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INDUSTRIAL COMPETITIVENESS AND INNOVATIONS MODELLING

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Economic growth is analyzed as a macroeconomic problem in many aspects of economic theory and primarily within the framework of macroeconomic and structural-institutional approaches. The model of R. Solow has identified the relationship between capital and labor and its change in the development process. It was a mathematical model in the form of differential equations that demonstrated how the per capita increase in productivity affects the growth of basic capital. it was proved that the increase of the portion of the income, which is kept as a deposit, cannot be a source of permanent growth of economic growth on its own. R. Solow's work has stimulated similar studies in other countries.

The Solow model was used to estimate the GDP growth in Azerbaijan due to scientific and technical progress. The contribution of scientific and technological progress to GDP formation during the period under review has increased slightly (2.8%), but this is not the case, considering the importance of accelerated modernization of the national economy. Given that the industry is actually a carrier of scientific technical progress, it is desirable to have such a high index of industrial production.

Keywords: capital, labor, innovation, industry, economy, macroeconomics, model, GDP.

Economic growth is analyzed as a macroeconomic problem in many aspects of economic theory and primarily within the framework of macroeconomic and structural-institutional approaches. Scientific and technical progress has been the object of numerous research since the mid-twentieth century. The problem of economic growth, A. Smith's "Research on the Nature and Causes of Peoples' Renaissance," remained the basis for economic science [Smith,2007]. Earlier growth models of E. Demar, R. Harrod, V.Leontyev and C.Fon Neyman were based on the coefficient determined and did not take into account the mutual relationship between capital and labor. However, the explanation of the "Leontyev Effect" demanded that the "productivity" parameter be considered. The interaction of these factors in R. Solow's model and its change in the development process have been determined. R. Solow first described his model in his article "Contributing to the theory of economic growth" in 1956 [Solow,1956]. It was a mathematical model in the form of differential equations that showed how the per capita increase in productivity affects the growth of basic capital. Moreover, no one has ever used the concept of "capital replacement of labor" in the development theory so simple and skillfully. R .Solow came up with a stable part of the national income. Collections in the existence of normal working accounts and capital are ultimately linked to the investments that companies want to invest. If the standard of accumulation is high enough, the capital adequacy ratio, ie the amount of real capital per employee, increases, if the capital is not high, th e capital is relatively expensive and the capitalized productivity, which is expressed in the prices of production emissions, also decreases.

R. Solow has shown that, in the absence of existing unchanging technology (that is, no scientific and technical progress), the capital, labor and production volume has the same development norm. This means that if the amount of capital falling to a worker and the product produced are stable, the real wage will not change. It was evidenced by the fact that the increase in the portion of the income as a deposit can not be a source of ever-increasing economic growth. Obviously, the economy with a higher collection rate can achieve a higher volume of per capita production and real wages. However, in spite of the lack of technical progress, the growth rate will remain at the same level, and will be equal to the increase in labor supply. The main result of R. Solow is that, when looked at for a long time, the rates of economic growth do not depend on growth rates of capital investments. According to R. Solow, in the long run, the fundamental basis of economic growth is technological development. Continuous technical progress in R. Solow's model and the efficient use of resources are crucial factors for growth.

R. Solow's theoretical model is widely used in modern economic analysis. Previously, the model used as an analysis of economic growth was later expanded to include other factors of production. For example, models called coefficients are based on R. Solow's model. The neo-classical economic growth model created by R. Solow was the basis for the development of modern macroeconomic theory. In his subsequent work - "technical changes and general production function" - 1957 [Solow,1957] and "Innovations and technical progress" - in 1960 [Solow,1960]. R. Solow has given an empirical assessment of the role of various production factors in the growth of the national product. His analysis shows that technical improvements that have been taken over a long period have somewhat "neutralized" because they did not affect the distribution of national productivity between capital gains and wages. R. Solow concludes that only a small proportion of the current product growth can be explained by increased labor costs. He proved that 7/8 of the US economy growth in 1909-1949 was due to technical progress and only one-eight of the capital investment. In "Investment and Technical Progress," R. Solow has shown the method of empirical determination of the importance of capital growth for economic growth. It has shown that technical progress primarily reflects capital investments directed to its machines and other capital, and should be taken into account in the empirical assessment of the role of capital in economic growth. This idea has found its expression in the so-called "vintage approach" that whenever it is taken separately, new investments are largely related to modern technology and the resulting capital investment will not change significantly during its entire service period (similar idea The same time was put forward by L.Yoqansen in Norway) [Smith,1995]. Here comes the following conclusion - making investment decisions takes into account some of the future technologies. Compared with previous models, R. Solow's results are of greater importance for understanding the role of additional investment in fixed capital in increasing labor productivity. R. Solow's work has stimulated similar studies in other countries.

Let's use the "Solow model" to assess the GDP growth in Azerbaijan due to scientific and technical progress:

$$\Delta Y/Y = \Delta A/A + \alpha \Delta K/K + \beta \Delta L/L, \quad (1)$$

Here

A - Increase in Scientific Technical Progress;

Y - GDP;

K - fixed assets (capital);

L - those engaged in production (labor);

$$\alpha = 0{,}5; \beta = 0{,}5.$$

Let's take the five-year periods for calculations:

Table 1 – Indicators of Azerbaijan's economy for 2006-2010

Indicators	**Years**				
	2006	**2007**	**2008**	**2009**	**2010**
GDP (mln. manats)	18746,2	28360	40137,2	35601,5	42465
Funds (mln.manats)	40641,2	50183	54735,8	61436	66659,5
Total number of people engaged in production from economic activity, (thousand)	4110,8	4162,2	4215,5	4271,7	4329,1

ΔY_5 - 23718,8

ΔY_1 - 23718,8 : 5= 4743,76

Y_5 – 165309,9

Y_1– 165309,9 : 5 = 33061,98

$\Delta Y_1 / Y_1$ =4743,76 : 33061,98 = 0,14

ΔK_5 – Over 5 year = 26018,3

ΔK_1 - Over 1 year =26018,3: 5 = 5203,66

K_5 – Over 5 year = 273655,5

K_1 - Over 1 year =273655,5: 5 = 54731,1

$\Delta K_1/K_1$ = 5203,66 : 54731,1= 0,095

ΔL_5 – Over 5 years = 218,3

ΔL_1– Over 1 year =218,3: 5 = 43,66

L_5 – Over 5 years = 21089,3

L_1 – Over 1 year = 21089,3: 5 = 4217,86

$\Delta L_1/L_1$ = 43,66 : 4217,86= 0,01

$0{,}14 = \Delta A/A + (0{,}5 \times 0{,}09) + (0{,}5 \times 0{,}001)$

$\Delta A/A = 0{,}048$

Thus, the GDP growth in Azerbaijan in 2006-2010 was 0.048 or 4.8%.

Table 2 – Indicators of Azerbaijan's economy for 2011-2015

Indicators	**Years**				
	2011	**2012**	**2013**	**2014**	**2015**
GDP (mln manats)	2082	54743,7	58182	59014,1	54380
Funds (th. manats.)	74186,4	84262,4	95451,1	110677,9	128333,1

Total number of people engaged in production from economic activity, (thousand)	4375,2	4445,3	4521,2	4602,9	4671,6

ΔY_5 – Over 5 year = 2298
ΔY_1 – Over 1 year =2298: 5 = 459,6
Y_5 – Over 5 year = 278401,8
Y_1 – Over 1 year =278401,8 : 5 = 55680,36
$\Delta Y_1 / Y_1$ = 459,6 : 55680,36 = 0,008
ΔK_5 – Over 5 years =54146,7
ΔK_1 – Over 1 year = 54146,7 : 5 = 10829,34
K_5 – Over 5 years = 492910,9
K_1 – Over 1 year =492910,9 : 5 = 98582,18
$\Delta K_1/K_1$ = 10829,34 : 98582,18 = 0,109
ΔL_5 – Over 5 year = 296,4
ΔL_1 – Over 1 year =296,4: 5 = 59,28
L_5 – Over 5 year = 22616,2
L_1 – Over 1 year =22616,2: 5 = 4523,24
$\Delta L_1/L_1$ = 59,28 : 4523,24 = 0,013
$0{,}008 = \Delta A/A + (0{,}5 \times 0{,}109) + (0{,}5 \times 0{,}013)$

Thus, the GDP growth in Azerbaijan in 2011-2015 was 0.048 or 4.8%.

The obtained results can be summarized below: The contribution of scientific and technical progress to the GDP formation during the period under review has increased slightly (2.8%), but given the importance of the accelerated modernization of the national economy, this is not very high.

The country's industry produces half of Azerbaijan's GDP and is the country's main sector. To do so, include the following "Solow model":

A- increase in Scientific Technical Progress;
Y-industrial production volume;
K - fixed assets (capital);
L-industrials (labor);
$\alpha = 0{,}5$; $\beta = 0{,}5$.
Let's take the five-year periods for calculations:

Table 3 – Azerbaijan Industry Indicators for 2012-2016

Indicators	**Years**				
	2012	**2013**	**2014**	**2015**	**2016**
Volume of industrial output (th manat, Y)	15544	22495,6	29773,3	22563,6	27978,2
Funds (th. Manats, K)	21029	28467	30660	34789	37165
Industry consumers (thousand people, L)	197	208,4	210,3	192,3	181,8

ΔY_5 – Over 5 years = 124342
ΔY_1 – Over 1 year =124342: 5 = 2486,84
Y_5 – Over 5 years = 118354,7
Y_1 – Over 1 year =118354,7: 5 = 23670,94
$\Delta Y_1 / Y_1$ = 2486,84: 23670,94 = 0,106
ΔK_5 – Over 5 years = 16136
ΔK_1 – Over 1 year =16136: 5 = 3227,2
K_5 – Over 5 years = 152110
K_1 – Over 1 year = 152110: 5 = 30422
$\Delta K_1/K_1$ = 3227,2: 30422 = 0, 15
ΔL_5 – Over 5 years = - 15,2
ΔL_1 – Over 1 year = - 15,2 : 5 = - 3,04
L_5 – Over 5 years = 989,8
L_1 – Over 1 year =989,8: 5 = 197,96
$\Delta L_1/L_1$ = - 3,04 : 197,96 = - 0,015
$0{,}106 = \Delta A/A + (0{,}5 \times 0{,}15) + (0{,}5 \times - 0{,}015)$

Thus, the increase in industrial production (ΔA / A) at the expense of ETT in Azerbaijan in 2012-2016 was 0.0385 or 3.85%.

In recent years, the share of labor in industrialized countries has increased and reached 80%. In countries rich in natural resources, as a rule, the elasticity ratio of production is greater in capital.

James Braith rightly pointed out that this is the only process that combines science, technology, economy, entrepreneurship and governance. It consists of the acquisition of the innovation and covers the process of the idea from its creation to commercial application [Ivanov, 2002].

The classical economic theory comes from the fact that as the amount of capital used increases the rate of profit decreases and its sustainable growth is possible only through the introduction of new technologies. Technological progress often involves the process of innovation, with new ways to create existing commodities and services with less capital and labor power.

From a theoretical point of view, the growth of the economy allows the production of goods to be sustained at the expense of increased productivity [Nelson, 1993; Stenberg, 1996].

By our opinion, as result of research the given below is almost a matter of priority for our country to activate innovation processes both in industry and in other areas of public production:

- Technology promotes the growth of public production through the production of new goods with higher solvency and higher flexibility in revenues;
- The impact of scientific and technical and educational potential on economic growth is strengthening. Today, innovations and increased management and workforce quality are key to economic growth;

- Science and technology are vital for productivity and contribute to the well-being of society. For example, one ton of computerized production is spent on melting of steel, 12 times less than the cost of the beginning of the 80s of the last century; - Scientific and technical progress brings great changes in the workplace. Their role is played by various types of synthetic raw materials that have pre-defined and non-natural properties. Their processing requires less labor costs. That's why the modern phase of the ETL reduces the role of natural materials in economic development and reduces the dependence of the processing industry on mineral raw materials;

- Under the influence of ETT, changes in labor force also occur. Over the past few decades, these are related to the development of microelectronics, robotics, bio and information technologies. The use of electronic machinery with machine tools and robots has led to the emergence of temporary production systems where mechanical processing of the product is consistent and uninterrupted. Equilibrium production systems considerably increase the automation capabilities. They have extended the functionality of this system to smaller series production, and even if they are of the same type, they can produce different models. Equilibrium production systems are able to quickly adapt to the product's production of new models. Their use significantly increases labor productivity by increasing the equipment use ratio and reducing the time spent on performing the auxiliary operations.

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