MACROECONOMIC MODELS OF ECONOMIC GROWTH BASED ON INVESTMENTS

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Abstract: The aggregate models of macroeconomic growth are instruments to research the influence of investments (the main factor of economic growth) on the economic phenomena and processes. They are economic and mathematical models that show the studied phenomenon and the theory to develop it. There are many models that deal with the direct correlation between investments and economic growth; the indirect correlation uses the fixed capital. This papers deals with the models developed by Keynes, Harrod, Domar, Clarke and Solow that refer to the impact of investments (as a material support) on the economic growth.

Key words: economic growth, investments, macroeconomic modelling

There is a bilateral connection between investments and economic growth: the investments provide a sustainable economic growth and, on the other hand, a "healthy" economic growth may provide the necessary resources to finance new investments programs. The main instruments to quantify this connection between the present investments and the future economic growth are the economic models. They can be used to determine the economic development for a certain investment volume and reversely, to calculate the necessary investment resources according to the future economic evolution.

The multiplier – Keynes

J. M. Keynes' main theory may be stated as follows: the labour increase leads to the revenue increase and hence the expenditure increase, but it does not equal the value of income increase[322]. For a certain value of expenditure ($\Delta C/\Delta Y$, C/Y), named the tendency of activity for expenditure, the equilibrium level depends on the "impulse to invest" which depends, on its turn, by the capital marginal efficiency. The capital *marginal efficiency* represents the future capital effect resulting from an effort unit (the replacement cost). The future effect is measured as the investors' future profit. The effort represents the investment, that is the price the capital will be replaced. Keynes sees the income from the point of view of expenditure and investment expenses, where the economic agents tend to increase expenditure as the income increases, but not proportionally.

For an income increase ΔV, the expenditure increases ΔC, but always $\Delta V > \Delta C$ and the ratio $\Delta V/\Delta C$ is positive and less than 1. The ratio $\Delta C/\Delta V$ is called the *marginal tendency for expenditure* and its symbol is $\boldsymbol{q}$. In Keynes' view, an additional expenditure depends on income increase.

The economic analysis provides the following expression:

$$V = C + E \text{ where}$$

- V represents the population's income;
- C is the population's expenditure;
- E represents the population's savings;
- I represents the investments.

If the population's savings turn into investments, the above mentioned expression becomes: $\mathbf{V = C + I}$. If this relation is valid in the integral analysis, then it is valid in the marginal analysis, too: $\mathbf{\Delta V = \Delta C + \Delta I}$.

Keynes defines the **investment multiplier** *m* as the supplementary income that increases the investments with one unit: $\boldsymbol{m = \Delta V/\Delta I}$. The investment multiplier shows the investment efficiency and it is crucial when planning the economic growth.

Nowadays, the fundamental idea of Keynesianism, according to which the income increase depends on expenditure, is disputable. However, the English economist's merit is indisputable from the point of view

of establishing an analytical economic instrument and using mathematics in economics, especially on macroeconomic level.

The capital coefficient – Harrod

Sir Roy F. Harrod, one of the founders of the theory of economic growth[323] supports and continues the Keynesian theory. He considers that there is a constant ratio between capital and income, if the technical progress remains neutral and the interest rate does not change. The relation that shows this connection is named the **capital coefficient** (*b*) and is calculated as follows: ***b* = K / V**, where:

- K represents the active capital;
- V is the income.

This model is applicable for a 4-5 year period, within a stable economy that provides a continuous development and restructuring without economic jumps and crises (inflation, unemployment, economic blocking). Harrod demonstrated through this model that the capital surplus of the current year will increase income in the following year, which will provide a new capital surplus. From the relation $b = K / V$ results **K = b * V** (integral approach). From the marginal point of view, the latter relation becomes: **ΔK = b * ΔV**, but $\Delta K = I$, and therefore **I = b * ΔV**. Concluding, a certain investment volume (I) determines a corresponding income increase[324].

The accelerator – Clark

Founder of marginalism and author of the theory of "marginal productivity", the American economist Colin Clark stated a similar model regarding investments and incomes 30 years before Harrod. The relation between them was the following:

$$a = I_h / (V_h - V_{h-1})$$

where:

- *a* is the investment accelerator;
- I – performed investments;
- V – incomes;
- *h* – respective year.

The accelerator shows the investment availability when the income increases with one unit. But Clark's model lacks the practical applicability; theoretically it cannot be applied because the investments in the year h function partially during the same year. However, this model may be used to determine the internal financing sources of investments. His famous study „*Conditions of Economic Progress*" from 1939 demonstrates the difference between the European countries and the rest of the world from the quantitative point of view. His further studies focused on issues of economic development and the role of population and investments for the economic growth.

The investment productivity – Evsey Domar

Evsey Domar, a Russian origin economist, made contributions in three main economic fields: economic growth, compared economy and history of economics. His study on economic growth began in 1944 with the model of public debt that shows how the economic growth may reduce the public debt. However, his most important contribution was the famous economic growth model Harrod-Domar (1946)[325].

In this model, he replaces the income with the production capacity achieved through new investments. Domar's model has the following expression:

$$\sigma = (dQ/dt) / I$$

where:

- σ – investment productivity;
- Q – production capacity;
- I – investment volume;
- t – time.

Using the finite differences, the first relation becomes: **σ = ΔQ / I**. The indicator calculated in this way shows the production volume that may be achieved for 1 leu invested, that is the production capacity surplus achieved with 1 leu invested. Comparing the investment productivity with the capital coefficient (calculated in the incremental form of K and V) and considering the production capacity as the maximum production achieved in certain technical conditions, the relation **σ = 1/b** may be established between the two indicators. This means that the investment productivity is the reverse of the capital coefficient and one or the other may be applied in economic practice. The two models were settled in the same year and therefore the literature mentions them as the *Harrod-Domar model*, too.

The Solow model

In the 1950's, the American economist Robert Merton Solow (the Nobel Prize Laureate of 1950 for important contributions made in the theory of economic growth) developed a mathematical model that showed how the various factors may contribute to the national economic growth. Contrary to the traditional economic thinking, he demonstrated that the technological progress supports the economic growth more than the capital accumulations and labour increase. In his paper "*Technical Change and the Aggregate Production Function*" from 1957, Solow showed that half economic growth cannot be justified by capital and labour increase. He assigns this unjustified share – named now the Solow's "**residual"** – to the technical innovation. Beginning with 1960, the Solow's studies have helped the governments to direct their funds to the technical research and development in order to stimulate the economic growth.

Robert Solow's model[326] is based on the following expression: **c = α / b**, where:

- c – rate of employed population growth;
- α – investment fund share in total NNP;
- b – capital coefficient.

The economic balance is achieved on equity terms between the rate of employed population growth and the fixed capital. If the rate of fixed capital increase is lower than the rate of employed population growth, then **c > α / b,** leading to inefficient labour use and productivity. Inversely, when the number of employees is lower than the fixed capital increase, that is **c < α / b**, the results are a forced rhythm for investments and an over-industrialization that cannot provide a proper use of equipment and installation of the national economy. It is obvious that none of these two cases is not favourable for a balanced economic development, and therefore the practice should respect the conditions required by the model of economic growth proposed by the economist Solow.

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