CHAPTER 2

EVOLUTION OF ECONOMIC GROWTH THEORIES AND MODELS

History of Economic Growth and Development

Classical economists, such as Adam Smith (1776), David Ricardo (1817), and Thomas Malthus (1798), and much later Frank Ramsey (1928), Allyn Young (1928), Frank Knight (1944) and Joseph Schumpeter (1934), provided the basic ingredients of economic growth (Barrow & Sala-i-Martin:2004). These ideas include the basic approaches of competitive behavior and equilibrium dynamics, the role of diminishing returns and its relation to the accumulation of physical and human capital, the interplay between per capita income and the growth rate of population, the effects of technological progress in the forms of increased specialization of labor and discoveries of new goods and methods of production and the role of monopoly power as an incentive for technological advancement. The theory of economic growth can be traced from the times of Adam Smith.

Adam Smith (1776)

Adam Smith, did not formulate a coherent theory of economic growth, rather he discussed it in terms of certain general economic principles in different sections of his monumental work "The Wealth of Nations". He moved away from the thoughts of Physiocrats and Mercantilists of natural equilibrium of circular flows. He may, thus, be considered to have started the revolution of theories of economic growth.

The motive force of the Smithian theory was the uniform and the constant efforts on the part of every man to better his own living condition. He advocated division of labor saying that it led to development by increasing the productivity of the labor force. This was Smith's fundamental argument for the economic growth of a nation. He believed that division of labor is limited by the market thus positing economies of scale argument. Smith argued that growth was self reinforcing as it exhibited increasing returns to scale. According to Adam Smith the increase in labor productivity would take place through

- an increase in skill
- saving of the time lost in moving from occupation to occupation and
- invention of better machines and equipments.

As per Smith manufacturing sector was more conducive to division of labor and was developed to meet the increased demand of the goods and services of the people of a nation. He also advocated for laissez faire policy and considered it indispensable for economic progress. This would lead to no boundaries and hurdles in the path of the economic functions, which could thus be carried out in accordance to the market forces prevalent in the economy at that point of time, smoothly leading towards the economic growth of a nation. Advocating for capital accumulation he said that it was vital to the process of economic growth. In other words, the savings done by capitalists creates investment and in turn growth in an economy. He further added that any increase or decrease of capital naturally tends to increase or diminish the real quantity of industry, the number of labor and consequently the exchangeable value of the annual produce of the land and labor of the country,

the real wealth and revenue of all its inhabitants. Thus, he saw income distribution as being one of the most important determinants of how fast or slow a nation would grow.

With adequate market and capital accumulation, division of labor takes place and raises productivity. National Income rises, so large savings is possible. Population also grows which expands the market. This leads to further division of labor and more specialization with consequential gains in productivity. External economies begin to operate which mean that environmental improvements such as growth of transportation facilities, better raw materials, bring down the cost of production of individual firm. With this background it can be said that Smith postulated a supply side driven model of economic growth. His simple production function can be put forth as:

$$Y = f(L, K, T) \text{ where,}$$

Y is the output, L is the labor, K is the capital and T is the land.

Thus it can be said that output is related to inputs like land, labor and capital as inputs.

Consequently output growth is driven by, as said by Smith, population growth, investment and land growth and increase in overall productivity. Thus we have the function as:

$$G_y = f(G_f, G_k, G_l, G_t)$$

As proposed by Smith in his time, population growth was endogenous that is it depended on the sustenance available to accommodate the increasing

workforce. Investment too was assumed to be endogenous, determined by the rate of savings (mostly by capitalists). The growth of land was dependent on the conquest of new lands or technological improvements of fertility of old lands.

Smith was of the view that technological improvements could also increase the overall growth of a nation. Smith saw improvements in machinery and international trade as engines of growth as they facilitate further specialization.

Despite of all these, Smith did not see growth as eternally rising, he posited a ceiling in the form of the stationary state where population growth and capital accumulation were zero. In words of Adam Smith, "when the stocks of many rich merchants are turned into the same trade, their mutual competition naturally tends to lower its profits, and when there is a like increase of stock in all the different trades carried on in the same society, the same competition must produce the same effect in them all". Thus, as population grows and capital accumulation becomes large, the economy reaches a full 'compliment of the riches' permitted by its soil, climate and situation with respect to other countries [The Wealth of Nations, ed. E. Cannan, The Modern Library, Random House, New York, 1937, p.94 as cited in Banerjee, M (1969) Economics of Growth – An Introduction. Katyayani Publishers, Calcutta, p.132].

In short it can be said that Smith advocated division of labor, specialization, accumulation of capital in a laissez faire ambience and emphasized a stable legal framework within which the market could function. Summing up, Smith

attributed economic growth of a nation to an increase in the quantity and quality of land, labor and capital (Gylfason: 1999).

John Stuart Mill (1848)

J S Mill regarded economic development as a function of land, labor and capital. According to Mill capital is "a stock, previously accumulated of the products of the former labor". Increase in wealth was possible only if land and capital helped to increase the production faster than the labor force. This wealth consisted of tools, machines, and skills of the labor force. Emphasizing on the productivity of labor he said that it was productive labor that is productive of wealth and accumulation of capital. And so population was considered to be consisting of only the number of working class. The conditions of the working class can be improved only if they adopted for population control measures and thus the fruits of technological progress and capital accumulation can be enjoyed by them. The elasticity of supply of labor was considered to be high in response to a rise in the wage rates. He assumed the wages to exceed the minimum subsistence level in general cases. Wages were paid out of the capital meant for paying the wages and so they (wages) were limited by the availability of the capital. Any change in the wage rate was brought about by the changes in the capital availability or the changes in the number of workers. The rate of capital accumulation depended upon the amount of fund from which savings can be made or the size of net produce of the industry and the strength of the disposition to save. Mill considered savings as spending because saving when used as capital is ultimately consumed in one form or the other (i.e. either for paying wages or for investment). Savings can be increased with the increase in the net produce i.e.

the profits of the industry and the increased desire of the people to save. He considered the rate of capital accumulation as a function of labor force employed 'productively'. Thus it can be said that he placed more emphasis on the productivity of labor for economic growth. Profits earned by employing unproductive labor were merely transfers of income as unproductive labor does not generate wealth or income. Only the productive laborers were assumed to go for productive consumption which was essential to maintain and increase the productive powers of the community. It implied that productive consumption was an input necessary to maintain productive laborers. The rate of profit on the other hand would decline due to the diminishing returns from agriculture and an increase in the population in an economy. With absence of technical advancements in the agricultural sector and the growth rate of population being higher than the rate of capital accumulation, the rate of profit as Mill described was "within a hand's breadth of the minimum" and the economy was "on the verge of stationary state". This stationary state, as per Mill, was imminent and does not stay forever, though it can always be postponed. On the contrary, Mill welcomed the arrival of the stationary state by saying that it would lead to improvement in the income distribution and hence large remuneration for the labor. But this can be possible only if the working class was not very large in number (as stated earlier a check on their population growth can be done with the help of measures of birth control and education). Thus in the stationary state of an economy, profit reached the minimum necessary level to prevent any further increase in population or stock of capital. However, there might still be rising standard of living due to the improvements in the art of living and increased leisure through technical progress.

Although he advocated for laissez-faire, he thought it important for the state to intervene in cases such as redistribution of the ownership of the means of production, reforms in the institutional framework of the market, compulsory education and examination system, regulation of working hours. He also advocated for free trade and defended the imposition of protective duties in the case of infant industries.

Karl Marx (1867)

Karl Marx further refined the classical theory by formulating a growth model and initiating the term "steady-state" growth equilibrium. The Marxian theory divided the capitalist society in two classes:

- The capitalists who owned all the means of production like the machinery and other equipments and natural resources and
- The workers who owned only the labor power which they had to offer.

The above two that is the machinery, equipment and natural resources and the labor power when combined, produced a flow of commodities which were greater than those needed to maintain intact the supply of labor and the stock of equipment. There was thus a surplus over the subsistence needs of the workers on the one hand and the value of raw materials and equipments used up in production on the other hand. This surplus was reaped by the capitalists in the form of net profits, interest and rent. On the other hand the volume of employment was determined by the natural resources and the state of technology at a given point of time in the economy. The actual supply of labor was more than that demanded and so the surplus labor force that Marx called the 'Industrial Reserve Army' competed with the already employed labor force

to keep the wages at the subsistence level. Hence, he discarded the belief that labor supply was endogenous to wages. Rather, the wages of the labor were determined by the bargaining between the capitalists and the labor. The capitalist's surplus is given by Marx in form of the following equation

$$V = c + v + s$$

Where, V = Value of total product during any period

c = Constant capital consisting of the value of plant and raw materials used up in the production process

v = Variable capital consisting of the labor value.

s = Surplus value

He derived three ratios from the above equation

s/v = rate of exploitation (surplus produced for every dollar spent on labor)

c/v = organic composition of capital (which can be viewed as a sort of capital-labor ratio)

s/c+v = rate of profit on invested capital.

According to Marx the capitalists tried to increase the rate of profit in the following three ways:

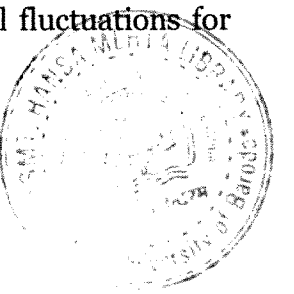
- By extending the working day
- By reducing the wages below subsistence level.

The above two have their own physical limitations as they are related to the labor force which has its own biological limitations.

- By raising the productivity of labor through improved technology i.e. by using labor-saving machinery for production and releasing the labor into unemployment.

On the one hand Marx said that technological progress is the main cause of growth as it tends to improve the productivity of labor and on the other hand he said that technological changes taking place at a rapid rate tends to replace the labor, which though benefits the capitalists to increase their surplus value, but it would also lead to unemployment of the labor force in the industries. Accumulation is beneficial to the labor as it increased their demand which would increase their wages and in turn their standard of living. When the same accumulation was done in excess amount it would lead to drawing in more and more labor force from the reserve army to the industries. When full employment was reached any amount of further accumulation would increase the wage rate and this would reduce the profits with the capitalists. Another reason for the profits to reduce was the technological changes leading to the fall of capitalism in the long run. According to him, there was a tendency for capital costs to increase relative to the labor costs. The capitalists who for the first time introduced the new technique in the market gained extra profit out of it as they were the only one with the latest technology. Later, they could increase their profits by expanding the output under the existing conditions. This was when there are other competitors in the market with the same technology. The said expansion could be done only when the capitalist increased the labor force, raw materials and capital equipments in the existing production function, for which a part of the surplus was to be reinvested. But the increase in the organic composition of the capital had a depressing effect on the average rate of profit through rise in capital costs.

Further he said that a capitalist system is subject to cyclical fluctuations for two reasons:



- Decline in the rate of profits as explained above and
- Persistent under consumption.

The problem was that production was limited by the consuming power of society. Capitalists restricted their consumption for the reason of accumulation and laborers were unable to consume as they were exploited by the capitalists. Thus they remained poor. Factors of production when shifted from consumer goods industries to producer goods industries eventually lead to severe crisis.

He further said that the urge for more capital accumulation and surplus value led to two situations:

- Concentration, wherein there was increase in the average size of manufacturing enterprises.
- Centralization of capital which decreased the number of manufacturing enterprises.

Both concentration and centralization led to increase in the size of big businesses and misery on the part of the working class as small enterprises were either forced to close down their businesses or sell off their business to the big houses. This would reduce the number of firms in an economy and boost the surplus value with the firms. This brought out the Marxian philosophy of socialism (wherein by the above process the capitalist structure was destroyed as a whole).

But this turned out to be erroneous in case of Italy where instead of becoming poorer the working class becomes more prosperous and at the same time the national wealth too increased. The same phenomenon was also observed in the United States, Great Britain and Germany.

Joseph Schumpeter (1934)

Joseph Schumpeter, for the first time, drew attention of many thinkers towards the difference between the processes of economic growth and that of economic development which took place in an economy. He considered economic development to be a distinct phenomenon different from that of economic growth. Development according to him is "spontaneous and discontinuous change in the channels of the circular flow, disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing" (Banerjee, M. 1969. Economics of Growth – An Introduction. Katyayani Publishers, Calcutta, p.174).

Schumpeter's work directed the attention of growth theorists to technology, emphasizing upon invention, innovation and entrepreneurship. He considered innovation to be the main spring of autonomous investment. According to him innovation led to increase in factor productivity by a change in the existing production function (i.e. by increasing the productivity of all the existing available resources in an economy). Innovation may take different forms like:

- introduction of a new good or a new quality of good
- introduction of a new method of production
- opening of a new market

- conquest of a new source of supply of raw materials or half-manufactured goods
- a new form of organization of industry

An important role in the Schumpeterian model was played by an entrepreneur. According to Schumpeter an entrepreneur is an innovator who stands apart from a manager and capitalist. An entrepreneur need not be an inventor of a new product or a process. The innovators function was to find out opportunities for newer products, processes and to exploit them successfully. He (entrepreneur) would raise the money, assembles the factors of production, chooses managers and sets the organization going. The entrepreneur was actuated by three kinds of motives:

- the dream and will to find a private kingdom of industrial or commercial venture
- the will to fight and conquer, to prove himself superior to others, to succeed for the sake of success and
- the joy of creating, getting things done, of just exercising his energy and ingenuity.

For the above said things the entrepreneur secured funds not from his past savings but as a credit facility provided by the banks or financial institutions. Thus, it could be said that he emphasized the role of investments and the financial institutions in the development process of an economy. As soon as the innovation project was completed the said loan would be repaid by him to the bank from the profit so earned from the project. In the same line Schumpeter added that economic development was not a smooth and steady process as depicted by the earlier writers. There were short-run ups and

downs resulting from activities like increased infrastructure, better transportation facilities, increase in the electricity, etc. Price and money income would rise as a result of imitative entrepreneurial activities. Productive factors would be released from consumption goods. Forced savings would take place and speculation would develop. When credit was availed by the innovator and innovation took place, it resulted in better quality and increase in the flow of products, and old firms might find their markets destroyed or diminished. As loans were repaid by the entrepreneurs, deflationary forces might set in motion which might cause fall in prices and incomes. Before there was full scale depression in the economy, the climate might again be ripe for entrepreneurial activity. So a new equilibrium would be reached and this equilibrium would be higher than the one from which the growth began. Over the long periods the national and per capita income in real terms rise continually and all the major income groups benefit. The Schumpeterian theory believed in the breakdown of the capitalism but the reasons for the same were different. According to him, capitalism saw a break down not due to the economic failure but due to the impact of success on the social institutions and socialism, finally making a ground for itself in the economy. There are five trends which provide for the same:

- Innovation as it proceeds and succeeds, degenerates into a routine activity carried out by a bureaucracy of trained managers.
- The original institutional framework is destroyed. As rightly put forward by Harper and Row, 'Dematerialized, defunctionalized and absentee ownership does not impress and call for the moral allegiance

as the vital form of property did. Eventually there will be nobody left who really cares to stand for it'[3]

- Industrialists and merchants enter into political arena and wield power and rule society but are unable to tackle domestic and international problems.
- Capitalism leads to the rise of the intellectual class, the educated white-collar groups who find employment opportunities insufficient in terms of their training and aspirations. They criticize persons, current events, classes and institutions and become hostile to the social order.
- The traditional idea of the home is replaced by a longing for more leisure, freedom and real income. The accumulation drive is weakened.

Harrod-Domar (1939 & 1946)

The Harrod-Domar model developed in 1930s suggests that savings provided with the funds which were borrowed for investment purposes. It was initially developed to analyze the business cycles. It was later adopted to explain economic growth.

Before the model could be discussed, let us consider following features:

Capital accumulation or investment has a vital role to play in the model. Investment has been considered as both demand and supply i.e. a source of productive capacity as well as income to consume the products.

The model can also be called as derivative of the Keynesian income analysis. Thus, it can be said that the Harrod-Domar model tried to review the theory of

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[3] Capitalism, Socialism and Democracy, New York, 1950 p.142

growth in the Keynesian perspective of full employment (which Keynes provided for short-run) in the long-run.

Their main question was 'was equilibrium possible over the long period?' They wanted to find a solution to the long-run period using the same tools as provided in the Keynesian system with a different setting and few significant differences. They also assumed some ceteris paribus. As Harrod himself have put it 'sooner or later we shall be faced once more with the problem of stagnation and it is to this problem that economists should devote their attention'.

The essence of the model is that maintenance of full employment depended on an ever-expanding amount of investment. This in turn required a continuous growth in real national income. An increase in investment accompanied by an increase in income, might lead to one of the following three situations:

- new productive capacity may just remain unutilized
- it may replace the old capacity, displacing its labor and
- it may be substituted for labor or other factors.

Thus it would result in unemployment of labor or capital. So it was necessary that the volume of spending generated by investment (since it also led to income) was sufficient to absorb the output of the additional productive capacity resulting from investment.

The model had been appropriately labeled the Capital Stock Adjustment Theory because its problem was the adjustment of capital stock to the rate of output.

The model is meant primarily for the developed countries, which according to Harrod-Domar, are faced with the danger of 'stagnation' or 'mature economy'. It was later extended to the underdeveloped nations.

Having seen the above features the Harrod-Domar model can be constructed as below:

The basic postulations that are to be kept in mind while constructing the model are as follows:

- The capital-output ratio i.e. the number of units of capital required to produce a unit of output is constant. It is on this basis that the generation of total output is related to the available capital stock.
- Total savings in any period are a given fraction of total income or output. This theory of savings follows from the Keynesian concept of the propensity to save.
- All savings are automatically invested and become additions to the capital stock.

Based on the above assumption the equations can be derived as follows:

First we shall present the savings and investment equations and later we shall combine the two to get the growth equation.

Let Y_t be the level of national income in period t and Y_{t+1} that in period t+1. If ΔY is chosen to indicate the increase of income in period t+1 over period t, then

$$\Delta Y = Y_{t+1} - Y_t$$

Now let I_t be invested in period t which turns out productive capacity in period t+1 and C/O represents the capital-output ratio.

It follows that since capital C produces output O,

$$\Delta Y = I_t \times O/C$$

Where O/C signifies output in relation to capital or the productivity of capital. It is easy to see that the productivity of capital is the inverse of capital-output ratio.

If both sides of the above equation are divided by Y_t, the result is

$$\Delta Y/Y_t = I_t/Y_t \times O/C \qquad (1)$$

On the other hand, for every level of income and employment, there is equality between saving and investment. Thus if S_t represents savings in period t, then

$$I_t = S_t \qquad (2)$$

So S_t can be substituted for I_t in equation I. The result is

$$\Delta Y/Y_t = S_t/Y_t \times O/C$$

Since $\Delta Y/Y_t$ represents the rate of growth of output,

$$G = S_t/Y_t \times O/C$$

Where, G = rate of growth

S_t/Y_t = ratio of savings to income or output

O/C = ratio of output to capital

Thus, this leads to the equation,

$$G = S/K$$

Where, S = savings income ratio

K = incremental capital output ratio

Thus, the rate of growth depends on two factors:

- the propensity to save
- the average productivity of investment

The various growth rates as discussed in the model are:

a) Steady Growth: Based on the above equation, the conditions for a steady rate of growth which led to a full employment of growing resources are clear viz. desired savings out of a full employment level of income must be counterbalanced by an equal amount of desired investment. But there were some lacuna in the economy for the assumption that all intentions to save were realized but intentions to invest might sometimes be frustrated. The desired savings might exceed desired investment leading to inventory accumulation.

b) Actual Growth Rate (G): The actual growth rate is that rate of growth, as Harrod said, that actually takes place on the basis of the available factors of production and at their existing level of utilization.

c) Warranted Rate of Growth (G_w): In the words of Harrod, the warranted rate of growth is "that rate of growth which if it occurs will leave all parties satisfied that they have produced neither more or less than the right amount. Or to state the matter otherwise, it will put them into a

frame of mind which will cause them to give such orders as will maintain the same rate of growth"[4]. In simple words it is that rate of growth that is required for the full utilization of the growing stock of capital.

d) Natural Rate of Growth (G_n): The natural rate of growth is that rate of growth which in the presence of full employment is permitted by the growth in the labor force and rate of technological progress. It is thus the maximum rate of growth that the economy can achieve given the rate of growth in the factors of production. "Broadly conceived, it is a ceiling growth rate where capital requirements are set by the combined growth in population and production techniques"[5].

He further said that there are upper limits or constraints to departures from the path of steady state growth. The upper limit was provided by the Natural Rate of Growth, the full employment ceiling beyond which real income cannot grow due to shortage of resources. The lower limit was set by a number of circumstances like the flow of autonomous investment, the rate of depreciation, etc.

The dynamic equilibrium envisaged in the Harrod-Domar model was of a feeble nature. This was often referred to as the knife-edge problem. Disequilibrium was caused by two factors:

- the difference between the warranted and the natural rates of growth and

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[4] An Essay in Dynamic Theory, Economic Journal, March 1939 p.16
[5] Hamberg, *Economic Growth and Instability*, W W Norton & Co. Inc., New York, 1956

- instability of the warranted rate itself. This was considered as the real knife-edge problem by F. H. Hahn and R. C. O. Matthews.

The implications of Harrod-Domar model can be seen in a way that encourage saving and/or generate technological advances, which lower capital-output ratio.

M. Kalecki (1939)

According to Kalecki, investment in fixed capital per unit of time was determined with a time lag by the following three factors:

- The current internal gross savings of the firms
- The rate of increase in profits.

The above two had a positive influence on investment in fixed capital, while the next one would have a negative influence.

- The rate of increase in the volume of capital equipment.

Investment decisions in a given period were followed by actual investment but with a time lag. This time lag was largely due to the period of construction but also reflected such factors as delayed entrepreneurial reactions. There was a gradual fall in investment not through the accelerator mechanism but because of the accumulation of capital stock, the partial re-investment of business savings and the higher risks involved in new fields. His model as described by Hamberg is "essentially 'cobweb' in structure because once investment was deemed to have reached a satisfactory or equilibrium level, the continuation to completion of investment projects resulting from prior investment decisions built up the capital stock beyond desired levels, reducing investment and bringing on a slump in output and employment (Theory of Economic

Dynamics). On the other hand, when the bottom of slump was reached, since depreciation of capital was not made good, a relative scarcity of capital made itself felt and the rate of profit rose. This called forth new investment and moved the economy in the upward direction.

In Kalecki's view long-term development was not inherent in the capitalist economy. Specific developmental factors were needed to sustain a long-term upward movement. Innovations were the most important promoter of development. They tend to increase the long-run level of investment and this made for a long-run upward trend. A decline in the intensity of inventions in the later stages of capitalist development resulted in a retardation of the increase in capital and output. 'Rentier' savings, consisting of current savings outside firms, tend to depress investment and this detracted from long-run development. If the effect of the increase in the degree of monopoly upon the distribution of National Income was not counteracted by other factors, there would be a relative shift from wages to profits and this would constitute another reason for the slowing down of the long-run rise in output. If the rate of expansion in output fell below the combined rate of increase in productivity of labor and in population, unemployment would show a long-run rise.

Rosenstein – Rodan (1943)

Prof Paul N. Rosenstein – Rodan developed his "big push" thesis saying that a "big push" or a large comprehensive program was needed in the form of a high minimum amount of investment to overcome the obstacles of development in an underdeveloped economy and to launch it on the path to progress. The theory stated that proceeding "bit by bit" will not launch the economy

successfully on the development path; rather a minimum amount of investment was a necessary condition for this. It necessitated the obtaining of external economies that arise from the simultaneous establishment of technically interdependent industries. Thus indivisibilities and external economies flowing from a minimum quantum of investment were a prerequisite for launching economic development successfully. He distinguished between three different kinds of indivisibilities and external economies.

1) Indivisibilities in the production function, especially the indivisibility of the supply of social production function. According to him, indivisibilities of inputs, outputs or processes lead to increasing returns. He regarded social overhead capital as the most important instance of indivisibility and hence of external economies on the supply side. The services of social overhead capital comprising of industries like power, transport and communications are indirectly productive and have a long gestation period. They cannot be imported and their installations required a sizeable initial lump of investment. So, excess capacity was likely to remain in them for some time. They also possessed an irreducible minimum industry mix of different public utilities, so that an underdeveloped country would have to invest between 30-40 percent of its total investment in these channels. Thus, social overhead capital was characterized by four indivisibilities

a) It was irreversible in time and therefore must precede other directly productive investments.

b) It had a minimum durability, thus making it very lumpy

c) It had a long gestation period

d) It had an irreducible minimum industry mix of different kinds of public utilities

These indivisibilities of supply of social overhead capital were one of the principal obstacles to development in underdeveloped countries. Therefore, a high initial investment in social overhead capital was necessary in order to pave the way for quick-yielding directly productive investments.

2) Indivisibility of demand or the complementarity of demand requires simultaneous setting up of interdependent industries in underdeveloped countries. This was because individual investment projects have high risks as low income limit the demand for their products. The complementarity of demand reduced the risk of finding a market and increased the incentive to invest. In other words, it was the indivisibility of demand which necessitated a high minimum quantum of investment in interdependent industries to enlarge the size of the market.

3) Indivisibility in the supply of savings or a high income elasticity of saving was the third indivisibility. A high minimum size of investment required a high volume of savings. This was not easy to achieve in underdeveloped countries because of low incomes. To overcome this it was essential that when incomes increased due to an increase in investment, the marginal rate of saving should be very much higher than the average rate of savings.

Given these three indivisibilities and the external economies to which they give rise, a "big push" or a minimum quantum of investment was necessary to overcome the obstacles to development in underdeveloped countries.

Proceeding bit by bit in an isolated and small way does not lead to a sufficient impact on growth. A climate for development is only created when investment of a minimum speed or size was made within an underdeveloped economy.

J R Hicks (1950)

Shortcomings in the Harrod-Domar model led to the formulation of many other models of growth in recent times. An important refinement has been made by J R Hicks. Hicks integrated a theory of the trade cycle with that of growth and introduced time lags and psychological elements in respect to which the Harrod-Domar model was weak.

Harrod had provided for an upper limit to the growth of the real income in the ceiling imposed by the availability of the factors of production. But his explanation of how the downward swing started was not satisfactory enough. Hicks presented realistic features of the floors and ceilings. In an upward movement when there are no factor of production, natural resources, capital equipment or technical knowledge, production cannot increase further. If producers on psychological grounds tried to increase production, it would only cause a rise in the prices of goods and factor-services. But this cannot last. Sooner or later, further production must come to a stop and fresh investment must cease. So the accelerator (the relationship between the level of investment and the rate of increase in income) would disappear. At this stage disinvestment was likely to take place. It meant negative investment which consisted in not replacing the worn-out capital goods. But producers cannot go on that way till capital goods disappear. Gross investment cannot fall below zero. When the floor is reached, some basic investment for replacing

inventories and equipment becomes necessary. At this stage autonomous investment asserted itself. Investment is larger than disinvestment. This caused an upward turn of the income. The accelerator and the multiplier operated again to push the economy.

Thus, Hicks superimposed in the accelerator a constant rate i.e. percentage of growth of autonomous investment. It was this rate which determined the equilibrium growth of national income. In conjunction with the multiplier it established the equilibrium level of the output of the economy.

Arthur Lewis (1954)

A theory of growth for thickly populated, underdeveloped countries was formulated by Sir Arthur Lewis in 1954. As the population is large in relation to capital and natural resources, it is assumed that there is unlimited supply of labor in such economies. Thus, the theory assumed for the elasticity in the supply of labor at subsistence wage rate. Another assumption is that, the economy consisted of two sectors:

- The subsistence: This sector consisted of the farmers, casual workers, petty traders and so on who suffered from disguised unemployment and
- The capitalists: The capitalists were the owners of the high capitalized industries, highly concentrated at a number of points in the economy.

The wages which the capitalist sector had to pay to the subsistence sector were determined by what people could earn outside that sector. Now, the wages in the capitalist sector were higher as compared to the subsistence sector. Taking advantage of the low wages in the subsistence sector, the capitalists sector

would make profit. The key to the process of growth was the use which was made of the surplus (the profit earned as a case of low wages to the subsistence sector) in the capitalist sector. The capitalists' surplus was reinvested in creating new capital. As a result the sector expanded and there was an autonomous expansion in the demand for the products of industry. The laborers from the subsistence sector would now seek employment in the capitalist sector. There would be further rise in the demand, pushing up prices and profits of the capitalist sector. This process would continue causing economic growth in an economy.

Lewis said that the above process of economic growth would not go on indefinitely in any economy. It would come to an arrest when disguised unemployment in agriculture is eliminated by transfer of labor to industry. Wages in the agricultural sector would rise as it felt the impact of relative shortage of labor. At the stage where transfer of labor ceases, the marginal productivities would equal in both the sectors. In the mean time, however, economic development would take place through increased capital formation and expansion of industries. It also proved beneficial to labor by raising the wages above subsistence level.

Improvising upon the above theory, Lewis said that "capital is not the only requirement for growth and if capital is made without at the same time providing a fruitful framework for its use, it will be wasted". He rightly emphasized in this connection the contribution of attitudes, research, technology, administrative experience to grow and the role of the state in capital formation and of economic development.

Thus Lewis's theory of economic growth could be described appropriately as a framework for studying economic development in general perspective for the major underdeveloped, populated economies.

Lewis – Ranis – Fei (Arthur Lewis, 1954; Gustav Ranis & John Fei, 1961, 1964)

The LRF model of economic growth is more of a model of economic development rather than economic growth. Using the classical assumption of subsistence wage rate, the model is build to understand the theory of Surplus Labor (unemployment and underemployment of labor in a dualistic developing nation). It was basically developed to study the initiation of growth in a developing nation with two sectors - traditional sector and modern sector. The basic assumptions on which the model was based are:

1. There are two sectors in an economy – the traditional agricultural sector and the modern industrial (manufacturing) sector.
2. The agricultural sector has virtually no capital and technology
3. There are surplus labor in the agricultural sector
4. The marginal productivity of the surplus labor in the agricultural sector is zero
5. These excess (surplus) laborers from the agricultural sector can be transferred to the industrial (manufacturing) sector with no change in the agricultural total output.
6. Wages in the industrial sector are higher than the subsistence wages in the agricultural sector attracting unlimited supply of unskilled rural labor to the industrial urban areas

The employer hired more and more workers till the value of its extra product (marginal revenue product) equaled the wages in the industrial sector (i.e. above the subsistence wage rate). Further, it was assumed that the capitalists saved the entire surplus which was reinvested in the form of capital into the business and the workers saved nothing. This reinvestment of surplus (profit) added to the capital formation thus raising the capital labor ratio i.e. the amount of capital per worker. This in turn increased the labor's marginal productivity leading to an increase in the number of workers hired and the surplus. This cycle continues till all the surplus labor from the agricultural sector was absorbed in the industrial sector. Beyond this point more labor could be hired only with higher wages offered. Thus the economic growth of such an economy took place with the structural changes that took place (transformation of an agricultural economy into an industrialized economy).

The critics argued that the larger industrial labor force contributed to greater food demand, not to forget the agricultural output was assumed to be constant. This would lead to a raise in the food prices which must be balanced with an increase in the wage rates. They go ahead with criticizing Lewis for his overestimating the extent that the availability of cheap rural migrant labor can stimulate industrial growth.

Later this theory of Lewis was modified by John Fei and Gustav Ranis with the incorporation of technological changes in the agricultural sector which led to growth of this sector, expansion in the population of the economy, and the government intervention in the form of non market forces supporting and maintaining the institutional wage (minimum wages or labor union

pressures)[6]. In order to avoid the problem of increasing the average product of labor in agriculture, and the industrial institutional wage that would halt industrial expansion, they suggested that the less developed countries maintain a constitutional wage wherein each farm worker took his or her own subsistence bundle to the industrial sector.

Lewis, Fei and Ranis significantly contributed to the literature on economic growth, however, they did not formulate a cohesive theory of economic growth. Instead, they mentioned new dimensions to the existing theories of growth and thereby looking at things in a different manner.

N. Kaldor (1956)

In Kaldor's model it was the ratio of savings to income rather than the required capital-output ratio that bared the burden of adjustment for equilibrium. Kaldor's model of economic growth was considered as a Keynesian version of economic growth as saving adjusted passively to investment. He adopted the Keynesian view that savings depended upon investment meaning that investment was determined independently of the saving propensities on the basis of entrepreneurial investment decisions. This contrasted the pre-Keynesian models where investment was governed by savings. A distinctive feature of these models was that savings and investment combine to determine, inter alia, the distribution of income.

Investment at a particular period was a function partly of the change in output in the previous period and partly of the change in the rate of profit on capital

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[6] This institutional wage can remain infinitely elastic even when the marginal revenue productivity of labor is greater than zero; this wage remains at the same level as long as marginal productivity is less than the wage

in that period. Given full employment, a rise in investment and thus in total demand will raise prices and profit margins and this reduce real consumption, whilst a fall in investment and thus in total demand, causes a fall in prices (relatively to the wage level) and thereby generates a corresponding rise in real consumption. Assuming flexible prices (or rather flexible profit margins) the system is thus stable at full employment. The model operates only if the two saving propensities differ and the marginal propensity to save from the profits exceeds that from wages i.e. the stability condition.

He also gave importance to the technological progress as factor of growth which was embodied in capital accumulation. The prime mover in the process of growth was the capacity and readiness of the economy to absorb technological improvements and to invest capital in business ventures. As the share of profits in the national income increased, savings ratio also would rise. There was equilibrium rate of growth when the profit rate is such as to equate savings and investment.

In his later work called 'Economic Growth and the Problem of Inflation' (Part II Economica, November 1959), Kaldor emphasized the effects of inflation in real rates of interest as an incentive to larger investment. When prices rose during inflation, real rate of interest tend to fall. This would encourage greater fall of resources into investment. By maintaining prices at a sufficient high level, booms can be perpetuated. A slow and steady rate of inflation acted as the most powerful aid to a steady rate of economic progress.

In his works with T A Mirrlees, 'A New Model of Economic Growth' (review of Economic Studies, Vol.XXIX, June 1962), forecasted 'high level stagnation' for

the advanced capitalist countries, by reason of labor shortages and shifts in demand from goods to services, as standard of living rose. These would combine to check the growth of manufacturing and hence of income as a whole.

Joan Robinson (1956)

The growth model of Mrs. Robinson is included in the Cambridge models as it rests on the neo-Keynesian argument that savings ex-ante adjusts passively to planned investment through changes in income distribution. She too, as other Cambridge growth models, rejected the neoclassical production function.

Joan Robinson's model is based on the understated assumptions:

- There exists a laissez-faire closed economy.
- Capital and labor are the only productive factors in the economy.
- Capital and labor are combined in fixed proportions in order to produce the given output.
- There is neutral technical progress.
- Capital formation depends on the way in which income is distributed. If a major part of the income goes with the capitalists there is more capital formation than if it goes to the laborers.
- Utilization of labor depends on the supply of capital on one hand and that of labor on the other.
- Wage earners spend their income wholly on consumption and profit makers on investment (from their profits) without any consumption.
- Savings equal investments (S = I). (Because of the above assumption)
- There are no changes in the price levels.

The net National Income in Robinson model was the sum of the total wages and the profits:

$$Y = wN + pK$$

Where; Y = Net National Income

w = Real wage rate

N = Number of laborers

p = Profit Rate

K = Amount of capital

And so it can be said that National Income or output is the function of labor and capital. Profit rate can thus be shown as:

$p = Y - wN/K$

$p = Y/N - w/K/N$ (dividing by N)

Where; p = Profit rate

w = Wage rate

Y/N = Labor productivity

K/N = Capital – Labor ratio

If $Y/N = \alpha$ and $K/N = \beta$, then we have

$$p = \alpha - w/\beta$$

The rate of profit depended on the relationship between the income that remained after wage payment and the capital/labor ratio. Thus in order to

define the profit rate it could be said that the profit rate is the ratio of labor productivity minus the total real wage rate to the amount of capital utilized per unit of labor.

The growth rate of capital being equal to the profit rate depended on the ratio of the net return on capital relative to the given stock of capital. If the income after deducting wages is constant and the capital-labor ratio is high, profit rate and the rate of capital formation were low and vice versa.

The growth rate of population was another factor which determined the growth rate of the economy. Full employment was possible if the growth rate of population was matched by that of capital (growth rate). This was called the 'Golden Age' i.e. a smooth and steady growth with full employment. An increase in population and labor force without an increase in capital reduced labor productivity and if real wages are constant, it lowered the margin of profit and widened the gap between supply of capital and that of labor. This resulted in unemployment. If population increased faster than capital, equilibrium might be attained only by an equilibrating behavior of profit-wage relationship i.e. if excess of labor caused fall in real wage rates and increased the rate of profit leading to a growth of capital to catch up with population. But if real wage rates did not fall or the wage rate fell in the same proportion as prices, the result was progressive underemployment. Rise in prices helped capital formation if there was no corresponding rise in wages. On the other hand if capital growth exceeded the growth of population, equilibrium might be regained through technological improvements and shifting of the whole production function so that the economy was adjusted to a higher capital-labor ratio.

According to Mrs. Robinson, an economy was in the golden age when the potential growth ratio was being realized. The potential growth ratio represented the highest rate of capital accumulation that could be permanently maintained at a constant rate of profit. This growth ratio was approximately equal to the proportionate rate of labor force plus the proportionate rate of growth of output per head. The golden age was not an ideal one. A new growth ratio made a new golden age possible. A static state was a special case of a golden age where the growth ratio was zero, the profit rate was also zero and the wages absorbed the entire net output of industry. Robinson called this "the state of economic bliss" since consumption was at the maximum level which could be permanently maintained in the given technical conditions. This, in the Harrodian terminology is a state where the natural, actual and the warranted rates of growth are equal.

The rate of technical progress depended upon the demand and supply of labor. When the firms fail to take advantage of the profitable markets expanding around them, they try to adopt labor-saving devices. This was because the rate of technical progress was defined as the rise in output per head, assuming zero growth rate of population. However, technical progress continues even when there was massive unemployment. Robinson pointed out that the growth of knowledge may lead to 'autonomous innovations', competition among firms may lead to 'competitive innovations' and the scarcity of labor may lead to 'induced innovations'. The desired rate of growth may fall short of the possible rate of growth due to competitive and autonomous innovations. This desired rate of growth is the rate of accumulation which made the firms satisfied with the situation in which they

found themselves. It was determined by the rate of profit caused by the rate of accumulation, and the rate of accumulation induced by that rate of profit. On the other hand, the possible growth rate depended upon the physical conditions resulting from the growth of population and technical knowledge. When the desired growth rate equaled the possible growth rate at near full employment, the economy was in a golden age. The real wage rate was rising with increasing output per head due to technical progress. But the rate of profit on capital remained constant. And the techniques of production appropriated to the rate of profit were chosen.

Solow (1956)

A Keynesian, Solow's major paper on growth was "A Contribution to the Theory of Growth" in which he presented a mathematical model of growth that was a version of the Harrod-Domar growth model. Only with the difference of dropping out one of the Harrod-Domar assumption of fixed proportions in production. Solow was the first to develop a growth model with different vintages of capital. The idea was that because capital is produced based on known technology and by improving the technology the new capital was more valuable than the old one. He established the primacy of technological progress in accounting for sustained increases in output per worker.

The Solow model assumed that GDP is produced according to an aggregate production function technology. Output can be produced by both labor and capital taking a Cobb-Douglas production function with constant returns to scale, we have

$Y = L^a K^{1-a}$

Where Y = Output

L = Labor

K = Capital

a = Share of labor in output

1-a = Share of capital in output ($a<0<1$)

The above production function in terms of growth rate can be written as:

$$g = an + (1-a)\,\Delta K/K$$

Where $g = \Delta Y/Y$ i.e. Rate of growth of output

$n = \Delta L/L$ i.e. Rate of growth of labor force

and $\Delta K/K$ is the Rate of growth of capital stock

Now if the capital/output ratio i.e. K/Y is constant in the long run, so that $\Delta K/K = g$, then output per capita must also be constant because $g = n$ (as in the above equation). And therefore it can be said that the long run growth is exogenous. But when $g = n$ the growth of output per capita is zero. And so in order to explain the observed growth of output per capita, Solow invoked technological progress adding a technological shift parameter to the original Cobb-Douglas production function.

$$Y = AL^aK^{1-a}$$

Where, the additional A is the technological progress or the multifactor productivity measuring the productive efficiency of the factors or the so-called

Solow residual i.e. the total factor productivity. If we assumed technology to grow at a given rate (aq), embodied in labor, we have $A = Be^{aqt}$, where B is constant representing an initial state of technology.

With more and better education, labor becomes more and more productive over time and so in order to express labor input in units of efficiency we can write:

$$Y = B(e^{qt}L)^{a} K^{1-a}$$

The rate of technological progress (aq) is less than the rate of growth of labor productivity (q) because the quality of capital is unchanged as per the assumption. Whereas, the technical progress was assumed to be in the form of increased labor productivity. Thus the rate of growth of output can be:

$$G = a\,(n + q) + (1 - a)\,\Delta K/K$$

As before if $\Delta K/K = g$, then the output per efficiency unit of labor us constant and

$$g = n + q$$

And therefore the long run growth is still exogenous. And the long run growth of output per capita is no longer zero. In the long run savings and efficiency make no difference for growth unless they affect the rate of technological change.

Solving the Harrod-Domar equation for capital/output ratio:

$$v = s/\,g + \delta = s/\,n + q + \delta$$

Including gross investment (sum of net and replacement investments) we have:

$$I/Y = K/Y\ (\Delta K/K + \delta)$$

As savings equals investment in the long run (S=I), I/Y equals savings rate (s) and the above equation can be solved for capital/output ratio as

$$K/Y = s/\ \Delta K/K + \delta$$

As long as the saving rate, the depreciation rate and the rate of growth of the capital stock are constant, the capital/output ratio must also be constant. For given s and δ, a constant rate of growth of capital stock must be equal to the rate of growth of output, for that is the only way for the capital/output ratio to stay put.

If the rate of growth of capital stock is constant, then it must be equal to the rate of growth of output. And therefore we have:

$$g = a\ (n + q) + (1\text{-}a)\ (s.Y/K - \delta)$$

This equation tells us that an increase in the saving rate must increase the rate of growth of output so long as the capital/output ratio remains unchanged.

But the capital/output ratio will not stay put.

Gunnar Myrdal (1957)

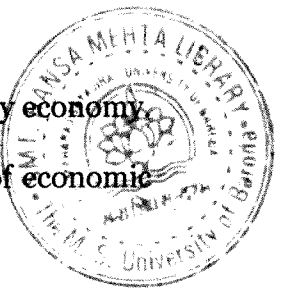
Myrdal analyzed the problem of underdevelopment in his earlier works from the standpoint of regional and international inequalities. Within the boundaries of an underdeveloped country some regions may have advantages

over others in more raw materials and thinness of population. Expansion of trade also helped this process.

Myrdal distinguished between 'spread' and 'backwash' effects. The 'spread' effect represented the spreading and sharing of prosperity while the backwash effect represented the aggravation of differences in income and other economic benefits. Expansion in one region had both kinds of effects on another region but the spread effects were more predominant. So Myrdal suggested economic integration through equalization of factor prices as a pre-condition for development. If labor could earn money in industry than in agriculture, but does not move there is a strong case for reallocation. Similarly in the world economy as a whole there are disequalizing forces. Trade between underdeveloped and advanced countries, because of 'circular causation' leading to vicious spirals and backwash effects, resulted in a tendency away from equilibrium and aggravates the differences between the productivity of the two countries. The shifts in the terms of trade in favor of advanced countries resulted in increasing the differences in their standards of living from those of underdeveloped ones. So the policy in international factor movements, including foreign investments needed recasting in favor of a lashing benefit to underdeveloped economies.

W. W. Rostow (1959)

Rostow gave an outstanding theory of economic growth popularly known as the 'stage' theory of economic growth. His theory of growth can be considered as an alternative to the Marx's theory of modern history.



According to Rostow there are five stages of economic growth in any economy. An economy would pass through these stages during its process of economic growth. These stages can be briefed as:

1) Traditional Society: The initial stage of an economy wherein the structure (of the traditional society) is developed within a limited production function. This meant that the production or output is carried out through the most backward and traditional means of production. No technology is used or applied for production. Thus a ceiling existed on the level of attainable output per head. As a result there would be limited and small amount of output for the use or consumption of the existing population.

2) Pre-Conditions for Take-off: This is the stage from where the economy strives to attain growth. The pre-conditions for take-off can be described as the ways and means that are necessary to exploit the fruits of modern science and to repel the diminishing returns. Thus, enjoying the blessings and choices opened up by the rapid economic growth taking place in the economy.

3) Take-off: It is the interval when the old blocks and resistances to steady growth would be finally overcome. The forces leading to economic progress expand and dominate the society. Growth becomes its normal feature. For the take-off to take place three conditions were put forth by Rostow during the mid twentieth century:

- Rise in the rate of productive investment from 5% or less to over 10% of National Income.
- Development of one or more substantial manufacturing sectors with a high rate of growth and

- The existence or quick emergence of a political, social and institutional framework which exploits the impulses to expansion in the modern sector and the potential external economy effects of the take-off gives to growth an ongoing character. This implies a considerable capability to mobilize capital from domestic sources.

His findings indicated that in a decade or two the economic, social and political structure of society would change in a way that would make the process of growth self sustained.

4) Drive to Maturity: After the third stage of take-off the next stage viz. the drive towards maturity would take a long time. During this stage the economy would achieve sustained progress. It would extend its modern technology over the whole front of activity and steadily invest a substantial percentage of national income so that output outstrips increase in population. This would help in accelerating new industries in the economy. Goods formerly imported would now be produced at home, developing requirements for new imports and new export commodities matching them. The society would develop new values and institutions to keep up with the efficient production. He further added that maturity is a stage in which an economy has the technology and the entrepreneurial skills that an economy could produce not just everything but anything that it chooses to produce.

5) The Age of High Mass Consumption: During this stage the leading sectors of the economy would shift towards durable consumer goods and services. The three objectives here are:

- The welfare state

- Extension of consumption beyond basic to better food, clothing and shelter along with the mass consumption of durable goods and services and
- National pursuit of external power and influence through increased allocation of more resources to military and foreign policies.

Thus, an economy would have to submit to all the above stages when in the process of economic growth.

Meade (1961)

Prof J E. Meade constructed a model of economic growth to show the way in which the simplest form of economic system would behave during a process of equilibrium growth. The basic assumptions on which the model was built are:

1. There is a laissez-faire economy which is a closed economy

2. There is perfect competition in the economy

3. There are constant returns to scale

4. Two commodities are produced in the economy, consumption and capital goods

5. Machines are the only form of capital in the economy and are alike

6. There is a constant money price of consumption goods

7. Land and labor are fully utilized

8. The ratio of labor to machinery can be changed both in the short and long run. He calls it as the assumption of perfect malleability of machinery

9. There is perfect substitutability in production between capital goods and consumption goods

10. Each year some percentage of machines wears our which requires replacement i.e. depreciation by evaporation

The net output, in an economy with the above stated assumptions, was produced depending upon:

a) The net stock of capital available in the form of machines

b) The amount of available labor force

c) The availability of land and natural resources

d) The state of technical knowledge which continues to improve through time.

This relationship was expressed in the form of a production function as -

$$Y = f(K, L, N, t)$$

Where, Y = Net output or National Income

K = Existing stock of capital (machines)

L = Labor force

N = Land and Natural Resources

t = Time, signifying technical progress

Assuming the amount of land and natural resources to be fixed, net output can increase in any one year with the growth in K, L and t. This can be shown as

$$\Delta Y = V\Delta K + W\Delta L + Y'$$

Where, Δ = an increase in each case

V = marginal product of capital

W = marginal product of labor

Y' = t (time, signifying technical progress)

The annual proportionate growth rate of output is

$$\Delta Y/Y = (VK/Y \,.\, \Delta K/K) + (WL/Y \,.\, \Delta L/L) + \Delta Y'/Y$$

Where, $\Delta Y/Y$ = proportionate growth rate of output

$\Delta K/K$ = proportionate growth rate of stock of capital

$\Delta L/L$ = proportionate growth rate of labor force

$\Delta Y'/Y$ = proportionate growth rate of technical progress during a year

Let these proportionate growth rates be expressed as y, k, ℓ, and r respectively, the proportionate marginal product of capital VK/Y as U (i.e. the proportion of the net national income being paid as profits to the owners of machines) and the proportional marginal product of labor WL/Y as Q (the proportion of income going to the labor force as wages). Thus the above equation can be written as

$$y = Uk + Q\ell + r$$

This equation shows that the growth rate of output (y) is the weighted sum of three other growth rates viz. the growth rate in stock of capital (k) weighted by the proportional marginal product of capital (U); the growth rate of population (ℓ) weighted by the marginal product of labor (Q), and the growth

rate of technology (r). But the real index of the growth of the economy is the growth rate of real income per head rather than the growth rate of income (y). The growth rate of real income per head is

$$y - \ell = Uk + Q\ell + r - \ell$$

$$y - \ell = Uk - \ell + Q\ell + r$$

$$y - \ell = Uk - (1 - Q)\ell + r$$

The equation revealed that the growth rate of real income per head was raised in two ways

1. By an increase in the rate of real capital (k) weighted by its proportional marginal product (U) and
2. By an increase in the rate of technical progress (r).

While it was depressed by the growth rate of population (ℓ) weighted by one minus the proportional marginal product of labor (1-Q). The [– (1 - Q) ℓ] shows the tendency for diminishing returns as the quantity of labor is increased on a given amount of land and capital.

The addition to the stock of capital, ΔK, is equal to the savings out of the net national income. Thus,

$$\Delta K = SY, \text{ and}$$

$$k = \Delta K/K = SY/K$$

where SY represents the amount annually added to the stock of capital through savings (S is the propensity to save and not absolute savings). Thus,

$$Uk = VK/Y * SY/K = VS$$

Hence the basic growth relationship can be expressed as

$$y - \ell = VS - (1-Q)\ell + r$$

Assuming ℓ and r to be given and constant, changes in growth rate would be determined by the behavior of V, S and Q over time. If there is no change in the population (ℓ) and technical progress (r), an increase in the rate of savings (S) would raise capital per head and bring a decline in the marginal product of capital (V). This decline in V will, however, be less if it is possible to substitute capital for land and labor. And if technical progress takes place, V will tend to rise instead of declining. But the amount of land and labor being fixed in the economy, more capital per head will be used and at the same time technical progress will tend to raise V. Under these conditions, the rate of growth of income per head over time would rise which in turn would tend to rise S. There will be a tendency for S to rise still further due to a change in income distribution towards larger profits caused by the above mentioned factors. We may conclude that with a constant population, real income per head depends upon the rate of capital accumulation and technical progress. Thus,

$$y - \ell = VS - (1-Q)\ell + r$$

$$y = VS + r \qquad (\text{Since } \ell = 0)$$

If the rate of technical progress along with population growth is assumed to be constant, the growth rate in income per head will vary directly with VS.

The state of steady economic growth requires the existence of the following three conditions to endure a constant growth rate in total income:

1. All elasticities of substitution between the various factors are equal to unity
2. Technical progress is neutral towards all factors
3. The proportions of profits saved, of wages saved, and of rent saved are all constant

Conditions 1 and 2 meant that the proportions of the national income going to profits, wages and rents remain constant. So the proportions of national income saved out of these remunerations of factors remain constant as per condition 3. Let these savings out of profits, wages and rents be represented by Sv, Sw and Sg respectively, so that total savings

$$S = SvU + SwQ + SgZ.$$

Since all the elements in this equation are constant vide conditions 1, 2 and 3 it follows that the ratio of total savings to total national income will also be constant. The growth rate of income is represented by the basic relationship

$$y = Uk + Q\ell + r$$

wherein U, Q, ℓ and r are assumed to be constant. Therefore, for y to be constant, k should be constant. Knowing that $k = SY/K$ is constant. Y/K will be constant if the rate of growth of Y and K is the same which implies that $y = k$. The obvious conclusion follows that the growth rate of income will be constant if the growth rate of capital stock is equal to the growth rate of national income.

The equilibrium position ultimately depended upon the rate of accumulation of the capital stock. According to Meade, there is a critical growth rate of the capital stock which makes the growth rate of income equal to the growth rate

of capital stock. A more or less growth rate in the capital stock than this critical growth rate will not bring about the equality of y and k. If we put 'a' for critical growth rate then the basic relationship will be

$$a = Ua + Q\ell + r$$

$$a = Q\ell + r/1- U$$

It was this critical rate which will make y = k, and keep the growth rate of national income constant at the steady growth level. If, at any time, there is any deviation from this level of steady growth, forces will set in to bring the growth rate of the capital stock at the equilibrium level.

D W. Jorgenson (1967)

His model related to a dual economy consisting of the agricultural and the industrial sectors.

His model was based upon certain assumptions:

- Labor was divided between the two sectors in a straight forward manner. If there was no agricultural surplus, all labor remained on land. In case of agricultural surplus, a part of the labor force became available for the employment in the manufacturing sector and it grew at a rate equal to that of growth of agricultural surplus.
- Manufacturing in the advanced sectors started with some initial injection of capital. Thereafter capital formation proceeded at a pace determined by the growth of the industrial labor force and the terms of trade between the two sectors.

- There was persistent differential in wage rates between the two sectors and development caused a steady migration of labor from the agricultural to the industrial sector. This differential determined the terms of trades between the two sectors and thereby the rate of investment in the advanced sector.

The output in the agricultural sector was the function of land and labor.

$$Y = f(L, N)$$

Where, Y = total output

L = land and

N = labor

The agricultural sector faced the diminishing returns with no capital accumulation.

On the other hand, in the industrial sector, output was the function of labor and capital

$$Y = f(N, K)$$

Where, Y = total output

N = labor

K = capital

Here the productive capacity expanded on basis of constant returns to scale.

The above two functions shifted over time to give more output than before due to the technological changes. Thus the rate of capital accumulation could be given as

Manufactured goods – Consumption

Once the agricultural workers get their share of manufactured goods for the exchange of food, the remainder of the manufactured goods could be used for further investment in industries. The consumption of manufactured goods in both the sectors was equal to the share of labor in the production of the manufacturing sector.

Thus, with the above discussion it could be said that – the more rapid the rate of technical change and the higher the saving ratio, the more rapid is the pace of growth in the advanced sector. Emphasizing on the rate of the industrial sector in the economic growth he said that "the industrial sector plays a strategic role in the development of a dual economy with or without disguised unemployment"[7].

It can thus be observed that according to Jorgenson, capital accumulation in the industrial sector and the technological changes in both the sectors bring about growth in a dual economy wherein the major role is played by the industrial sector.

Harris-Todaro (1970)

The Harris-Todaro model of rural-urban migration is usually studied in the context of employment and unemployment in developing countries. In the

[7] Jorgenson, 1967, "Surplus Agricultural Labor and the Development of a Dual Economy". Oxford Economic Papers, New Series, pp.311-12 as cited in Banerjee (1969).

model, the purpose was to explain the serious urban unemployment problem in developing countries. The Harris-Todaro model of economic growth is popularly known as the model of Migration and Unemployment. Their thesis was based on the problems of rural-urban migration and the urban unemployment. The labor migration from the rural to the urban areas was due to the differences in the wage rates prevailing in both the regions, which led to the urban unemployment. In order to remove this unemployment the model suggested a subsidized minimum wage through a lump sum tax.

The propositions that were considered while building this model are:

- There exist only two sectors in the economy, the rural or the agricultural sector and the urban or the manufacturing sector.
- Each of the sectors produces only one good.
- The model operates in the short run
- Both the sectors have fixed quantity of capital available with them
- The number of urban jobs available is exogenously fixed. In the rural sector some work is always available. The total urban labor force comprises of the urban labor force along with the available rural migrants.
- The urban and the rural wages are fixed at a particular level where the urban wages are higher than the rural wages.
- The rural wage equals the rural marginal product of labor and the urban wage is exogenously determined.
- Rural urban migration continues so long as the expected urban real income is more then the real agricultural income

- The expected urban real income is equal to the proportion of urban labor force actually employed multiplied by the fixed minimum urban wage
- There prevails perfect competition among the producers in both the sectors of the economy
- The price of the agricultural good is determined directly by the relative quantity of the two goods produced in both the sectors

Based on the above assumptions the Harris-Todaro growth model can be built as:

Output in the rural sector is supposed to be a function of labor so that the production function for the agricultural good is

$$X_A = f(N_A, \bar{L}, \bar{K}_A)$$

Where, X_A = output of agricultural good

N_A = rural labor units employed to produce the output

$\bar{L}$ = fixed given land

$\bar{K}_A$ = fixed available quantity of capital in rural sector

Similarly output in the urban sector is supposed to be a function of labor so that the production function for manufactured goods is

$$X_M = f(N_M, \bar{K}_M)$$

Where, X_M = output of manufactured goods

N_M = urban labor units employed to produce the output

$\overline{K}_M$ = fixed quantity of available capital in the urban sector

The price determination equation in the economy is

$$P = P(X_M / X_A)$$

Where P is the price of agricultural goods in terms of the price of manufactured goods which is a function (P) of the relative output of agricultural and manufactured goods.

The agricultural wage equals the value of marginal product of labor expressed in terms of the manufactured good

$$W_A = f'_A(N_A) = P(f'_M)$$

In the urban sector, the producers are wage-takers and they aim at profit-maximization which means that the urban market wage is

$$W_M = f'_M(N_M)$$

However, in this economy, the urban real minimum wage ($\overline{W}_M$) is at a lower level due to institutional or political factors so that

$$W_M = f' \geq \overline{W}_M$$

This equation expressed that wage in the urban sector was equal to the marginal product of labor because of the price-taking behavior of the producers. This assumption was called the wage-rigidity axiom.

Assuming wage to be flexible, if wages are above $\overline{W}_M$, there will be an excess supply of labor in the urban sector and competition among producers will drive W_M to the level of $\overline{W}_M$. Thus, the profit maximization condition becomes

$$\overline{W}_M = f'_M(N_M)$$

The urban expected wage which led to the migration of workers from the rural to the urban sector is given by

$$W^e_u = \overline{W}_M \,.\, N_M / N_U \qquad (N_M / N_U \leq 1)$$

Where the expected real wage (W^e_u) in the urban sector is equal to the urban real minimum wage (W_M) adjusted for the proportion of the total urban labor force (N_U) actually employed. When $N_M / N_U = 1$, there is full employment in the urban sector and the expected real wage equals the real minimum wage

i.e. $W^e_u = W_M$.

The total labor endowment in the economy was

$$\overline{N} = \overline{N}_A + \overline{N}_U = N_A + N_U$$

This equation shows that there is labor constraint in the economy in the form of workers actually employed in the rural sector (N_A) plus the total urban labor force (N_M) with equals the initial endowment of total labor ($\overline{N}_A$) plus permanent urban labor (N_U) which in turn equals the total labor endowment (N)

The equilibrium condition is given by the equity equation

$$W_A = W^e_u$$

This is based on the hypothesis that migration from the rural to the urban sector is a positive function of urban-rural wage differential.

The migration from the rural to the urban sector will cease when the expected wage differential is zero i.e. $W_A = W^e_u$ (at the equilibrium level).

Paul Romer (1986)

Paul Romer is considered as one of the chief architects of the new growth theories. His theory of economic growth revolutionalized the study of growth economics. His work amounted to constructing mathematical representations of economies in which technological change was the result of intentional actions of the people, such as research and development. According to him growth was not just adding more labor to more capital, but new and better ideas expressed as technological progress. In his words "Economic growth occurs whenever people take resources and rearrange them in ways that are more valuable. A useful metaphor for production in an economy comes from the kitchen. To create valuable final products, we mix inexpensive ingredients together according to a recipe. The cooking one can do is limited by the supply of ingredients, and most cooking in the economy produces undesirable side effects. If economic growth could be achieved only by doing more and more of the same kind of cooking, we would eventually run out of raw materials and suffer from unacceptable levels of pollution and nuisance. History teaches us, however, that economic growth springs from better recipes, not just from more cooking. New recipes generally produce fewer unpleasant side effects and generate more economic value per unit of raw material. Every generation has perceived the limits to growth that finite resources and undesirable side effects would pose if no new recipes or ideas were discovered. And every generation has underestimated the potential for finding new recipes and ideas. We consistently fail to grasp how many ideas remain to be discovered. Possibilities do not add up. They multiply".

In his article "Increasing Returns and Long-Run Growth" (1986) he specified a long run growth model wherein knowledge was considered as an input in production which had an increasing marginal productivity. Technological change had been considered endogenous to this competitive equilibrium model. In sharp contrast to the models that assume diminishing returns, the article stated that growth rates can be increasing over time and that large countries would grow faster than the smaller ones. The model was based on the following postulations:

1. Technology was assumed to be endogenous
2. Long-run growth was driven primarily by the accumulation of knowledge by forward-looking, profit-maximizing agents
3. New knowledge was assumed to be the product of a research technology that exhibited diminishing returns (i.e. "given the stock of knowledge at a point in time, doubling the inputs into research will not double the amount of new knowledge produced")
4. Investment in knowledge had a natural externality
5. Knowledge cannot be perfectly patented or kept secret. Thus, the creation of new knowledge by a firm had a positive external effect on the production possibilities of other firms.
6. Knowledge was assumed to be a capital good having increasing marginal productivity (i.e. "production of consumption goods as a function of the stock of knowledge and other inputs exhibits increasing returns") Production of consumer goods was assumed to be globally convex not concave as a function of stock of knowledge while all other inputs were held constant.

7. Romer discarded the steady state stating that new research was undertaken continuously. Thus, new knowledge was being added to the existing state of knowledge.
8. No government intervention

Keeping these postulations in mind Romer developed his model stating that production was possible with all the factors of production in addition to knowledge. While knowledge can be augmented, it was assumed that other factors of production (physical capital, labor and size of population) were fixed in supply. The research technology produced knowledge for tomorrow's better production from the consumption that is foregone today and the trade-off was assumed to be one for one. Thus the equilibrium in a two-period model, in words of Romer, "is a standard competitive equilibrium with externalities. Each firm maximizes profit taking knowledge, the aggregate level of knowledge, as given. Consumers supply part of their endowment of output goods and all other factors of production (that are assumed to be fixed in supply) to firms in the first period. With the proceeds, they purchase output goods in the second (next) period. Consumers and firms maximize taking price as given. As usual, the assumption that agents treat prices and the aggregate level of capital as given could be rationalized in a model with a continuum of agents. Here, it is treated as the usual approximation for a large but finite number of agents. Because of the externality, all firms could benefit from a collusive agreement to invest more in research. Although this agreement would be Pareto-improving in this model, it cannot be supported for the same reasons that collusive agreements fail in models without externalities. Each firm would have an incentive to shirk, not investing its share of output in research. Even if all existing firms could be compelled to

comply, for example, by an economy-wide merger, new entrants would still be able to free-ride and undermine the equilibrium". Further, he proceeded with the infinite-horizon growth model in line with the above model and went on to calculate the welfare gains in a no-intervention competitive equilibrium.

Further, he proceeded with the infinite-horizon growth model in line with the above model. Though additional knowledge was produced by foregoing the consumption today, the only difference here lied in the fact that the trade-off was no longer assumed to be one for one (as in the earlier case). The rate of growth is a function of investment in research (i.e. the foregone amount of consumption) and the current stock of private knowledge with the firm and went for a competitive equilibrium. The welfare analysis of the competitive equilibrium stated that "the social marginal product of knowledge is greater than the private marginal product in the no (government) intervention competitive equilibrium".

Since the model here can be interpreted as the special case of the two-state-variable model in which knowledge and capital are used in fixed proportions, this kind of extension can only increase the range of possible equilibrium outcomes.

Robert Lucas (1988)

His theory was rather a theory of economic development than that of economic growth. He closely followed the applications of the neoclassical models of Robert Solow, Edward Denison and others to study the US growth in the 20th century but concluded to find these models inadequate. He then went ahead by including the effects of human capital accumulation in to the

one-sector (interaction of physical and human capital) model and the two-goods system where there are possibilities of interaction between trade and development. Thus, the model regarded human capital and technology to be the driving forces of growth in an economy. It assumed population growth as constant and treated all exchanges as goods for goods (barter exchange). The basic assumptions, in addition to those stated earlier, on which the model was built, are:

1. A closed economy having competitive markets
2. Presence of identical and rational agents in the markets
3. Constant returns to the technology.

On the basis of these assumptions it was said that the total output (Net National Product) was summation of the product of man-hours devoted to production and per capita consumption and the rate of change of stock of capital. And production was a function of capital and labor at the existing level of technology. Solving for the equations along the balanced path, it was found that "the rate of growth of per capita magnitudes is simply proportional to the given rate of technical change and the constant of proportionality is the inverse of labor's share". Higher savings (induced by low time preference and low risk aversion) were associated with relatively high output levels on a balanced path. To put in Robert's words "a thrifty society will, in the long run, be wealthier than an impatient one, but will not grow faster".

Lucas went on with adding the novel dimension of human capital to the technologically driven growth model of Solow. Human capital was defined by Lucas as "...the general skill level, so that a worker with human capital $h(t)$ is the productive equivalent of two workers with $\frac{1}{2}\ h(t)$ each, or a half time

worker with *2h(t)*". Thus the theory of human capital focused on the fact that the way an individual allocated his time over various activities in the current period affected his productivity or his human capital level in the future periods. In order to simplify the theory Lucas made simple assumptions on the following lines:

There are N workers in total, with skill levels h ranging from zero to infinity. Let there be N(h) workers with skill level h, so that $N = \int_0^\infty N(h)\, dh$. Suppose a worker with skill h devotes the fraction u(h) of his non-leisure time to current production, and the remaining 1-u(h) to human capital accumulation. Then the effective workforce in production is the sum $N^e = \int_0^\infty u(h)N(h)hdh$ of the skill weighted man-hours devoted to current production. If output as a function of total capital K and effective labor N^e is $F(K, N^e)$, the hourly wage of a worker at skill h is $F_N(K, N^e)h$ and his total earnings are $F_N(K, N^e)hu(h)$. In addition to the internal effects of human capital, Lucas went on to identify the external effects of the human capital – which too contributed to the productivity of all the factors of production. He describes the average human capital as

$$h_a = \int_0^\infty hN(h)dh \,/\, \int_0^\infty N(h)dh$$

The effective workforce in an economy is $N^e = uhN$, wherein the all the workers are identical with skill level h and all choose the time allocation u. Here the description of technology of goods production was

$$N(t)c(t) + \mathbb{K}(t) = AK(t)^{\beta}[u(t)h(t)N(t)]^{1-\beta}h(t)^{\gamma}$$

Where, $h(t)^{\gamma}$ = external effects of human capital and

A = level of technology (constant)

In order to understand the effects of human capital accumulation, Lucas adapted the Uzawa-Rosen (linear) model formulation which stated that if no effort was devoted to human capital accumulation, then none accumulates. And if all efforts are devoted to the accumulation of human capital then the rate of change in human capital grew at its maximum rate. This human capital was assumed to stream from one generation to the other in a way that the other next generation started acquiring the human capital from the point beyond the past generation's acquired human capital.

Keeping these assumptions in mind, the model followed in line with the assumptions of the Solow model of a closed economy where the population grew at a fixed rate. He employed Romer's and Arrow's analysis in order to obtain the optimal and equilibrium paths and to compare them. The balanced path was derived as

$$v = \delta(1-u)$$

while the common growth rate of consumption per-capita capital is

$$\kappa = (1 - \beta+\gamma / 1-\beta)\, v$$

and the exogenous rate of technological change μ is

$$(1 - \beta+\gamma)v$$

Solving the equations for further mathematical solutions, the efficient rate of human capital growth along a balanced path was arrived at which was

$$v^* = \sigma^{-1}[\delta - (1-\beta/1 - \beta+\gamma)\,(\rho-\lambda)]$$

and the competitive equilibrium growth rates of human capital along a balanced path was

$$v = [\sigma(1 - \beta+\gamma)- \gamma]^{-1} [(1 - \beta)(\delta-(\rho-\lambda))].$$

In the case with the above two equations, the growth increased with the effectiveness (δ) of investment in human capital and declined with increases in the discount rate (ρ). While $\kappa = (1 - \beta+\gamma / 1-\beta) v$ gave the corresponding rate of growth of per capita physical capital. However, it should be kept in mind that the theory predicted sustained growth whether or not the external effect was positive.

Further, he explained that an efficient economy, on a balanced path, will have a higher level of human capital for any given level of physical capital. He also stated that the returns to capital were constant and also constant over time even though capital stocks of both kinds were growing. In the absence of the external effect the real wage rate for labor of a given skill level i.e. the marginal product of labor is constant.

He further analyzed the impact of learning-by-doing on the accumulation of human capital. For this purpose he postulated for; a closed economic system with two consumption goods, c_1 and c_2 and no physical capital. The growth in population was assumed to be constant and learning effects (of human capital accumulation) were assumed to be external to the system. He then, went on with analyzing the effects when the economy was opened to international trade. Thus, adding the possibility of different growth rates across countries, though differences were not systematically related to income levels. "Each country would produce a good for which its human capital endowments suit it.

Given the learning technology, countries accumulate skills by doing what they are already good at doing, intensifying whatever comparative advantage they begin with". However, it should be noted that the model does not capture the offsetting forces in an economy.

This discussion leaves us with the basic ingredients and recipes which are essential for the process of growth and development of any economy. Nonetheless, it should be remembered that the true essence of a good recipe can be noticed only after tasting. And so the next question I intend to answer is – whether the ingredients, given by the growth theories, have passed the test of time? These ingredients formulate the various factors that affect the process of economic growth of an economy. In view of this, the next chapter evaluates these various factors considered to be vital to the process of economic growth.