Economic Growth

Economic Growth:

Theory and Practice

Edited by

Ahmet Gülmez and Furkan Beşel

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List of Abbreviations

GDP:	Gross Domestic Product
R&D:	Research and Development
EU:	European Union
IMF:	International Monetary Fund
OECD:	Organisation for Economic Co-operation and Development

INTRODUCTION

Some of the chapters in this book have emerged from the ICPESS conference held in Sarajevo in May 2017, which invited Turkish Ministry of National Education undersecretary representatives, the head of board of regents for the Turkiye Maarif Vakfi (Turkish Education Foundation) Prof. Dr. Birol Akgün, and also representatives from the Bosnia-Herzegovina Ministry of National Education. The conference brought together valuable studies from the fields of Economics.

Economic growth is defined as a constant increase in real Gross Domestic Product (GDP) per person. Economic growth is associated with welfare levels of each country and it has been an attractive topic for centuries. If the pre-industrial revolution period is investigated, in a global sense, income per capita has been constant for centuries. After the industrial revolution, in a global sense, significant increases in income per capita have been observed. This outcome leads many researchers to analyse the underlying resources for the growth.

Smith's research on free trade, cooperation and specialisation, Ricardo's partition and growth based on the law of diminishing returns, and Mathus's works on population and growth are the first individual studies in the field of economy. After the first wave of growth theories presented by Keynes as the "General Theory", the Harrod-Domar growth model was built on savings, investment, capital, disposal and growth. If technological developments are discarded, this model defines the source of economic growth as savings and therefore investment.

In 1956, the Neo-classical growth model which was the second growth wave presented by Solow, stated that growth is the unexplainable residual of labour and capital input. In this model, economic growth (increase in income per capita) is based on an external variable which is technological development under a steady state balance.

Internal growth models, which were developed in 1980s and explained as the third wave of growth models, defined the source of growth inside the economic model. Romer's Research and Development based growth model, Lucas's human capital-based growth model, and Rebelo's AK model are among the important internal models.

Particularly after World War II, various books on economic growth were written. Books about economic growth generally have complex and hard to understand theoretical structures. This book is different from classical economic growth books since it contains theory and practice. Additionally, the book includes chapters that investigate the relationship between macro-economic size and economic growth.

This book can be selected as a supporting resource for economy and finance education in universities as well as serving as a valuable resource for everyone interested in economic growth.

In the first chapter, relevant theoretical frameworks for economic growth are presented. In the second chapter, the relationship between defence expenditures and economic growth is studied. In the third chapter of the book, the Feldstein – Horioka Hypothesis is evaluated in the context of developed and transition countries. In the fourth chapter Aççı et al. analyse the relationship between inflation targeting and economic growth in the context of Turkey. In the fifth chapter, which was prepared by Bayat et al., the relationship between import-export and economic growth is tested. In the sixth chapter, convergence analysis is undertaken for the OECD countries. In the seventh chapter, the relationship between borrowing and economic growth is evaluated in the case of Turkey. In the final chapter, the relationship between interest payments, external debt and economic growth is analysed using a causality test.

In this book economic growth which has a significant place in the literature in economics is studied from different perspectives. We hope that this book will be useful for readers, researchers, policy makers and those concerned with the focus of this book: external debt and economic growth.

CHAPTER ONE

THEORETICAL APPROACH TO ECONOMIC GROWTH

FURKAN YILDIZ

Introduction

Economic growth is generally described as the increase in a country's real gross domestic product (real GDP) or the productive capacity in one year or over a certain period of time. The GDP of a country is determined by the number of factors of production and the organization quality that is used while putting the factors of production into the production process. If a country rich in factors of production does not build up a production process by organizing these factors efficiently, the GDP can be lower than the GDP of another country's economy that is poorer in factors of production but has a better organization.

Although the first modern model to determine the components of economic growth was developed by Harrod and Domar, it is also possible to see some other efforts in the Mercantilism, Physiocracy and Classical School to explain economic growth.

Adam Smith and David Ricardo, two of the prominent economists of the Classical School, have explained the resources of economic growth in various ways though not quite specifically. According to Smith, the impetus of growth, as in Physiocracy, is the employment level realized in productive sectors. However, taking a different approach from the physiocrats, Smith has denominated both agriculture and the manufacturing industry as productive sectors. For Smith, the capital accumulation which arises from the employment in agriculture and manufacturing sectors will bring economic growth with it. Nevertheless, the economic growth will cause a recession in the long term due to the decreasing profit rates and increasing level of wages. By adding the rule of decreasing returns to the economic growth process, Ricardo chose to fill the deficiencies of Smith. According to Ricardo, if profit margins are above the market interest rates, the savers will accelerate capital accumulation by directing savings into investments. This leads to the increase of wages and consequently the population. The increase in population rate causes the rise of food prices due to the decreasing returns in the agriculture sector. Because of the absorption by rents, the extra profit obtained from the increase of prices leads to the decrease of the profits in agriculture. Although innovations in agriculture and industry are partially able to prevent profit margins from decline, the eventual long-term result is a recession as in Smith's theory (Kazgan, 1993, 88-96).

According to Karl Marx who is the founder of socialist economic thought, economic growth is a result of capital accumulation. Capital accumulation comes from the surplus value seizure that occurs when the capital owners determine a wage level below the real benefit that the workers create. For Marx, accumulation of surplus value and capital accumulation depend on each other. While surplus value causes capital accumulation, capital accumulation leads to the occurrence of a higher surplus value. As a result of this relationship, the capital owner will be the side who always benefits more from economic growth (Küçükkalay, 2011, 389-391).

One of the economists that made important contributions to the literature on economic growth is Joseph Alois Schumpeter. Schumpeter explains his ideas on growth over the concepts of innovation, entrepreneur and creative destruction. According to Schumpeter, capitalism is a structure that is not stable, and innovations are the main reason for this. By using innovations at production, marketing and design stages, profit-oriented entrepreneurial production can both increase its own profit and trigger the sector it operates in through providing positive externality. The efforts of entrepreneurs to produce innovation cause the complete vanishing of traditional goods/products and their replacement with new goods/products, or the manufacturing of goods using newer production methods. According to Schumpeter, this is the *'creative destruction process'* and this concept is the main dynamic of economic growth (Taban, 2014, 78-82).

Theoretical contributions to economic growth literature started to increase between the two world wars. Beyond expressing the process of growth in new theories descriptively, it also began to be described through various models. Harrod-Domar is the first known growth model in this sense. Afterwards came the neoclassical growth model which internalized effort that was neglected in Harrod-Domar's model and where technology was included externally. However, the neoclassical growth model has been insufficient to explain long-term growth. Therefore, endogenous growth models in which technology was also internalized, emerged especially in the 1980's.

A number of basic modern growth theories will be examined in this chapter. To begin with, the Harrod-Domar growth model which is the first known modern economic growth model will be discussed, followed by explanation of the neoclassical growth model which included the labour to the system that was neglected in Harrod-Domar's model. Later, the endogenous growth theories, Paul Romer's technological change model and research and development (R&D) model, the AK model, Robert Barro's growth model based on public expenditures, the human capital accumulation model of Robert Lucas and Aghion-Howitt's Schumpeterian growth model will be explained in detail.

The Harrod-Domar Growth Model

Only the income increasing effect of total investment spending was discussed in "The General Theory of Employment, Interest and Money" published by John Maynard Keynes in 1936. According to Keynes, economic growth consists of the income increasing effect and the initiation of the multiplier mechanism of investment spending. However, this analysis has an approach that is static and can only explain the short term (Taban, 2014, 93). This approach was criticized by Roy Harrod (1937). A parallel thought to Harrod's objection to Keynes was explained in "Capital Expansion, Rate of Growth, and Employment" by Evsey Domar in 1946 on the other side of the ocean. In addition, Domar claimed that there is also a capacity increasing effect besides the income increasing effect of investments (Domar, 1946, 139). Due to the almost similar assumptions for their growth models developed independently from each other, this model was named the Harrod-Domar Growth Model in the literature.

Harrod suggests three main assumptions before laying forth his model. These are: that the level of a community's income is the most important determinant of its supply of savings, that the rate of increase of its income is an important determinant of its demand for saving and that demand is equal to supply (Harrod, 1939, 14).

Closed economy conditions are dominant in Harrod's model and all economic output consists of homogeneous goods. This produced homogeneous output is used both by companies as investment goods as well as by consumers in consuming products. Economy in this model is underemployed. It is assumed that economy reaches a sustainable full employment level from inadequate employment (Ülgener, 1991, 413).

The Harrod Domar basic growth equation is shown below. G stands for the geometric rate of growth of income or output in the system, s for the fraction of income which individuals and corporate bodies choose to save and C for the value of the capital goods required for the production of a unit increment of output:

$$G = \frac{s}{C} \tag{1}$$

Harrod has added a new concept called warranted growth rate (G_w) which is taken to be that growth rate which, if it occurs, will leave all parties in the economy satisfied that they have produced neither more nor less than the right amount (Harrod, 1939, 16). When G_w is written instead of G in Equation 1, the basic equation becomes:

$$G_w = \frac{s}{C} \tag{2}$$

As understood from the basic equation of the Harrod model, economic growth is totally determined by the social marginal propensity to save and the state of technology (Harrod, 1939, 17).

According to the model, ex-ante savings are always equal to ex-post investments. However, as ex-ante investment is a different concept than ex-ante savings, ex-post savings and ex-post investments, it cannot be expected that the ex-ante investments and ex-ante savings are equal in all circumstances. If the ex-post investments are less than ex-ante investments in economy, an undesired reduction of stocks occurs and there is a stimulus to further expansion of output. In the opposite case, there is an undesired increment in the amount of stock and the amount of output decreases in the next term (Harrod, 1939, 19).

There are three growth rates in the model that are different from each other. These are the warranted growth rate (G_w), the actual growth rate (G_A) and the natural growth rate (G_N). G_w is the growth rate that would satisfy all economic actors and would not cause supply or demand surplus in the economy. G_A, or in other words the actual growth rate, points out the end of term and is an ex-post concept.

G_w and G_A can be differentiated from each other. Three possibilities emerge if G_w and G_A are equal to each other or different from each other. The first of them is $G_w = G_A$, the equilibrium condition. In such a condition, there is no imbalance in the economy. All goods produced in the economy are consumed, so there is a supply and demand equilibrium. A second possibility is that the actual growth rate exceeds the warranted growth rate $G_A > G_W$. In such a circumstance, the required warranted growth rate is achieved and is even exceeded. However, this situation leads to demand surplus and puts the economy in an inflationary process as a result of disinvestment of the stocks in the economy. The last possibility is the $G_A < G_W$ situation. In this case, the actual growth rate has stayed below the warranted growth rate which is able to satisfy all economic actors. Here, all of the produced goods could not be consumed, an increment in stocks took place and the economy headed towards recession, a deflationary process (Ülgener, 1991, 416).

The last growth rate that Harrod has defined is G_N, which is the natural growth rate. This concept is the maximum rate of growth allowed by the increase of population, accumulation of capital and technological improvements (Harrod, 1939, 30). As the model has the approach that the increment of labour force caused by the increase of population should also be employed, G_N will reach a level to the extent permitted by the population growth rate and the innovations in manufacturing technologies. In the Equation 3 below, n stands for population growth rate and t for technological improvements:

$$G_N = n + t \tag{3}$$

The relationship between G_w and G_N is an important part of the model. If G_w exceeds G_N, the economy will be dragged into a recession; this will cause G_w to drop below the beginning level and thereby the average G_w rate will stay below G_N. Such a situation will only emerge under the condition of chronic unemployment. In a contrary case, G_w will increase with the increment of profit margins and surpass its average value. This will result in the economy's tendency to an inflationary propensity (Harrod, 1939, 30).

Under these circumstances, the ideal growth rate according to Harrod is the equilibrium condition of G_w and G_N (Harrod, 1939, 32). So, convenient and sustainable economic growth is only possible with the $G_W = G_N$ condition as neither a demand and supply gap will occur in the economy nor will there be inflationary or deflationary pressure at this point. However, providing this balance or keeping the economy always at this point even if this balance is provided is not practically possible all the time. This condition which is the weak part of Harrod's growth model is called knife edge equilibrium.

Ewsey Domar's and Roy Harrod's models basically match up with each other. The main difference between these two models is the origin of the economy. While Harrod's economy looks for ways to equally transfer from underemployment to full employment, Domar seeks the conditions for an economy's balanced growth at a level of full employment (Domar, 1946, 138).

Like Harrod, Domar also referred to some assumptions before he laid forth his model. According to these assumptions, there is a constant general price level which is inflation-adjusted in the economy, no lags are present, savings and investment refer to the income of the same period, both savings and investments are net and the productive capacity of an asset or of the whole economy is a measurable concept (Domar, 1946, 137).

Under the preconditions mentioned above, the economy will be said to be in equilibrium when its productive capacity P equals its national income Y. So, if the income generating effect of investments is equal to the capacity-increasing effect of investments, the economy is in equilibrium (Domar, 1946, 138).

Domar's motive to develop an economic growth model that allows the continuation of full employment in economy was, according to Domar, that the Keynesian system does not offer any means to determine a balanced economic growth rate. Domar argued that Keynes' "full employment as a function of income" assumption is only valid for a short period of time, and put forth instead the assumption that "full employment is a function of the rate of production (productive capacity) of income" (Domar, 1946, 138). Domar described the productive capacity as the total output that the economy could produce at a full employment level (Domar, 1947, 37).

Domar has seriously criticized the one-sided role of investment in the Keynesian system. While the Keynesian system stated that investment has only an income-generating effect, Domar found this approach insufficient and revealed that the capacity-increasing effect of the investment is as important as its income-generating effect. The economy cannot follow a balanced growth path if only the income-generating aspect, in other words the demand aspect of the economy, is considered as in the Keynesian system. If the capacity-increasing effect of investment, which accounts for the supply aspect of an economy, is taken into consideration in addition to its side of demand, the economy will grow in a balanced manner (Domar, 1947, 39).

While investments in the model increase by an annual rate of I and the additive productive capacity of new investments to the potential net value is indicated by s, the net annual potential output of these new projects to the economy will be then Is. However, the productivity of the whole economy is not certain to increase with the new investments because the new investments can cause the closure of the existing factories or decrease the value of previous investments. Domar explains this through the concept of potential social average investment productivity. The relationship between the potential social average investment productivity defined as σ, the time-based productivity defined as $\frac{dP}{dT}$ and the investments defined as I, is shown as:

$$\sigma = \frac{\frac{dP}{dt}}{I} \tag{4}$$

When the expression 4 is taken, it is written as $\frac{dP}{dt} = I\sigma$. With the explanations up to now, we have tried to understand the supply side of the economy.. On the demand side of the Domar model, the coefficient of acceleration, a well-known and useful instrument of the Keynesian system, is used.

$$\frac{dY}{dt} = \frac{dI}{dt}\frac{1}{\alpha} \tag{5}$$

When we again take the above equations of the Domar model which tries to develop a model that explains a full employment economy to grow without any imbalance at a point of the supply and demand equilibrium $P_0 = Y_0$, then the expression becomes as follows:

$$\frac{dP}{dt} = \frac{dY}{dt} \tag{6}$$

When 4 and 5 are equalized, the following is found:

$$I\sigma = \frac{dI}{dt}\frac{1}{\alpha} \tag{7}$$

When mathematical analysis of Equation 7 is made, the following emerges:

$$I = I_0 e^{\alpha\sigma t} \tag{8}$$

The expression $\alpha\sigma$ above is the economy's equilibrium rate of growth. Within this framework, the condition of balanced growth at the level of full employment is that the investment and income must increase by the product of the potential social average investment productivity and marginal savings tendency (Domar, 1946, 139-141).

These two models that Harrod and Domar developed independently from each other match up in terms of the methods they used and the results they obtained. In both models, the Keynesian investments were opposed and the analysis that investments have just income-generating aspects was criticized. In addition to the investments' income-generating effect, the importance of their capacity-increasing effect is also underlined.

The Neoclassical Growth Model

In 1956, Robert Solow and Trevor Winchester Swan investigated the reasons for the wage gap among countries while conducting independent studies from each other (Jones, 2001, 18). Solow, in his work "A Contribution to Economic Growth" that he published in 1956, attributed a great importance to the capital accumulation regarding economic growth. In this first model, the long-term economic growth gets near to (steady state) zero. The lack of solution at the point of long-term economic growth, led to the development of his older model. Therefore, Solow published his work "Technical Change and the Aggregate Production Function" in 1957. In this study, Solow introduced technology to the model and explained long-run economic growth by using technological progress. However, Solow added technology to the model as an external, and argued that technological progress has an impact on growth but claimed that economic growth has not affected technological progress (Solow, 1957, 312). In other words, there is one-way relationship between technological progress and growth in Solow's growth model. In addition to this, Solow did not explain in his model how technology emerged and what the determinants of technological progress were (Shaw, 1992, 611); technology was suddenly introduced as *"manna from heaven"* (Jones, 2011, 33).

The main assumptions of the neoclassical growth model can be listed as follows (Jones, 2001, 18-19; Barro and Sala-i Martin, 2004, 25):

- Homogeneous and single good is produced in economy.
- There is no international trade because there is only single and homogeneous good.
- Closed economy conditions prevail.
- Substitution between labour and capital is possible.
- Labour is also considered a production factor unlike in Harrod-Domar's model.
- Those who save and those who invest are the same people.
- The economy is stable.
- Technology is added to the model externally.

The amount of savings, population growth rate and technology are regarded as exogenous in the Solow model. The output obtained is produced by capital and labour. As a result of participation in production, labour and capital generate income as much as marginal products. The Solow model has a Cobb-Douglas[1] type production function in which there is a constant return to scale (Solow, 1956, 66-67). Production function at any given time t is as follows:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha} \qquad 0 < \alpha < 1 \qquad (9)$$

In Equation 9 above, Y stands for the amount of produced output at any given time t, K for the amount of capital used for production, L for the amount of labour and A for the changes in technology. The amount of labour and changes in technology increase externally by n and g rates.

$$L(t) = L(0)e^{nt} \qquad (10)$$
$$A(t) = A(0)e^{gt} \qquad (11)$$

In the model, the efficient labour amount increases by a rate of $(n+g)$ as $A(t)L(t)$. The amount s (unconsumed and allocated savings) of the produced output is spent on investments in the model. Defining k as the stock of capital per effective unit of labour, $k = K/AL$, and y as the level of output per effective unit of labour, $y = Y/AL$, the evolution of k is governed (Mankiw et al., 1992, 409-410) by:

$$k(t) = sy(t) - (n+g+\delta)k(t) \qquad (12)$$
$$= sk(t)^{\alpha} - (n+g+\delta)k(t) \qquad (13)$$

The δ symbol in Equation 12 represents the depreciation rate due to the usage of capital, or in other words the depreciation rate. The main assumption of this equation is that the stock of capital per effective unit of labour $k(t)$ increases by the saving (investment) per effective unit of labour in an economy with technological developments, and that it decreases by population growth, technological changes and the depreciation rate. In addition, the equation implies that k, standing for the

[1] A Cobb-Douglas type production function is in a structure of constant returns to scale. If the two production factors such as K (capital) and L (labour) are increased by λ, the output also increases by λ. For further details on Cobb-Douglas type production functions, see Charles W. Cobb, Paul H. Douglas, "A Theory of Production". The American Economic Review. Vol. 18 No: 1, 1928, pp. 139-165.

stock of capital per effective unit of labour, converges to a long-term steady-state value k^* defined by $sk^{*\alpha} = (n+g+\delta)k^{*\alpha}$ or $k^* = \left[\frac{s}{(n+g+\delta)}\right]^{\frac{1}{1-\alpha}}$ (Mankiw et al., 1992, 410).

Solow has argued that the long-term steady-state level is determined by population growth and saving rates. Therefore, he stated that countries with a high rate of savings and low rate of population growth are richer than the countries with a low rate of savings and high rate of population growth (Mankiw et al., 1992, 407).

In his article "*Technical Change and the Aggregate Production Function*" published in 1957, Solow divided economic growth into three and described them based on increment in capital, increment in labour and increment in technological changes. If Y represents output, K and L represent capital and labour inputs and t represents the technical change over time, then the production function can be written as (Solow, 1957, 312-313):

$$Y = f(K, L; t) \tag{14}$$

In the equation above, production is obtained by using two production factors, labour and capital. t explains any kind of shift in the production function over time (Solow, 1957, 312). If technology is considered as exogenous:

$$Y = A(t)f(K, L) \tag{15}$$

In Equation 15, the output at the rate of given labour-capital only increases as much as the increment at the level of $A(t)$ technology. In other words, Solow explains that the parts of economic growth which cannot be explained through labour and capital factors, are due to technological changes. The decrease of return on capital due to the usage of additional capital per unit is ruled out with the help of technological change (Solow, 1957, 320).

$$\frac{y}{y} = \frac{A}{A} + w_k \frac{K}{K} + w_l \frac{L}{L} \tag{16}$$

To sum up, economic growth is a result of savings and technological changes according to the Solow model. Two factors such as labour and capital are used for production. Although economic growth can be achieved through the increment in savings in the short term, it does not guarantee economic growth in the long term and leads the economy from a steady state situation to a higher steady state situation. The basis of long term economic growth is technological change. The reason for wage gaps between nations is the difference of population growth and saving rates. According to this, countries with high saving rates and low population growth rates are richer than countries with low saving rates and high population growth rates.

Paul Romer: the Endogenous Technological Change Model and R&D Model

Paul Romer's articles *"Increasing Returns and Long Run Growth"* published in 1986 and *"Endogenous Technological Change"* published in 1990, have made significant contributions to economic growth literature by internalizing technology and not accepting it as an exogenous factor.

According to Romer (1986), knowledge is a production factor that directly participates in the production process and accelerates marginal productivity. With the internalization of knowledge, long term economic growth based on technological change can be obtained by the accumulation of knowledge through forward-looking, profit-maximizing agents. This approach to knowledge as the basic form of capital changes the standard aggregate growth equation as well. At this point, "new knowledge" occurs as a product of research technology. For Romer, this new knowledge is a free by-product that originates from production and investment processes and makes it possible to produce output at less cost. Impressed by Arrow's concept of *"learning-by-doing"*[2] Romer characterizes the term by-product as a without-knowing activity of producing new knowledge, not a deliberative activity of it. This new knowledge that emerges with production and investment, has externality. The creation of new knowledge by an individual or one firm is assumed to have a positive effect on the production possibilities of other firms unless the knowledge is perfectly patented or kept secret. Therefore, the process will create a domino effect that will bring a positive situation to the entire economy (Romer, 1986, 1002-1003). As he thinks that new knowledge production depends on capital stock, Romer states that the higher the level of investment, the higher the level of new technologies (Taban, 2014, 149).

In another study of his, Romer (1990) stressed the importance of R&D activities in the process of economic growth. According to this model, economic growth is a product of technological change based on international

[2] For further details see: Kenneth J. Arrow, The Economic Implications of Learning by Doing, *The Review of Economic Studies, 29*(3), 1962.

investment decisions that were taken by those who seek profit maximization. The characteristic feature of technology, one of the production factors, is that it is not a traditional or public-good which is partially excludable and non-rival.

The advantage of this model is the idea that there are particular benefits from R&D costs. The compensation of new knowledge production motivates companies to increase their R&D activities (Romer, 1990, 77). In addition, monopolistically competitive market conditions are considered in this model differently from the neoclassical growth model. Companies which produce new knowledge with the additional cost of R&D activities cover the cost by setting a higher price than the cost. Firms which seek profit maximization have the opportunity to monopolize the market by keeping the new products or designs they have developed private with title and patent laws (Taban, 2014, 156-157).

The economic growth model based on technological change and R&D activities is based on three main assumptions:

- There is technological change behind economic growth. Technological change encourages the continuation of capital accumulation and with the capital accumulation increases the output per labourer.
- Technological change emerges mostly when economic actors respond to market incentives deliberately.
- Following R&D activities, a new design has to be developed once, and can be used again and again without any additional cost. Developing new or better designs causes only fixed costs. This is an explanatory characteristic of technology.

In this model of Romer, the distinguishing feature of technology is that it is a non-rival and partially excludable good. On the other hand, human capital and technological innovation (design) slightly differentiate from each other. Human capital has the characteristic of a rival commodity in terms of the ability to add. The ability to add is rivalrous because the person who possesses this ability cannot be in more than one place at the same time; nor can this person solve many problems at once. Human capital is an excludable factor due to this feature. In contrast, the design is a non-rival because it is independent of any physical object, can be copied and used in as many different activities as desired. According to Romer, knowledge-technology inputs have an increasing-returns-to-scale function as it they are a productive factor (Romer, 1990, 74-75).

In the R&D model economic growth rests on three sectors. The first one is the research sector which uses human capital and the existing stock of knowledge to produce new knowledge and designs. The second sector is the intermediate goods sector, where the new designs (new ideas, new types of production) of the research sector are used for the production of intermediate goods which are manufactured for producing final goods. The last one is the final goods sector, where the final output is produced by using labour, human capital and the intermediate goods. The final output can be either consumed or saved as new capital to be transformed into new investments (Romer, 1990, 79).

The innovations and developments obtained as a result of the R&D model in an economy will lead to the discovery of new knowledge, goods and production processes. All of these will result in the emergence of economic growth by creating a spill over effect in the economy. In addition to these, it is stated that free international trade and economic integration with countries of large amounts of human capital can act to speed up growth (Romer, 1990, 98-99).

The AK Model

The AK model is known as the first and simplest of the endogenous growth models. The key property of this model is the absence of diminishing returns to capital (Barro and Sala-i Martin, 2004, 63). One of the most distinguishing features of the model is that it puts forth that economic growth is possible in the long term even at an exogenous and stable technology level.

The model builds a linear relationship between the total output and the amount of capital. According to the model, capital does not only include physical capital but also human capital. As in the neoclassical growth approach, there is constant-returns-to-scale in the model. So, the production function in AK model is as follows:

$$Y = F(K, L) = AK^{\alpha}(HL)^{1-\alpha} \qquad (17)$$

In the equation above, A stands for the stable and exogenous technological level, K for physical capital, H for human capital that contains features such as knowledge, skills and talents of the labour force and L for labour force. As the labour force works with more capital and increases its own features such as knowledge and skills, the human capital also increases. As a result, the human capital rate changes in the same direction as the rate of capital per labour force stated as $= K/L$. If this statement is written in the equation above, the production function can be written as follows:

$$Y = AK^{\alpha}K^{1-\alpha} \quad (18)$$
$$Y = AK \quad (19)$$

If Equation 19 is stated with rates per capita, the $y = Ak$ equation emerges. In the function, A represents a constant. In this case, the output per capita y must increase too while capital per capita k increases, so that $A = y/k$ can stay stable. This situation eliminates the diminishing returns rule of the neoclassical growth model. This main difference between the AK model and the neoclassical growth model says that an increase of capital does not only mean an increment in physical capital, but also an increment in human capital.

In the model, the investment per worker can be stated as $i = sy$. If Ak is used instead of y, the $i = sAk$ equation emerges. The term s stands for the marginal propensity to save. The change in capital per worker while technology is stable is stated as follows:

$$\Delta K = i - (d + n)k \quad (20)$$

If i is replaced with sAk in Equation 20 and required mathematical operations are done,

$$\Delta K = sAk - (d + n)k \quad (21)$$
$$\Delta K = (sA - (d + n))k \quad (22)$$
$$\frac{\Delta K}{k} = sA - (d + n) \quad (23)$$

is obtained. By using the equation $\frac{\Delta K}{k} = \frac{\Delta Y}{y}$, it is possible to express the economic growth as follows:

$$\frac{\Delta Y}{y} = sA - (d + n) \quad (24)$$

In Equation 24, d stands for the capital's rate of depreciation and n for the population growth rate. According to this, economic growth is based on the amount of investment per worker sA and the total amount of capital's rate of depreciation and population growth rate $(d + n)$. If the amount of investment per worker in an economy is higher than the total amount of capital depreciation and population growth rates, economic growth will be achieved. So, a maximum rate of savings and minimum population growth and capital depreciation will lead an economy to a maximum economic growth (Taban, 2014, 144-147). This result shows the importance of savings-incentive fiscal policies. At this point, it is the responsibility of the governments to increase investments by promoting savings and provide the economic growth thereby. Another result obtained from the AK model is that the convergence hypothesis of the neoclassical growth model is not valid here. The rejection of the capital's rate of returns shows that countries with same s, A, d, n rates will reach the same economic growth rate. Such a case makes it impossible for the underdeveloped or developing countries to reach the level of developed countries.

Robert Barro: Endogenous Growth Based on Government Spending

In Robert Barro's growth model based on government spending, the broad concept of capital (physical and human capital) in the AK model was expanded and government spending was also included. In his endogenous growth model regarding government spending, Barro claimed that tax-financed government services would speed up growth. According to this model, while the increase of government spending on consumer goods affects economic growth and savings negatively, government spending on producer goods has a positive effect on economic growth and savings (Barro, 1990, 103).

While developing his model, Barro started with the assumption that capital is constant return to scale. The representative, infinite-lived household in a closed economy seeks to maximize the utility function as follows:

$$U = \int_0^\infty u(c)e^{-\rho t}\, dt \qquad (25)$$

In the utility function for the infinite time horizon above, c is consumption per person and ρ represents the time preference and is a constant rate greater than zero. Population is considered to be constant. From the information above, the utility function takes following form:

$$u(c) = \frac{c^{1-\alpha} - 1}{1-\sigma} \qquad (26)$$

In the function, the marginal utility shown as σ is greater than zero and has constant elasticity. In the model, there is no labour-leisure time choice for the household. Therefore, the maximization of the representative household's utility is as stated below, and f' stands for the marginal product of capital (Barro, 1990, 104):

$$\frac{c}{c} = \frac{1}{\sigma}.(f' - \rho) \qquad (27)$$

Technology in an economy is endogenous and there is a production function $y = Ak$. This function has a broad concept of capital and works with constant returns to scale. The assumption of constant returns to scale becomes more plausible when capital is viewed broadly to encompass human and nonhuman capital. In the model, human and nonhuman capital are not considered as perfect substitute factors. Therefore, when these two types of capital are taken together, there is a constant return to scale while diminishing returns to scale occur if they are taken separately (Barro, 1990, 105).

In the model, it is stated that tax-financed government services will lead to positive effects on production and overall utility. From this point of view, Barro included government spending as a new production factor in the production function. Government spending per capita in the amount of g is provided to each household producer. Consumers can use these services provided by government without any charges. This additional public spending will contribute to growth through externalities. With the condition of constant returns to scale, a new production function that contains public spending, transforms into:

$$y = \emptyset(k, g) = k.\emptyset(\frac{g}{k}) \qquad (28)$$

If the equation above is written in the Cobb-Douglas production function, it becomes $\frac{y}{k} = A.(\frac{g}{k})^{\alpha}$ while $0 < \alpha < 1$. Government spending is supplied by flat tax rates. As T stands for government spending and τ for tax rates and if the government is assumed to implement balanced budget policies, the budget policy is written as follows:

$$g = T = \tau y = \tau k(\frac{g}{k})^{\alpha} \qquad (29)$$

In a situation in which government spending is added to the function, the marginal return of the capital is as follows:

$$\frac{\partial y}{\partial k} = \emptyset\left(\frac{g}{k}\right).(1 - \emptyset')\frac{g}{y} = \emptyset\left(\frac{g}{k}\right).(1 - \eta) \qquad (30)$$

In this equation, η is the elasticity of y in the amount of given k with respect to g. Although there is a change in the amount of capital of the companies in the private sector, there is no change in the enormity of government spending. If the taxes collected by the government for public spending are taken into consideration, the individual optimum consumption is as follows:

$$\gamma = \frac{\dot{c}}{c} = \frac{1}{\sigma}.\left[(1-\tau).\emptyset\left(\frac{g}{k}\right).(1-\eta)-\rho\right] \quad (31)$$

In Equation 31 above, $\frac{g}{k}$, η and the growth rate of consumption γ will stay stable as long as τ and $\frac{g}{y}$ remain stable (in other words, if g, T and y increase at the same rate). Consumption will continue to grow at a flat rate γ starting from a value of $c(0)$. Similarly, k and y will also continue to grow at a flat rate γ beginning with the starting values of $k(0)$ and $y(o)$. Without moving from one steady state to another, the economy will maintain growth at γ rate at a similar steady state level.

With the given capital stock $k(0)$, levels of all variables are redetermined. The initial consumption function is as follows:

$$c(0) = k(0).\left[(1-\tau)\emptyset\left(\frac{g}{k}\right)-\gamma\right] \quad (32)$$

Participation of governments in the economy at different rates creates two different effects on economic growth. While an increase in tax rates t decreases the growth rate γ, the increase of the governmental investment rate in total investments $\frac{g}{y}$ results in the increase of γ. If the government's effectiveness in the economy is low, the second condition applies, if the effectiveness is high, the first condition applies. This situation can also be seen in the Cobb-Douglas production function. In the Cobb-Douglas function, the elasticity of governmental spending with respect to total output η is equal to α. In this case, the steady state growth rate becomes as follows:

$$\frac{d\gamma}{d(g/y)} = \frac{1}{\sigma}\emptyset\left(\frac{g}{k}\right)(\emptyset'-1) \quad (33)$$

In such a case, the share of government capital in total capital g/ k should be proportionately smaller so that the increase of governmental spending in total output results in high economic growth. If $\emptyset' > 1$, this condition can be created. The Cobb-Douglas type of production function is

$\emptyset' = 1$. So, if $\alpha = \eta = \emptyset'.(g/y)$, it is $\alpha = \frac{g}{y} = \tau$. This equation states that the part of governmental services based on governmental spending in gross domestic product should be equalized to the amount of services provided in a competitive environment in order to reach the maximum growth rate. The savings rate in an economy is as follows:

$$s = \frac{k}{y} = \frac{k}{k}\frac{k}{y} = \frac{\gamma}{\emptyset(g/k)'} \qquad (34)$$

If k/y decreases, g/y decreases, too. Therefore, the maximum level of savings rate is recognized at a level of governmental spending that is lower than the growth rate. If the production type of the economy is Cobb-Douglas like the production function, the maximum savings level will be reached under the condition of $\tau = g/y < \alpha$. Due to this, the government does not need to look for any policies to maximize the level of savings rate s or growth rate γ. As the economy is always in the same steady state balance, it would be more beneficial for the government to follow policies that ensure that the utility of the household stays at the maximum level as long as the $\tau = g/y$ rate remains stable over the course of time (Barro, 105-110). While the economy grows at the same steady state level, the utility function can be restated as follows:

$$U = \frac{[c(0)]^{1-\sigma}}{(1-\sigma)[\rho-\gamma(1-\sigma)]} \qquad (35)$$

Considering the $c\ (0)$ and γ expressions in the social utility function, the public spending/GDP ratio that can transport the social utility to the maximum level can be achieved. Therefore, the public spending/GDP ratio can be written as:

$$c(0) = \frac{k(0)}{1-\eta}[\rho + \gamma(\sigma + \alpha - 1)] \qquad (36)$$

When $c(0)$ is substituted in this equation, it shows the relationship between the social utility function and growth:

$$U = \left[\frac{k(0)}{1-\eta}\right]^{1-\sigma} \left[\frac{\rho+\gamma(\eta+\sigma-1)}{(1-\sigma[\rho-\gamma(1-\sigma)])}\right]^{1-\sigma} \qquad (37)$$

If η is constant between 0 and 1, the effect of the economic growth γ on the social utility U is positive for all values of $\sigma > 0$, as long as social utility is bounded. Therefore, if η is constant, the maximization of U corresponds to the maximization of γ (Barro, 111-112).