % growth

Year	GDP growth rate	L	K	The contribution of production technology	The contribution of scientific-technological progress (for Solow)
2000	5,9	3,4276	10,7094	-2,7206	-5,4963
2001	9,2	17,711	-2,0472	-0,8931	-5,5608
2002	5,2	10,637	-4,1945	1,3042	-2,5466
2003	9,6	0,7728	11,1237	0,7959	-1,4806
2004	12,1	-5,1965	22,7859	-3,3034	-2,1759
2005	2,7	14,0996	-9,8575	2,733	-4,2352
2006	7,3	17,2466	-7,4217	3,2067	-5,7315
2007	7,9	3,0038	7,5828	1,0357	-3,7223
2008	2,3	4,7597	4,8614	-1,6629	-5,6582
2009	-14,8	9,4899	20,0633	2,0848	-6,3114
2010	4,1	-5,8037	15,385	-2,3826	3,0986

2011	5,2	0,9797	7,2779	-0,0232	-3,0343
2012	0,2	14,7276	-11,1266	-0,0233	-3,3777
2013	-0,4	9,2992	-7,736	0,01	-1,96
2014	2	0,32181	3,0089	0,01	-1,327

Source: http://www.niss.gov.ua/content/articles/files/Prognoz2014-70261.pdf

The data are rather sad and disturbing. The average contribution of STP for 15 years is negative and amounts to -3.7%. This certifies that the financing of scientific and technical work is extremely low. According to the research of many scientists, to maintain the pace of scientific and technical progress at least at a constant (zero or positive) the level, it is necessary to maintain the level of financing of the STP (scientific and technological progress) at least 2.0%, and for its growth - 3.0% or more.

Figura. 2. Dynamics of the STP Rate and Level of STP Financing [8]
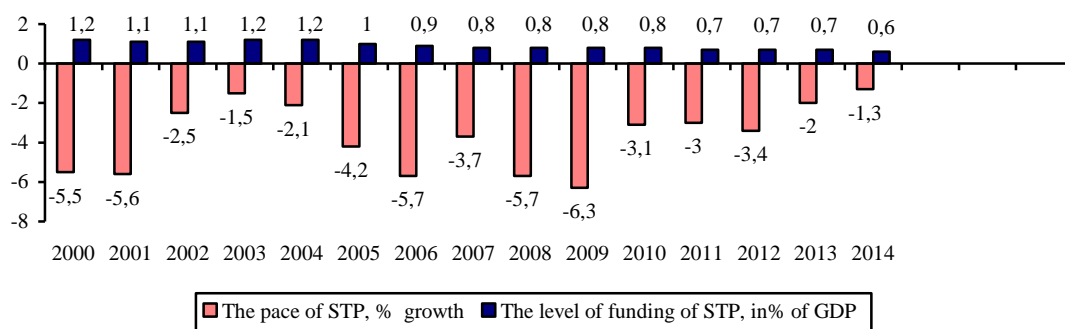
Source: Research and innovation activities in Ukraine in 2014

Thus, we can conclude that under the terms and conditions of slow technological progress decline in capital productivity and consequently increase in the capital intensity is connected with the law of declining capital productivity.

The given calculations, made according to the Ukrainian statistics data, correlate with the theoretical positions expressed by P.A. Samuelson and W.D. Nordhaus. They believed that in the United States in XX century "instead of steady increase, which can be predicted on the basis of the law of declining capital productivity with a constant technology, in fact, there was a decrease in capital

intensity. But since 1950 the situation has changed somehow"[9]. In this case "population and the labor force was increased, but at a more moderate pace than the capital, causing thus, capital deepening"[10]. In this case Capital Deepening shall mean the increase in the capital volume by more significant rates than the growth of population and labor force, that is - the capital-labor ratio at constant technology. The fixed capital in the US has increased over the century by almost 10 times the number of employees - by 3 times. As a result, the capital-labor ratio increased approximately y three times. In this case the volume of production has grown faster than the fixed assets and number of employees and capital intensity decreased, and labor productivity increased. An outpacing growth in production in comparison with the growth of the basic factors of production - labor and capital is connected with the factor of scientific and technological progress.

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Thus, this study gives an opportunity to make some conclusions.

The theoretical analysis and practice indicates that the quality of the economic growth under the modern conditions is a complex and multifactorial function, which expresses its dependence on the quality of technical and technological factors of the production process, determining the level of intensity of the economic growth. The main factor of the economic growth quality is a scientific and technological progress and scientific and technical level of the society development determined by it. Ukraine by this indicator lags far behind other countries.

In general, the Ukrainian economy is facing serious problems that can be solved only by increasing the efficiency and by increasing the labor and capital returns. This requires the activation of the introduction of innovation materials, technologies, management, as well as the promotion of entrepreneurial activity.

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