

REFERENCE MODELS OF ENDOGENOUS ECONOMIC GROWTH

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Abstract:

The new endogenous growth theories are a very important research area for shaping the most effective policies and long term sustainable development strategies.

Endogenous growth theory has emerged as a reaction to the imperfections of neoclassical theory, by the fact that the economic growth is the endogenous product of an economical system.

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JEL classification: *E10, E19, O11, O47*

The publication "The Economist" known as an ardent supporter of globalization critics argue that such practices do nothing to deprive the poor of economic opportunities are offered. Perhaps no idea is rooted in modern political culture, than ensuring that economic growth is the key to meet the most important human needs, including poverty eradication and environmental protection. Who tries to talk about the growth risks due to environmental limits, will automatically be categorized as an opponent of the eradication of underdevelopment. Therefore, the vast majority of environmental scientists invoke the need of a "different kind of growth", although it is not clear what form it takes.

Economic growth is the main goal of world states and also a natural historical process that has characterized the global economy as a whole. The last century has been a sustained increase in production of goods and services and national income, especially due to technical and scientific large discoveries and widespread dissemination. The economic growth "brought about welfare and social progress, people's real incomes have generally increased from one generation to another, allowing the consumption of goods and services increase, raising living standards and welfare, but also negative consequences (environmental harm). However, economic growth is a prerequisite of social development and states sovereignty, thus becoming a field of international economic competition"¹.

Economic literature after the Second World War focused on the analysis of conditions and factors that increase the production of goods and services; have been developed various studies and analysis theoretical-mathematical models and prognosis of the national economies development.

The study of economic growth has old implications. Starting from the *School Classic* representatives - A. Smith, D. Ricardo and Th. Malthus - there were concerns for studying growth. In Malthus's view - assuming limited land and population growth - a balance is achieved when the salary falls to a level where labor demand increases with a slower pace and the economy remains in steady state. In their models, the classics have omitted the contribution of technical progress to increase production per capita.

¹ Barro, RJ, Hall I., Martin, X., *Economic Growth*, McGraw-Hill, New York, 1995

In growth theories evolution were crystallized two distinct periods, marked especially by the work of American economists:

1. first period, which started in the late 50's had at its core the **neoclassical growth theory (exogenous)**, which is based on Robert Solow (Nobel Laureate in Economics);
2. the second important period began in the late 80's with the advent of **endogenous growth theory** (Robert Lucas, Nobel Laureate in Economics).

Models of economic growth "represents a tool for investigating and understanding the influence of their investments as the main factor of growth, concerning economic phenomena and processes"². Like any economic and mathematical model, the economic growth models also have to express, on the one hand the phenomenon investigated, and on the other hand the theory that was the basis for its elaboration, this linking the theory with the reality of the object studied.

Given the importance of investment is that material support economic growth, the economic literature presents a number of models that address the link between investment and growth. Among these models, most representatives are the models developed by Keynes, Harrod, Domar and Solow, through the impact the investments have on economic growth.

Endogenous growth theory emerged in reaction at neoclassical theory imperfections, supporting the idea that endogenous growth is the product of an economic system, and not the result of outside forces that influence it. Therefore, research and theoretical contributions have tried and are trying to discover the actions of private or public sectors determining residual variation of growth factor (given the increase in total factor productivity) from one country to another. As neoclassical growth theory, the focus is the behavior of the national economy as a whole. The reason that was the origins of endogenous growth has as basis the observation that there are sufficient reasons to reject all growth models built in the 1950, 1960, 1970.

Paul Romer has identified five truths³ extracted from economic reality and that economists should call the building growth models:

1. supply atomicity, the existence of several companies working within the market economy. This assumption excludes *a priori*, the conception of a model in which all production is concentrated in the hands of one manufacturer - monopoly, thing otherwise, embedded in almost all the assumptions of growth models;

2. knowledge differs from other inputs (production factors), meaning that more people can use them simultaneously. The idea behind the transistor design, internal combustion related principles, organizational structure of a corporation are some existing information that can be used simultaneously by several persons, ie have non-rivalry property; scientific and technical discoveries varies from other inputs, meaning that people can use them simultaneously, unlike the ordinary goods that are rival (in terms of public economy), information is non-rival;

3. economic activity from which are resulting tangible goods can be resumed, meaning that re-entering the same inputs in a specific production process will result a good identical to that obtained from a previous production. Therefore, in terms of the competitive market, the aggregate production function must be homogeneous of first degree - for all inputs. If we have, for example the production function, doubling the amount of the three inputs K, N, L will result in doubling production (Y). About the factor A, is not a requirement to be duplicated because, being a non-rival good,

² Vasilescu, I., Românu, I., (coordinators), *Dictionary of investments*, Lumina Lex Publishing House, Bucharest, 2003

³ Romer, P.M., *The Origins of Endogenous Growth*, The Journal of Economic Perspectives, vol. 8, no.1, 1994

embedded knowledge can be used simultaneously in multiple production economic activities. Assuming that the production function is homogeneous of first degree, and the companies as recipients of price (pricetakers), payments for use of the three factors of production – that have the rivalry feature - will be equal to the value of the process of which they participated. This is the reasoning that lies behind the neoclassical growth model. Regarding the remuneration of the factors that were the discoveries foundation designed to increase the production of A factor, neoclassical recognize that those models not envisage this fact, being considered a exogenous given stock;

4. findings are derived from the human actions; all new ideas that increase the stock of available knowledge, are the result of creative manifestations of individuals or otherwise, resulting from human action. Therefore, the stock of knowledge has the ability to continuously increase and human activity generally, the economic especially, is the only supply source of this stock; technological progress occurs due people work;

5. there are many individuals or companies who earn monopoly rents as a result of owning some valuable ideas. Even if the information itself is non-rival, valuable discoveries can be economically more or less characterized by exclusion. Because the individuals or the firms may have control over information contained in the discoveries, the latter category we find the quasi public.

The model developed and applied by Solow is remarkable as an important step in growth models construction process .This model holds hypotheses (1), (2) and (3), but postpones consideration of the last two. Theoretically, the model key advantage is to treat technology as a pure public good. Such an approach makes it possible the model accommodation with the hypothesis (2) - knowledge is non-rival goods - although it the conditions of perfect competition are kept.

What does not correspond with the model is the hypothesis (4) and then (5), since they are treated as pure public goods, knowledge are characterized by way of non-exclusion, so companies can not profit from approaching their discoveries, it denied the reality .

Endogenous growth models try to take the next step and to include in the analysis the assumption (4).Work in this direction began in 1960. For example, Karl Shell (1966) proposed a model where factor A is financed from revenues collected by the government through fiscal policy. However, much of the modeling attempts tended to remain open to Arrow (1962), emphasizing rather private entrepreneurial initiatives and contributions to technological progress than public research funds. Other models had followed the incorporation of (4) and (5) assumptions. Among them are particularly remarkable s because he accentuates the importance of the monopoly power existence - temporarily - continuity and promoting of innovation process. Based on Schumpeter perspective, can be distinguished two directions: models in which the emphasis is on knowledge diffusion and linear models.

Endogenous growth models can be grouped in models with or without research-development, meaning those in which growth is stimulated in the absence of technical progress (AK models) concerned the technical progress which is the result of the economic activity performed in research-development area of developed countries.

According to endogenous growth approaches, state intervention is justified if it causes scale increasing returns of economic activities and, therefore, will involves an economic growth process. This intervention may take various forms:

- subsidizing activities that generate positive externalities;
- taxing activities that lead to negative externalities;
- mechanisms creation for stimulating and innovations implementation (patents);
- development projects in transport infrastructure;
- investment promoting and supporting in education.

The main contribution of the new endogenous growth theory was therefore, solving this impasse introducing some mechanisms by which balanced economic growth become sensitive to some endogenous variations.

Endogenous growth mechanism can be understood and highlighted by technical progress this way:

$$A = Ak^b I^c, \text{ unde } A > 0.$$

Equation determines the rate of technical progress as a positive function k (labor capital endowment) and I , a period of capital accumulation rate (per capital gross investment), so the rate of technical progress is determined endogenously. For $b = c = 0$ is where neoclassical type of exogenous technical progress.

In particular the U.S.A, endogenous growth theory emphasized the role of technical knowledge and human capital formation. Thus, in 1986, **Paul Romer** introduced externalities of technical knowledge in the aggregate production function, promoting innovation and growth acceleration. In 1988, R. Lucas highlights the role of human capital in growth process, showing the need for introducing it as an additional factor in the production function. Also, Romer points out later, that endogenous growth occurs when the aggregate stock of human capital has positive externalities on technical progress.

Paul Romer, professor at Stanford's Graduate School of Business, has focused his researches on economic growth; *and currently his research is focused on technology and wages and also on political science*. Paul Romer believes that economic growth theorists would have to stop price-taking assumption. Otherwise, regardless the situation or the model construction, there is no way to consider the hypothesis (5).

Submitting a retrospective analysis, the chronological structure of growth modeling, although endogenous growth is based on imperfect competition, curiously, it appears that, initially, the model of Romer (1986) and Lucas (1988) included the assumption (4), but they left out the (5). In both models, technology is treated as endogenous, side effect of the private decision for investing economic resources.

In these first reference models by R. Lucas and P. Romer, technological progress is endogenously produced as a side effect of investment decisions from private sector.

Romer has proposed in 1986 a model⁴ in which the production function can be written as: $Y = A(R)f(R_j, K_j, L_j)$ where R_j are the findings stock obtained from research and development expenditure by firm j . He considered the existence of some knowledge diffusion resulted from private research efforts, thus it is obtaining a knowledge stock increase available to all (A). By configuration the production function as being a first-degree homogeneous in all inputs, including R , Romer's model does not meet the assumptions (2) and (3). Assuming that R_j as being non-rival, according the hypothesis (3), would result that the firm faces increasing returns in all inputs under their control, because production would be doubled only by doubling K_j and L_j . When Romer himself admits that the assumption on R as good rival, and function as being a first-degree homogeneous in all the inputs, he made a fundamental mistake. „After all, if someone ignores the complexity of economic activity by assuming that there is an aggregate production function, how much worse can made if it is unclear in differentiating rival from non-rival inputs? Unfortunately, this approach may cause important uncertainties. The distinction between rival and non-rival inputs, and also between goods characterized by non-exclusion and exclusion is very important for shaping growth and, more importantly, for the formulation of economic policies”⁵. The author has assumed that the positive externalities of private innovation efforts lead to

⁴ Romer, P.M., *Increasing Returns and Long Run Growth*, Journal of Political Economy, October 1986

⁵ Romer, P.M., *Increasing Returns and Long Run Growth*, Journal of Political Economy, October 1986

improvements in technology public stock A, and thus influence the rate of technical progress.

Romer (1986) had refined the model by incorporating the utility maximization during lifetime with an inter-temporal function. However, in the initial model, as Romer's model, does not provide an explicit role for human capital. Conversely, the second endogenous growth model of Romer's (1990) recognizes human capital "as a primary source of technological progress and therefore of economic growth"⁶. Romer sees researchers in business as a source of new ideas and profit. In this model, Romer also distinguished the technology protected by patents, by knowledge stores shared by the researches community. There is no consensus on how human capital affects growth.

The so-called linear models of endogenous growth have as a starting point Romer's strategy to treat the knowledge that company controls as being an average good, rival - and thus un-characterized by increasing efficiency. The effect was that we chose to analyze all inputs that are accompanied by characteristic of rivalry. Production function becomes $Y = F(R, K, H)$, a first degree homogeneous function. It therefore eliminates the hypothesis increasing returns occur since each input is treated as being characteristic of rivalry. In order to further simplifications inputs R, K, H (human capital) were aggregated as a single measure, larger, of capital notion, resulting a function such as $Y = F(X) = a(X)$. Considering that a constant part of the output is saved and used in the production of Factor X, the model can lead to a sustainable endogenous growth.

Paul Romer finally managed to establish two models of growth that should respect the five hypotheses. The first of these (Romer, 1987) examined growth under monopolistic competition, without giving knowledge and technology diffusion. Then, holding imperfect competition, he had combined monopoly power with technological diffusion, a phenomenon that can be considered the effect of the action of incomplete property rights. In evaluating various growth models, Romer pointed out that Lucas's observation - people with particularly human capital migrate from poorer in some wealthier areas - is a serious argument in support of the idea of endogenous growth, but also to reject convergence. Therefore, this and others such as trade that takes place in a branch of industry or the fact that human actions are the source discoveries, will not be found in the statistical data collected by different organizations, for the simple reason that they are, by nature, endogenous.

From the perspective of *Lucas* (1988), individuals choose in each moment how to allocate time between current production and of skills and abilities accumulation (or school), taking into account productivity and wages increases, that will occur in the future due to current investments in education and training.

Lucas's model since 1988 is using a production function of the form:

$$Y = K^\alpha \times (hL)^{1-\alpha}, \text{ where } h \text{ is human capital per habitant.}$$

He assumed that it evolves according to the following equation:

$$\partial h = (1-u) h, \text{ where: } u \text{ is the time spent working;}$$

1- u time for training.

Consequently, the latter increases the growth rate of human capital $\partial h/h = (1-u)$, and also of income, in a permanent way.

By comparison with the neoclassical model, these linear models capture economic premise (4) mentioned above, namely that technical progress is resulting from economy agent investments; so the investments are crucial in endogenous growth.

British variant of endogenous growth theory emphasized the role of investment in physical capital. Maurice Scott, in 1989, suggests that the endogenous growth

⁶ Romer, P.M., *Endogenous Technological Change*, Journal of Political Economy, October 1990

mechanism occur through effects of investment spending in the rate of technological innovation, technical progress being the endogenous product of capital accumulation.

In this approach, technical progress is both identified and made by investments so that they serve simultaneously as:

- means of increasing the capital stock;
- way of finding new opportunities for innovation;
- means of technological innovations in production process.

In conclusion, we can say that in view of endogenous growth theory, technology development will be internal for the system if the economic agents will decide to allocate a certain amount of resources for this purpose, such as the expenditures on research and development or staff training programs.

With the rapid development of applied mathematics and econometric techniques, the importance of investing in growth patterns was assessed and tested also by J. Tinbergen and H. Bos, indicating that "as the phenomenon of investment is crucial for the development process, no model can be conceived without this variable"⁷.

P. Romer suggests that investment spillovers, as the new capital goods are bearing new technical knowledge. Therefore, a company private investment offer the opportunity to find out about a new technology; in this case, no firm can not retain full benefits of their investments, and the rate of social return on investment exceeds the economic private return rate. However, the **endogenous growth** essence is arising from positive externalities of wide development and dissemination of scientific and technical knowledge.

The new endogenous growth theory, demonstrating a system for transmitting positive externalities of growth, is a very important research direction for shaping the most effective policies and development strategies long-term sustainable.

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