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# ON ENDOGENOUS GROWTH THEORY

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**Özet**

20. yüzyılın ikinci yarısından itibaren neo-klasik büyüme teorisi hakim paradigma olarak büyüme konusundaki çalışmaların çerçevesini çizmiştir. Neo-klasik büyüme teorisinin dışsal öngördüğü nüfus ve teknolojik değişim Romer'in 1986 yılında yayınladığı makale ile birlikte, ekonomi teorisinde içsel bir değişken olarak kabul edilerek günümüzün hakim paradigması olan yeni klasik makro iktisatta önemli bir yer edinen yeni büyüme teorileri doğmuştur.

## Introduction

Neoclassical growth theory began with the pioneering study of Solow and Dension. Notably Cass and Koopmans with their theory optimal growth, made some refinements in the mid-1960's, but had a limited impact.[1] These studies have basic assumptions of a closed economy with competitive markets, identical rational individuals, and a production technology exihibiting diminishing returns to capital and labour separately and constant returns to both input jointly. Labor growth and technological change are exogenously determined, and no effective role is given to government policy or human capital. Over time, capital-labor ratios and wage rates a cross different countries are expected to convergence. Because of these assumptions initial conditions or current disturbance have no long-run effect

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1 Robert SOLOW, "**A Contribution to the Theory of Economic Growth**", Quarterly Journal of Economics, Vol.70, 1956, p.65-94; Edward DENSION, **The Sources of Economic Growth in the United States**, Comm. Econ. Development, Washington, 1961; David CASS, "**Optimum Growth in an Aggregative Model of Capital Accumulation**", Review of Economic Studies, Vol.32, 1965, p.223-240; Tjalling KOOPMANS, "On the Concept of Optimal Economic Growth", **in The Econometric Approach to Development Planning**, Amsterdam, 1965.

on the level of output and in the absence of technological change, per capita output should converge to a steady-state value with no per capita growth.[2]

With the pathbreaking study of Romer, the dominant role of neoclassical growth theory shifted to the endogenous growth theories.[3] Recent empirical evidence on the diversity of the rate and level of economic growth showed the usefulesness of the convergence inference of neoclassical growth theory. Using analitical tools of neoclassicals, Romer explained the divergence in income across nations.[4]

**1. Endogenous Growth and Romer**

Until endogenizing them, economists tended to assume some key variables as exogenous. The much known of these variables are population and technolocigal change. In the classical era, Malthus endogenized population by the dependence of growth on the economy's material conditions, especially food suply. After 158 years, Solow exogenized population and also technological change. With Romer the hegamony of exogenously determined growth ended.

Romer developed an alternative view of long-run growth in his famous article. According to his model per capita output can grow without bound in a competitive equilibrium in contrast to neoclassical growth models. He argued that the rate of investment and the rate of return on capital may increase rather than decrease with increases in the capital stock. So the convergence is not necessary. All these arguments depend on the departure from the traditional assumption of diminishing returns.[5]

In Romers model, knowledge is taken as an input in the production function and new knowledge, the ultimate determinant of long-run growth, is produced by investment in research technology which exhibits diminishing returns. In other words, a doubling of investment in research technology will not double knowledge. The creation of new knowledge by one firm raises

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[2] Paul ROMER, "**Increasing Returns and Long-Run Growth**", Journal of Political Economy, Vol. 94, 1986, p. 1002-1003.

[3] Paul ROMER, **Dynamic Competitive Equilibria with Externalities, Increasing Returns and Unbounded Growth**, Ph.D. Dissertation, University of Chicago, 1983.

[4] Danyang XIE, "**Increasing Returns and Increasing Rates of Growth**", Journal of Political Economy, Vol .99, 1991, p.429.

[5] ROMER, "**Increasing Returns and Long-Run Growth**", p. 1003.

production possibilites of other firms by spillover effect. This natural externalitiy of knowledge comes from imperfectly patented or kept secret.[6] So the production of goods from increased knowledge demostrates increasing returns, that is to say knowledge displays increasing marginal productivity.

Demostrating three elements of his model, namely, externalites, decreasing returns in the production of new knowledge and increasing returns in the production of output, Romer proved consistency of these elements with competitive equilibrium. His model is an endogenous technological change equilibrium in which long-run growth is driven primarily by the accumulation of knowledge by forward looking, profit maximizing agent. In other words, endogenous technological change is explained in terms of the aquisition of knowledge by rational profit maximizing economic agents.

The assumption of increasing marginal productivity ended the presupposition the converging incomes per capita in neoclassical two sector or international trade models. Thus LDC's(Less Developed Countries) can have lower rates of growth than industrial countries. This will increase the gap between rich and poor countries. Because, given increasing marginal productivity of capital of industrial countries may cause to flow of capital and investments from LDC's to industrial countries. Weak economies can not take the advantages of growth process.

### 2. Endogenous Technological Change and Romer

Romer's second attempt to explain endogenous technological change came out in 1990. Similiary with Romer, same conclusions can be found in Uzawa and Lucas.[7] In these models technical advance comes from a sector which produces productivity enhancing ideas. The research sector invokes human capital together with the existing stock of knowledge to produce new knowledge. The crucial endogenous variable is then the amont of resources which are allocated to this sector. Ideas produced by research sector are

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[6] ROMER, p.1003.

[7] H. UZAWA, "**Optimum Technical Change in an Aggregative Model of Economic Growth**", International Economic Review, Vol .6, 1965, p.18-31; Robert LUCAS, "**On the Mechanics of Economic Development**", Journal of Monetary Economics, Vol. 22, 1988, p .3-22.

available to other sector's firms at zero marginal cost, which produce a good which can be consumed or invested.

"The raw materials that we use have not changed, but as a result of trial and error, experimentation, refinement, and scientific investigation, the instructions that we follow for combining row materials have became vastly more sophisticated. One hunderd years ago, all we could do to get visual stimulation from iron oxide was to use it as a pigment. Now we put it on plastic tape and use it to make videocassette recordings". These are the sentences of Romer for the explanation of the importance of technology.[8] Romer used three premises for his model. The first one is that technological change that is improvement in the instructions for mixing together raw materials, lies at the heart of economic growth. Technological change provides continued capital accumulation and together, capital accumulation and technological change cause the increase in output per hour worked. The second premise is the endogenous technological change which comes out by the intentional actions taken by people who respond to market incentives. Of course this does not mean that all technological changes are motivated by market movements. But market incentives have the essential role in the translation of knowledge into goods. For the issue Romer gives this example: "Our initial understanding of electromagnetism arose from research conducted in academic institutions, but magnetic tape and home videocassette recorders resulted from attempts by private firms to earn profit".[9]

For Romer the third and most basic premise is the instructions for working with raw materials. After the creation of a new instruction set, these instructions can be used for many times without additional cost. Cost of creating instructions occured only once.

In the Romer model knowledge enters into production in two different ways. A new design or idea allows the production of a new intermediate input. But also, a new idea increases the total stock of knowledge and accordingly increases the productivity of human capital employed in the research sector. If a firm creates a new good, it has to

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[8] Paul ROMER, "**Endogenous Technological Change**", Journal of Political Economy, Vol. 98, 1990, p. 71.

[9] ROMER, p. 72.

recover those costs arise from production of a new good by selling the new good for a price that is higher than its constant cost of production.

The conclusion from Romer model is the importance of market size in the creation of new goods. Thus population is less important in determining rates of growth. Instead the human capital stock in the labor force is very important. The technological change is in the center of model as being the crucial determinant in the growth process. So production of human capital is more important than the production of capital. Learning by doing, formal education and on the job training are the most important parts of human capital formation.

If the population is not the right measure for the market size, then largely populated countries do not create effective demand which will turn into new design activity.

Stern critizes the model of Romer from the viewpoint of research sector. "There are problems with this approach, however, if we try to tell empirical stories. It is extremely difficult to identify anything approximating to a knowledge-producing sector in real economies. R&D activity for example, is poor defined, diffucult to interpret and in many cases in practice probably contains little real research in the sense of the 'ideas' in the model".[10]

### 3.Lessons From Endogenous Growth For LDC's

Tamura tried to converge human capital which would cause convergence in both growth rates of income and the level of per capita income.[11] But divergence is still active in growth rates among nations. and this is widening the gap between LDC's and industrial countries. In ortodox theory of economics LDC's have to distribute their resource according to their marginal costs and products. This static allocation would not cause a rapid increase in the growth rate.

Lucas explained the background and determinants of the miracle in Asia. The dragons of Asia performed higher rates of growth and a continuing

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[10] Nicolas STERN, "**The Determinants of Growth**", Economic Journal, Vol. 101, 1991, p. 127.

[11] Robert TAMURA, "**Income Convergence in an Endogenous Growth Model**", Journal of Political Economy, Vol. 99, 1991, p. 522.

transformation.[12] The main determinants of this miracle are human capital and physical capital accumulation, learning by doing, imitation, R&D and other creative activities. So the endogenous growth theory tells LDC's that they have chance to make a economic miracle. Utilizing their resources in R&D sector, increasing school enrollments rates, opening their markets to global competition are the main factors for the success of LDC's. On the other hand, according to endogenous growth theory globalization can increase the gap between the poor and the rich economies. Before this theory, the ortodox theory assumed that capital has lower marginal productivity in rich economies because there exists much capital than poorer ones. But Romer concluded that knowledge may compensate the low productivity of capital in rich ones. Therefore liberated flow of capital, in the global system of world, seeks its return and goes to anyplace where it can get the best. Until Romer, ortodox theory instisted on that the rates of return of capital is higher in LDC's. In contrast, Romer's explanations proved that it can be higher in rich countries. This means outflow of capital from LDC's. To avoid the outflow of capital, LDC's must subsidize not only physical capital investments but also human capital investments in the long-run for higher rates of return of capital.

Externalities and spillover effect teach LDC's another lesson.[13] If the knowledge exihibits externalities and may consumed buy other the firms with a little cost then MNC's(Multi National Corporations) can be regarded as the major mechanism for the transfer of technology. MNC's can be used in the diffusion of high-tech in LDC's. Making strategic alliences with MNC's or susidizing MNC's investments will encourge technology transfer.

**Conclusion**

Endogenous growth theory born with Romer.[14] Although many different aspects of growth became popular, the basic themes remained mostly the same. These themes are capital and other factor market imperfections, the scarcity problem, take-off stage, tarnsformation and the

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[12] Robert LUCAS, "**Making Miracle**", Econometria, vol. 61, 1993, p. 251.

[13] On the other hand Sergio REBELO argued that increasing returns and externalities are not necessary to generate endogenous growth, "**Long-Run Policy Analysis and Long-Run Growth**", Journal of Political Economy, Vol. 99, 1991, p. 500.

[14] Also Arrow's article can be regarded as the first the attempt; "Kenneth ARROW, "**The Economic Implications of Learning by Doing**", Review of Economic Studies, Vol. 29, 1962, p. 155-173.

transition dynamics, human and physical accumulation. But recent pradigm in the literature is the development of dynamic analysis which examines growth and population as andogenously and simultaneously determined rather than seperate outcomes. Development economists have for many years felt the need to go beyond the neoclassical model to understand the experience of developing countries. Their attempts were unsuccessful because of inconsistency between theory and evidence. The endogenous growth theory ended this inconsistency.

The main contribution of endogenous growth theory is the creation of an analitical framework or an unified theory in which growth and development can be analyzed together.

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