A Review and Critique of the Harrod-Domar Aggregate Growth Model

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I. Introduction

The process of economic growth is influenced by many factors. Some basic elements of the growth process include the quantity of capital per worker; the quality of capital including factors such as improved technology, innovation and invention; the quantity of labor; and the quality of labor involving education, improved labor skills, and better health. Investment in the quality of labor, or human capital, enhances economic growth through activities that influence future real income by embedding resources in people.

The purpose of this paper will be three-fold: first, to review the Harrod-Domar "Long-Run Aggregate Growth Model,"[1,2] second, to examine the importance of investment in human beings, and third, to critique the Harrod-Domar model.

II. Review of the Harrod-Domar Aggregate Growth Model[3]

Initial writings to extend the basic Keynesian macroeconomic model were undertaken by Evsey Domar and Roy Harrod focusing on analysis of long-run economic growth. In the long-run, the stock of capital is not constant because net investment adds to the already existing stock of capital, thus increasing the full employment income level.

The fundamental theoretical structure of the Harrod-Domar model contains a simple production function that relates output to the capital stock by way of the output-capital ratio, which states that national income is proportional to the quantity of capital. This is shown by the equation

Y = ºK (1.1)

where

Y = national income
K = the amount of the capital stock employed in the production of the national income
º = the stable constant of proportionality called the output-capital ratio[4]

Further simplifying assumptions made in the Harrod-Domar model are: full employment is initially assumed, no government intervention or international trade is allowed, and no lags in adjustments occur (output responds quickly to changes in expenditures and expenditure immediately responds to changes in income). The model is static, not dynamic.

Dividing both sides of the equation 1.1 by K, one obtains

º = Y/K (1.2)

From equation 1.2, it is now evident why º is called the output-capital ratio.

Assuming that the output-capital ratio is stable from equation 1.1, equation 1.3 shows that the growth in income must be proportional to the growth in the physical capital stock employed.

ΔY = ºΔK (1.3)

If it is assumed initially that full employment exists, it can then be shown that the annual growth of income will be limited by the growth of the capital stock.

If the net annual change in the physical capital stock is defined to be net physical investment (I), then one could substitute I for -K in equation 1.3, resulting in equation 1.4

$$\Delta K = \text{º}I \quad (1.4)$$

In the case where an economy saves a constant proportion(s) of its income each year (note also that consumption will be a constant proportion of income) and desired saving (leakage) equals desired investment (injection), one can write:

$$S = I = sY \quad (1.5)$$

where s = marginal propensity to save. Now, if one substitutes sY for I in equation 1.4, we obtain

$$\Delta Y = \text{º}sY \quad (1.6)$$

By dividing both sides by Y, our resulting equation is

$$\Delta Y/Y = \text{º}s \quad (1.7)$$

Examining the relationship $\Delta Y/Y$, one can see that this ratio is the annual growth rate of income necessary to maintain a fully-employed stock of capital. At this growth rate, business expectations will be realized or "warranted." This is why the growth rate described above is referred to as the warranted rate of growth in the literature.

By keeping the º (output-capital ratio) constant, from equation 1.7 above, one can see that $\Delta Y/Y$, or the annual rate of growth, is in fact a function of the proportion of income that has been saved. For purposes of exposition, assume that º = 1 and s = 0.50 then the annual growth in income would be 50 percent. This "warranted rate of growth" changes in proportion to the economy's marginal propensity to save. If the marginal propensity to save were to double, then the warranted growth rate would also have to double.

With a positive level of net investment, continued increases in potential aggregate capacity will occur over time. In order to fully utilize this additional capacity, it is necessary to continually increase aggregate expenditure. Also, if the equilibrium level of full employment saving increases at a constant rate over time, and if full employment saving is to be balanced by an equal amount of investment expenditure, there must be an increasing amount of investment forthcoming in every year. That is, in order to continually maintain production at full employment, aggregate demand must increase by larger and larger amounts over time so as to fully utilize the newly created potential output.

This growth process may be illustrated by making the assumption that the stock of capital is proportionate to the level of output which the economy is capable of producing. By following the original assumptions of no fiscal activity, no foreign trade, and proportional changes in consumption related to income, one can see that "these assumptions imply that equilibrium income occurs when planned savings equals planned investment"[5] and that the consumption function may be represented by C = bY, where b equals the marginal propensity to consume.

Net investment adds to an economy's productive capacity. The more net investment that occurs in a period, the larger will be the productive capacity of the economy in the next period. So with a stable consumption (saving) function, the level of investment will have to be increased over time in order to maintain aggregate demand at the new full employment (capacity) output. This is illustrated by Figure 1 on the next page.

Assume that the output \$100 represents the economy's full employment level of output in time period 1. Given these initial assumptions, consumption will be equal to \$50, and the level of saving will equal \$50. If all saving flows into investment (that is, planned saving equals planned investment), then the output level of \$100 will be maintained. Because of the new investment, the economy's potential output is increased in time period 2 to the output level \$150. If the economy is going to sustain this new output level, the amount of planned saving (\$75) must flow into new investment. If this happens, the potential capacity of the economy will again increase in time period 3 to $225.

If this process continues, then the economy's potential to produce will increase by increasing amounts over time. The amount of the increase depends upon the output-capital ratio, i.e. the relationship between the economy's productive capacity and its stock of real capital. An output-capital ratio of 1 means that one unit of capital produces one unit of output per period of time.

This process is shown in Table 1.

(1) Time Period	(2) Full-Employment Output	(3) Investment =Saving = Increase in Capital (APS = .50)	(4) Output-Capital Ratio = 1	(5) Increase in Potential Output (Col 3 x 4)
1	100	50	1.00	50
2	150	75	1.00	75
3	225	112.5	1.00	112.5

Table 1

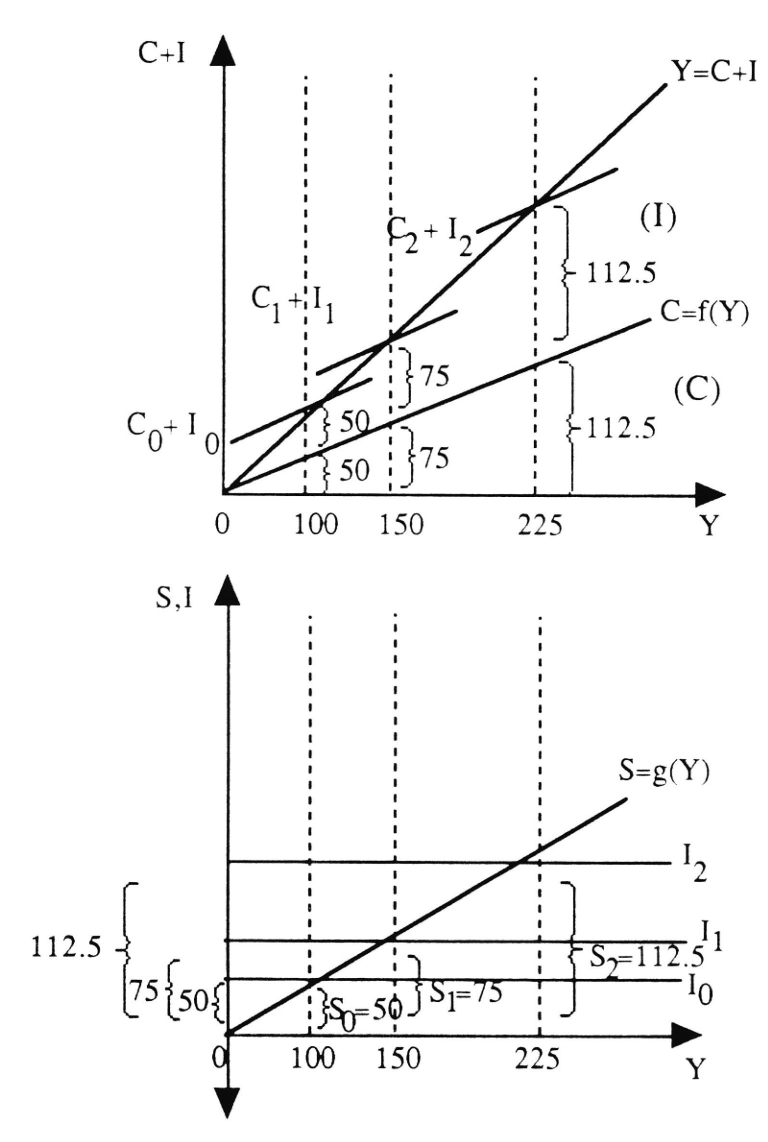

Figure 1

Column (2) shows the full employment level of output for each time period. Assuming an initial level of output of $100, column (3) shows that planned saving equals planned investment (or the increase in capital) along with the assumed average propensity to save of .50. Given that the output-capital ratio is equal to 1, the resulting increase in output will be equal to the increase in the stock of capital.

This addition to potential output is added to the additional output level in time period 2, etc. Given the long-run APS of .50 and the output-capital ratio of 1, we can calculate the rate of economic growth. The full employment growth rate is (.50)(1) = .50, or 50 percent per time period. Recall that the Harrod-Domar model is a simple model of economic growth based on a number of assumptions. Some of these assumptons are: fixed output-capital ratio, fixed average propensity to save, and the absence of such factors as government fiscal and monetary policies, changes in technology and business taxes.

The "warranted rate of growth" for an economy is not necessarily equal to its actual rate of growth in the Harrod-Domar model. This can be seen by understanding the implication put forth by the production function suggested by equation 1.1(Y=ºK). Because both labor and capital are required factors of production, one possible interpretation of the fixed output-capital ratio could be that capital and labor are perfectly complementary and are combined in fixed proportions.

From this we can deduce that there would be only one combination that would be appropriate to produce any one specific level of income. The L-shaped isoquants, shown in Figure 2 below, are characteristic of a production function that uses factors which are perfect complements. In this figure, we can see for example that three

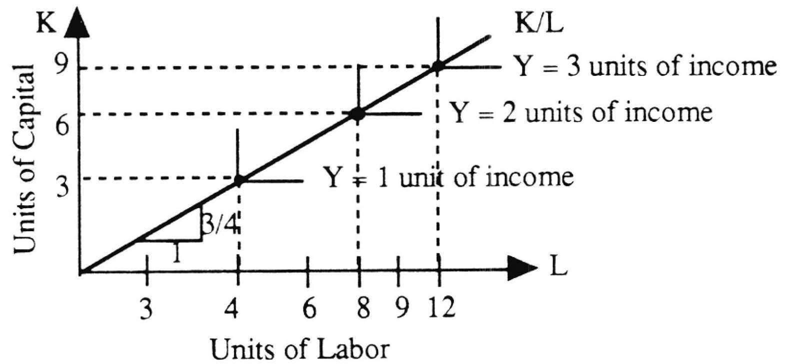

Figure 2: A Fixed Output-Capital Ratio Production Function

units of capital and four units of labor will be required to produce one unit of national income.

The required capital-labor ratio (K/L) for any given amount of output in this instance is 3/4. Because labor and capital are perfectly complementary, if labor increases as capital is held constant, there will be no increase in the level of national income; in effect labor becomes redundant. This will also hold true if capital is increased while holding labor constant. Capital then becomes the redundant factor. However, it can be seen from Figure 2 that if all inputs (both capital and labor) are increased at the same time and in the same proportions, national income will be increased by the same proportion. For example, if both labor and capital were doubled, national income would also double. This kind of production function exhibits constant returns to scale.

Because the aggregate production function in Figure 2 has L-shaped isoquants, it is evident that national income will only increase at the warranted rate when there is an excess supply of labor or when the labor force is growing at the same rate as net physical investment. Even if the capital stock is growing, there will not be an increase in the level of income if no excess labor is available to combine with capital.

This can be shown by the following example: assume that the stable output-capital ratio (º) is equal to 1 and the marginal propensity to save (s) is equal to 0.5. The "warranted rate of growth" (ºs) would then be equal to 50 percent per year. The actual rate of growth would also be 50 percent provided an excess amount of labor is available to be combined with capital in fixed proportions as is suggested by the L-shaped production isoquants. However, the 50 percent growth rate in income will not be maintained if the supply of labor does not continue to also increase at a rate of 50 percent per year (fixed input proportions requires this to be true).

The actual growth rate of an economy is constrained by the failure of the labor supply to keep pace with the increase in net physical investment. In fact, given the assumption about the form of the aggregate production function, the actual growth rate of the economy will be held to the amount of the growth rate of labor. For example, if the growth rate of labor were only 25 percent per year, the maximum change in national income could be no more than 25 percent per year. Because of this, unemployment of capital would result.

There is another source for increasing the growth rate of income if the change in the economy's labor supply is unable to keep pace with net physical investment. By employing labor-saving technological processes, fewer units of labor will be needed in order to produce a given quantity of output when combined with the same amount of capital as before. Labor-saving techniques can be viewed as imperfect substitutes for an increase in the growth rate of the labor supply. This labor-saving technology can be illustrated graphically and is shown in Figure 3 on the following page.[8]

By acknowledging labor-saving technological progress, the amount of labor needed for any given amount of capital will decrease, and the capital-labor ratio (K/L) will increase. This movement is shown in Figure 3 by a counterclockwise movement of the capital-labor ratio ray to (K/L)*.

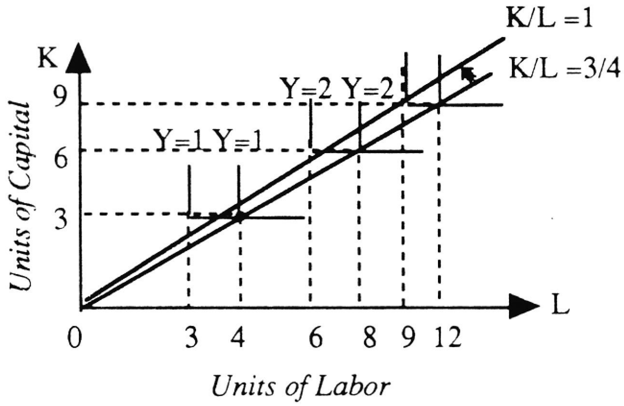

Figure 3: Labort Saving Technological Progress in a Harrod-Domar Model Production Function

Because the output-capital ratio is a stable constant, three units of capital will still produce one unit of income, but now will have to be combined with only three units of labor instead of four.

This "effective" growth rate of the labor force ($\Delta L/L$) can now be divided into two parts. This is shown in equation 1.8 below:

$$\Delta L/L = \Delta N/N + a \qquad (1.8)$$

where -N/N = the "actual" growth rate of the labor force

a = the growth even if the growth rate of the labor supply is unable to keep pace with net physical investment of labor-saving technology.

If one assumes that a labor-saving technological process increases the efficiency of the labor supply by 3 percent, this would have the same effect as a 3 percent increase in the labor supply. With this kind of increase in the efficiency of the labor supply (labor-saving technological process), the economy could still attain an effective growth rate of 28 percent rather than the 25 percent arrived at earlier even if the growth rate of the labor supply is unable to keep pace with net physical investment. The maximum "actual" growth rate of national income will be only 28 percent (25 percent assumed growth rate in the labor supply plus 3 percent increase in the efficiency of the labor supply) and not the "warranted" growth rate of 50 percent (which would exist if º = 1 and s = 0.50). The maximum "actual" growth rate of national income is what Harrod termed 'the natural rate of growt.'[9]

Because of the marginal propensity to save, the output-capital ratio, the growth rate of the labor force, and the rate of labor-saving technological progress are all determined independently from each other, there exists a very low probability that a Harrod-Domar economy would grow at an equilibrium or full employment rate. For example, if the natural rate (i.e. the actual growth rate) is greater than the warranted rate (capital stock fully employed), unemployment of labor would be present; or if the warranted rate is larger than the natural rate, there would be unemployment of capital. Because of this the Harrod-Domar model is often referred to as a "razor-edge" model.

The razor-edge character of the Harrod-Domar model has been criticized as too rigid by some economists. Too much emphasis is placed on the assumption of a fixed output-capital coefficient (productivity of capital). This assumption results in the razor-edge character of the model. The economy is locked into a very rigid and narrow equilibrium path.

A disequilibrium condition will result if there is the smallest change from initial equilibrium in any of the parameters contained in equation 1.8. There exists no inherent mechanism in the model to move the economy back on its equilibrium growth path.

At this juncture, I have detailed the Harrod-Domar long-run aggregate growth model. The model put forth by R.F. Harrod and Evsey Domar is an important contribution to the body of received economic theory. However, one area not touched upon in their model concerns the investment in human beings. In the next section, we turn to a discussion of the role of human capital in the growth process.

III. The Importance of Investing in Human Capital

Not until fairly recently has the important notion of investment in human capital come to the attention of the social and economic community.[10] In the 1950s, economists noted that "increases in national output had been large relative to the increase in land, man-hours, and physical reproducible capital. Investments in human beings is probably the major explanation for this difference."[11]

This theory of 'intangible resources' was prompted, in part, by the study performed by Solomon Fabricant, in *Basic Facts on Productivity Changes* ("National Bureau of Economic Research Occasional Papers," No. 63 [New York, 1959]).[12] Fabricant "presents estimates that show the output of the United States private domestic economy as having increased at an average annual rate of 3.5 per cent between 1889 and 1957, whereas total inputs increased at an annual rate of only 1.7 per cent. For the more recent part of this period, (between 1919 and 1957) these annual rates of increase were 3.1 and 1.0 percent respectively."[13] According to Edward F. Denison, "advances in knowledge and residuals" accounted for approximately 37 percent of the rate of growth (3.2 percent) in potential real national income during 1929 and 1982. For the shorter time span (1948-1973), Denison estimated that "advances in knowledge and residuals" accounted for approximately 43 percent of the growth rate (3.89 percent) in potential real national income.[14]

The residual difference between the rate of increase in inputs and the rate of increase in output over time has many indeterminable components. According to Schultz, "Economists have come upon numerous signs pointing to improvements in the quality of human resources as one of the major sources of economic growth."[15] One possible explanation would be the contribution made by the improvement of intangible inputs; investment in human beings appears to have played an important role in economic growth over the past five decades.

Keeping in mind that increases in dollar expenditures on education do not necessarily translate into better "quality" education, the following data may lend some qualified support to this notion: 1) "Public education expenditures rose to $19.3 billion in 1960 from $7.3 billion at the turn of the decade. 2) Priced at cost, gross investment in education in the United States has risen from 9 percent of gross physical investment in 1900 to 34 percent in 1956."[16]

From this one can see that investment in the future productivity of the United States has evolved over time from investment solely in tangible forms, such as plant and equipment, to include investment in intangibles; the prime examples being traditional college education and pre-professional and professional programs. This broader concept of investment, noted above, provides a more accurate source from which one can identify more correctly the actual determinants of growth in potential gross national product.

Before 1929, quantitative factors such as increases in the supplies of labor and capital accounted for about 67 percent of the economy's expansion. Qualitative factors (education, improved technology, etc.) accounted for the remaining one-third. After 1929, qualitative factors had a more important role in economic growth and quantitative factors played a less important role.

Investment in physical capital must be accompanied by investment in human capital if increased productivity is to accelerate economic expansion. It is no accident that the populations of developed countries have higher average levels of education and longer life spans than those of underdeveloped countries.

Investment in education provides society with knowledge of available resources, possible production methods, financial and industrial skills, as well as other techniques which contribute to economic growth. Professor Theodore W. Schultz in his paper "Reflections on Investments in Man" conveys this need for investment in education in the following way:

> Suppose there were an economy with the land and the physical reproducible capital including the available techniques of production that we now possess in the United States, but which attempted to function under the following restraints: there would be no person available who had any on-the-job experience, none who had any schooling, no one who had any information about the economy except of his locality, each individual would be bound to his locality, and the average life span of people would be only forty years. Surely production would fall catastrophically. It is certain that there would be both low output and extraordinary rigidity of economic organization until the capabilities of the people were raised markedly by investing in them.[17]

Economies that fail to increase investments in education may suffer a severe constraint to economic progress. These constraints are manifest in many forms such as "low labor efficiency, factor immobility, limited specialization in occupations and in trade, a deficient supply of entrepreneurship, and customary values and traditional social institutions that minimize the incentives for economic change."[18]

Investment in education can be seen to have a dual character: a consumption side and an investment side. The consumption side is manifest through the enjoyment education enables one to have by being able to lead a fuller life. The investment side is demonstrated through the gains accruing to the educated person in the form of higher wages and earnings and increased real output for society. Investment in education also increases the foundation of knowledge, piloting the advancement of productivity and the improvement of health for society as a whole.

There are also the external benefits or spillovers associated with education that affect those other than the educated person. The children of the educated person may profit through a better informal education in the home, and the surrounding community benefits by having an educational system that instills proper principles and morals in its students which may promote better citizenship.

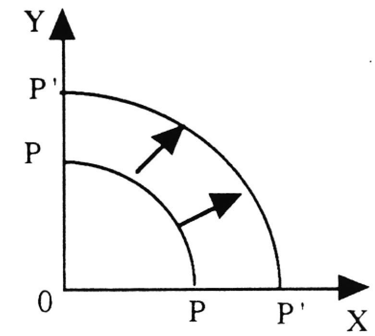

Figure 4

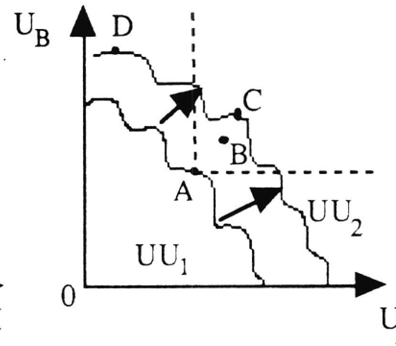

Figure 5

Actually, a benefit from education can refer to anything which pushes both the production possibilities curve and utility possibilities curve outward for society. Such benefits may be a result of increased productivity, through increases in technological know-how, and increased labor efficiency. According to Paul A. Samuelson, "A uniform shift in the production-possibilities function must certainly shift the utility-possibility function outward. The converse is not true. An outward shift in the utility-possibility function may have occurred as the result of a twist of the production-possibility curve."[19] This relationship is shown in figures 4 and 5 above:[20]

Some observations regarding Figure 5

follow: Any point on the utility possibilities function is Pareto Optimal (efficient), in the sense that one person cannot be made better off without the other being made worse off. A movement from point A to point B would be Pareto Superior (improvement). A movement from D to C (a movement along the new utility possibilities function) would be Pareto Noncomparable, because both points are Pareto Optimal. However, a movement from point A (on UU1) to point D (on UU2) would be Pareto Noncomparable because person B would be better off while person A is left worse off. One policy implication is that economic growth *per se* need not make everyone better off. Some individuals may be worse off. However, further discussion of the "normative" aspects of the growth process is outside the realm of this paper.

On-the-job training may be as important historically as formal education in contributing to economic growth. According to Jacob Mincer, "Measured in terms of cost, on-the-job training is as important as formal education for the male labor force and amounts to more than half of total (male and female) expenditures on school education. Aggregate and per capita investments in on-the-job training have been increasing since 1939, though at a slower rate than investments in formal education."[21]

The productive skills of many workers are increased by learning new techniques and mastering old ones while on the job. An apprentice, for example, will learn new skills while the lawyer perfects ones already learned in law school. The process of on-the-job training differs only slightly from its educational counterpart of specialized institutions in that it most likely will be less expensive and less time-consuming; the main cost incurred will be the time expended teaching the skill, along with the equipment and materials used. In short, a dollar invested in on-the-job training may yield a more rapid payoff to society in terms of increased output than a dollar spent on the more traditional liberal arts education. The payoff to a society of a more traditional (college) education, though probably more important, overall, may be further out in the future.

IV. Critique of the Harrod-Domar Aggregate Growth Model

In the previous four decades, the aggregate economic growth models most widely accepted have rarely taken into account the concept of investment in human capital. The Harrod-Domar aggregate growth model is no exception to this trend.

Basically, it is a model of long-run economic growth, the stock of capital is not fixed; net investment is positive. At best, the concept of equilibrium has meaning for only a short period of time due to the capacity-creating effects of net investment: potential or full employment gross national product will grow over time. In addition, the model is basically Keynesian. However, as stated above, it is long-run oriented rather than short-run. Given the increase in potential gross national product over time, output must grow in order to guarantee that the additional capacity will be fully utilized. In other words, aggregate (expenditure) demand must continue to increase over time.

The model suggests that investment must grow at an annual rate equal to the product of the average productivity of investment and the marginal propensity to save so that full employment will be reached over time. It assumes that the marginal and average propensities to save are equal and that the marginal and average values of the output-capital ratio are also equal.

In order to maintain full employment over time, Domar states "that it is not sufficient, in Keynesian terms, that savings of yesterday be invested today, or, as it is so often expressed, that investment offset saving. Investment of today must always exceed savings of yesterday... The economy must continually expand."[22]

Constant values for the marginal propensity to save and the productivity of investment coefficient (Y/K) are taken as given in the growth model. One would obtain different results by assuming different values of s and º. For example, investment would not have to increase continually over time if the long-run propensity to save would fall (an angular rotation downward in the saving function, as shown in Figure 6. In Figure 1, the same result can be demonstrated by an upward rotation in the consumption function).[23] Also, a fall in the productivity of capital would imply that the influence on capacity

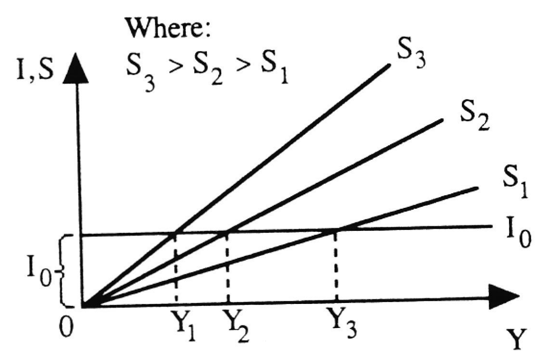

Figure 6

for any particular amount of new investment would be smaller. Income (aggregate demand) would not have to grow as rapidly to absorb the additional capacity.

Moreover, the model demonstrates some practical drawbacks as an applied policy tool. First, determining the proper rate of income growth, requires knowledge of what the values of s (marginal propensity to save) and ♀ (output-capital coefficient) actually are. Secondly, the output-capital coefficient is an average value for the entire economy. This value will more than likely vary from industry to industry. Finally, the model does not distinguish between the growth rate necessary to fully employ the labor force and the growth rate needed to fully employ the economy's capital stock. The growth rate which would ensure full employment of capital may not ensure full employment of labor and vice versa.

Further, if the notion of investment in human capital is included in our discussion of the Harrod-Domar model, then the conclusions that flow from the original model can be modified. The introduction of human capital as an additional input in the aggregate production function would allow us to drop the assumption that capital and labor are always combined in fixed proportions. If one allows that physical capital and human capital are substitutable (they can be combined in different proportions), then it would not follow that the growth rate of an economy can be explained only in terms of the output-capital coefficient and the average propensity to save.

If one postulates a variable proportions aggregate production function, then an adequate explanation of the growth rate would be one that must explicitly include human capital in the analysis. When one allows for the possibility of variable proportions, one departs from the rigid assumptions of the Harrod-Domar model.

The model would now reflect more of a neoclassical growth model which acknowledges substitutability between factors of production. Instead of having a production function which produces a single production process (fixed input proportions), we now have a larger number of production processes; that is different combinations of human capital and physical capital are possible.

With a production process capable of varying the combination of human and physical capital employed, it follows that instead of the fixed relationship between physical capital and the output level presented in the Harrod-Domar model, the output-capital ratio would also be capable of changing. It would no longer be rigidly fixed.

For example, the larger the amount of human capital that is combined with a given stock of physical capital, the larger the output-physical capital ratio (or the productivity of physical capital) will be and the smaller will be the output-human capital ratio or the productivity of human capital. The converse of the above argument is also true becuase the results flow from the notion of diminishing marginal productivity. The introduction of human capital into the model takes some of the "edge" off of the "razor."

Theodore Schultz states that "a concept that is restricted to structures, producer equipment and inventories (the omission of expenditures on research is also serious) may unwittingly direct attention to issues that are not central or critical in understanding economic growth over long periods."[24] A further quote from the same author points out the importance of human capital in the long-run growth process:

Empirical research has revealed a basic contradiction that face economists. The observed growth rate of output has been considerably greater than the rate of increase in the main resources that produce the output. The most reasonable explanation for this apparent contradiction is that the economist's estimates of the real stock of capital and labor hours worked failed to include many of the improvements made in the quality of these resources, especially improvements in the quality of human inputs.[25]

V. Conclusion

The growth model discussed here and developed by R.F. Harrod and Evsey D. Domar seems appropriate given its assumptions. Harrod-Domar's analysis, even with limitations, has pointed out the capacity-creating effects of net investment. Thus, one can better understand why an economy must continue to grow if full employment is to be maintained over time and that the growth rate necessary to generate a fully employed economy is not automatically guaranteed.

However, by not dealing directly with the importance of investment in human capital, the Harrod-Domar theory does fall short in terms of a fuller understanding of the growth process. The attention being given to investment in human capital is still evolving.

There are still many questions that should be asked and others that remain unanswered concerning the contribution of human capital to the general growth process.

Five questions that merit further investigation are: 1) The problem of measurement; is it possible to separate the consumption and investment components of human capital investments, both formal education and on-the-job training? 2) How does a nation determine the correct composition between the investment in tangible goods and investment in intangible goods (i.e. education)? 3) At what point in a country's development does the formation of physical capital become less important than the development of human capital or vice-versa? 4) How does a country determine the appropriate long-run mix of physical and human capital needed for continuous growth? and 5) what are the "normative" implications of economic growth? These questions and others have to be addressed in order to firmly establish criteria for investing in human capital.

Notes

(1) Domar, Evsey D. "Expansion and Employment," *The American Economic Review*. (Evanston, Illinois, The American Economic Association), 1947. pp.34-55.

(2) Harrod R. F. "An Essay in Dynamic Theory," *The Economic Journal*. (London, Macmillan and Co.), 1939. pp. 14-33.

(3) *Ibid.*, (1)(2).

(4) The output-capital ratio is defined as the annual ratio of the value of output produced to the value of the capital which produces the output (Y/K). It emphasizes investment in what economists call capital widening, (i.e. increases in an economy's stock of capital so as to maintain the capital to labor ratio constant over time).

(5) Thomas F. Durnberg and Duncan M. McDougall, *Macro Economics*, 6th ed. (New York: McGraw-Hill Co.), 1980, p. 253.

(6) *Ibid.*, p. 254.

(7) Glahe, Fred R. *Macro Economics*. 3 ed. (New York, Harcourt Brace Jovanovich, Inc.), 1985. pp. 441.

(8) *Ibid.*, p. 442.

(9) Harrod R. F. "An Essay in Dynamic Theory," *The Economic Journal*. (London, Macmillan and Co.), 1939. pp. 17.

(10) Investment in human beings can be thought of as the present value of the flow of income from future labor services.

(11) Gerald M. Meier, *Leading Issues in*

(11) Gerald M. Meier, *Leading Issues in Economic Development.* (New York: Oxford University Press), 1984, p. 641.

(12) Theodore W. Schultz, "Capital Formation by Education," *Journal of Political Economy.* (Chicago: University of Chicago Press), October 1962. p. 571, footnote #2.

(13) *Ibid.*, p. 571.

(14) Edward F. Denison, *Trends in American Economic Growth 1929-1982.* (Washington D.C.: The Brookings Institute), 1985, p. 112.

(15) Theodore W. Schultz, "Reflections on Investment in Man," *Journal of Political Economy.* (Chicago: University of Chicago Press), October 1962., p. 3.

(16)Burton A. Weisbrod, "Education and Investment in Human Capital," *Journal of Political Economy.* (Chicago: University of Chicago), October 1962, p. 106.

(17) Theodore W. Schultz, "Reflections on Investment in Man," *Journal of Political Economy.* (Chicago: University of Chicago Press), October 1962. p. 2-3.

(18) Gerald M. Meier, *Leading Issues in Economic Development.* (New York: Oxford University Press), 1984, p. 610.

(19) P.A. Samuelson, "Evaluation of Real Income," *Oxford Economic Papers.* (London: Oxford University Press), 1950, p. 17.

(20) See, for example, E.J. Mishan, *Introduction to Normative Economics*, (London: Oxford University Press), 1981 Chapter 16 for a derivation of the utility possibilities frontier for the two good-two person case. As the production possibilities curve shifts outward, in a uniform fashion (as shown in figure 4), the various Edgeworth exchange boxes associated with different points on the new production possibilities curve will increase in size, thus pushing points on the utility possibilities frontier outward, e.g. from UU1 to UU2.

(21) Jacob Mincer, "On-the-Job Training: Costs, Returns, and Implications," *Journal of Political Economy.* (Chicago: University of Chicago Press), October 1962, p. 73.

(22) Domar, Evsey D. "Expansion and Employment," *The American Economic Review.* (Evanston, Illinois, The American Economic Association), 1947, p. 42.

(23)Sabella, Edward M., Intermediate Macro-Economics Class Notes, 9/87-12/87. Augsburg College, Minneapolis, Minnesota.

(24) Theodore W. Schultz, "Reflections on Investments in Man," *Journal of Political Economy.* (Chicago: University of Chicago Press), October 1962, p. 5-6.

(25) *Ibid.*, p. 3.

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