# A Post-Keynesian Criticism of the Solow Growth Model

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Abstract—Solow builds his model based on a continuous production function in the absence of an investment function with a tendency for capital-labour ratio to adjust itself through time in the direction of equilibrium ratio as an alternative to the Harrod-Domar line of thought without its crucial assumption of fixed proportions in production. The problem of the Solow model related to invested function is solved by changes in income distribution between wages and profits in Kaldor model which allows it to disappear the Harrod-Domar instability issue. However, Solow still leaves out to provide a role for prices in adjusting output to changes in demand. As Nell pointed out, the shift from Craft to Mass Production in the post-war era leads to new policy requirements; employment is more flexible than prices and if there is a deficiency in demand due to low investment or wages, unemployment can be reduced by increasing investment or wages.

*Index Terms*—Solow model, harrod-domar, neoclassical, production function .

## I. INTRODUCTION

Solow, a pioneer in constructing the basic neoclassical model, demonstrated why the Harrod-Domar model was not an attractive place to start and argues that in the Harrod-Domar model, capital-output ratio is rigidly determined by a fixed-coefficients production function. Solow set out an aggregative, competitive general equilibrium perfect foresight growth model built around a constant returns to scale, production function with diminishing returns to capital and labor, a labor supply function in which labor grows exogenously and capital accumulation equation with constant rate of savings. Although Solow growth model is a theory of transition dynamics rather than a theory of longrun growth, the model assumes that technical change such as productivity growth is the key to long-run growth of percapita income and output. In the Solow model, savings equals investment and investment is a constant fraction of output which means we re-state the equation for changes in the stock of capital.

$$I_t = sY_t \tag{1}$$

$$\frac{dK_t}{dt} = sY_t - \delta K_t \tag{2}$$

In Solow growth model, exogenous growth in a steady state which depends on the given rates of growth of the labor force and total productivity, the assumption of perfect

Manuscript received November 11, 2016; revised March 1, 2017.

competition, constant returns to scale and saving-driven growth make it possible to have stable path of steady growth. Moreover, factor prices are determined by the corresponding marginal productivities of capital and labor; in turn, factor shares are determined by capital output ratios and marginal productivities. Saving is independent of the distribution of income with a constant propensity; so, income distribution does not directly affect economic growth [1]. The main conclusion of the Solow growth model is that the accumulation of physical capital cannot account for either the vast growth over time in output per person and accumulation of capital creates growth in the long-run only to the extent that it embodies improved technology [2].

#### II. CRITICISM OF THE SOLOW GROWTH MODEL

Neoclassical growth theory was sharply criticized by the Post-Keynesian approach, building on works on capital accumulation and income distribution by Joan Robinson and Nicholas Kaldor, both published in 1956 [3]. The main difference between the Solow growth model and Post-Keynesian approach is the Harrod-Domar model, mainly due to the instability of growth process in an economy with fixed technical coefficients in production and a constant saving ratio. They argue that since capital goods are heterogenous, there is no physical measure of aggregate capital that is independent of prices income distribution.

The standard Neo-Classicial growth model, based on Solow, fails to provide a role for prices in adjusting output to changes in demand and aggregate demand plays no role. For instance, labor market flexibility<sup>1</sup> can be accepted as the speed with which the labor market adjusts to shocks, which can lead to market disequilibrium. In other words, in a flexible labor market, workers and employers are in a process which conditions and workforce can fluctuate with the least possible interference [4]. Moreover, Solow assumed diminishing returns and the marginal productivity conditions will be met even in the absence of price flexibility. According to marginal productivity theory, the real wage is a scarcity price, so as more labor is employed, its marginal product falls and marginal cost will rise. But in general, marginal costs do not rise, they are either constant or falling. Here, the other problem is relating with involuntary unemployment. According to scarcity approach, if employed labor is getting paid, there cannot be any involuntary unemployment. If labor is unemployed, it is not scarce. But factor prices reflect relative scarcity; if labor is

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<sup>&</sup>lt;sup>1</sup>Labor market flexibility is defined as the speed with which the labor market can adjust in response to economic shocks and a flexible labor market also can be seen as one that exhibits a good equilibrium such as low structural unemployment rate and some institutional features that influence wage settings and supply and demand in the labor [5].

not scarce, its real wage should be zero, and since the real wage is not zero, labor must be scarce, and so there cannot be any involuntary unemployment.

For instance, according to Solow, a perfect flexible market would be one that interposes no obstacle to the frictionless matching of an unfilled job and an unemployed worker with the appropriate skills [6]. That is, government interventions and any other fiscal policies employed to enhance labor market flexibility such as unemployment compensations and protection policies may lead to rigidities that adversely affect the labor market ability to adjust trade and technology shocks [7]. Where flexibility is limited, the labor market may fall to adjust completely and so, would have less ability to changing economic conditions. When we look at the Beveridge curve analysis, as can be seen in Figure 1, the scatter plot of unemployment rates versus vacancy rates which is also seen as an indicator to market flexibility by Solow, can reveal essential information about labor market flexibility and the current state of the labor market due to cyclical structural changes in an economy [6]. Solow indicates that the Beveridge curve would coincide with the axes of the diagram; there could be vacancies with no unemployment or there could be unemployment with no vacancies and so, the more rigidities there are, the further the Beveridge curve diverges from the limiting case [6]. But Bleakly and Fuhrer [8] argued that the Beveridge curve is not a structural economic relationship because workers and firms do not consciously decide to make unemployment negatively related to vacancies; moreover, their decisions about setting wages and hiring workers result indirectly in the patterns of unemployment and vacancies.





Fig. 1. Beveridge curve.

Second, and most importantly, there is no price mechanism in Solow model: savings is assumed to drive investment and the equilibrium is determined by the changes in the capital/labor ratio brought about by saving [9]. The problem of the Solow model is the absence of an investment function which allows it to disappear the problems based on the Harrod-Domar instability. However, Solow reaffirmed the ability of the neoclassical growth model after Kaldor [5] put forward his famous "stylized facts" of long-run growth, which made it possible to have an independent investment function at full employment, as opposed to the sharp instability results of the Harrod-Domar model [10]. The stylized facts identified by Kaldor are:

- 1) Y/L (output per worker) exhibits continual growth.
- 2) K/L grows over time.

- 3) R (real interest rate) is roughly constant.
- 4) *K*/*Y* roughly constant over time.
- 5) rK/Y, wL/Y factor shares are roughly constant.
- 6) There are wide differences in the rate of growth of productivity across countries.

What makes the growth "investment driven" is the forced saving mechanism, an increase in the quantity of money that conduce to bidding of prices, dropped marginal productivity conditions and changes in the profit rate that lead to the desired changes in savings. Moreover, the existence of the inverse relationship between income distribution to labor and growth leads to redistribution of income from high saving tendency households to low saving tendency households.

Although Kaldor's model provides an answer to Harrod-Domar model's long-run problem of making the warranted rate of growth and "forced saving" mechanism, enters in the picture when the economy reaches its potential growth rate, lead to price increases through credit inflation which in turn change the distribution of incomes in favour of saving classes, Nell [11] pointed out that the process can not continue for too long, for with investment rising and consumption falling; furthermore, the monetary system may support prices for too long which may lead to an overshooting process. This is mainly due to the post-war mass production characteristics of economies in which prices do not play an important role in adjustment involves changes in demand and the positive relationship between the real wage and employment. In the modern economies, technological changes and market forces are often destabilizing which means that there is no process of gravitation. According to Nell, neither the behaviour of markets nor technological development can be foreseen with any clarity; and because of this, it is impossible to claim that there will be a reliable tendency for investment to push the economy towards any particular position. However, in the era of craft economies, it was possible because technological changes were irregular and market forces were stabilizing.

As Nell pointed out, in the Craft Economy, long-run prices are independent of demand; moreover they depend on technological coefficients and on the level of real wages and degree of competition. Furthermore, in craft economy, both prices and money wages were flexible. And in response to variations in demand, they both rose and fell, although prices were markedly more flexible in both directions than wages. Nell's model is based on aggregate function, the real wage is equal to the marginal product of labor in general. And the real wages are influenced by the level of employment in relation to full employment.

$$Y = Y(N, K^*) \tag{3}$$

$$w/\pi = \delta Y/\delta N = Y'(N) \tag{4}$$

 $C = (w/\pi)N \tag{5}$ 

- I = I(I,C), Ii < 0, LC > 0 (6)
- $M/\pi = L(i,Y), Li < 0, LY > 0$  (7)

$$Y = C + I \tag{8}$$

$$Y = (w/\pi)N + P \tag{9}$$

$$w = w - w^* = F(N - N^*)$$
 (10)

where Y, C, I and P are output, consumption, investment and profits, in real terms. N is employment. M, w, and  $\pi$  are money, money wages and the price level, all in money terms. The rate of interest is I. In Craft Economy both prices and money wages were flexible. And in response to variations in demand they both rose and fell, although prices were markedly more flexible in both directions than wages. Longrun prices are set at the same time with investment decisions, but short-run prices reflect current market conditions, the balance of current supply and demand. The real wage could be negatively related to the employment due to the assumption which assumes that industry is normally working subject to decreasing returns. The prices will be equal or proportional to marginal cost, which would imply a corresponding relationship between the real wage and the marginal product of labor. And the Craft Economy is represented by a curved line that rises from the origin with a diminishing slope, as shown in Figure 2. Aggregate demand is the line C+I, rising to the right from the point I on the vertical axis; its slope is the wage rate. Investment is unusually low, below normal, so that this line cuts the utilization function at a point below the normal level of output and employment. Since it is difficult to adjust employment and output, there will tend to be overproduction, and prices will fall. Since it is even harder to adjust employment than output, prices will fall more readily than money wages. Hence the real wage will rise. As a result the C+I line will swing upwards, until it is tangent to the utilization function. Notice that this point of tangency will tend to be close to the normal level of employment and output, and will be closer the more concave the function. In short, when investment is abnormally low, consumption will increase. So when the marginal productivity of labor was reduced, the only way to expand employment and output was reducing real wages. Therefore, in a Craft Economy lower demand was not provoked by the reduction of real wages, the final result was the opposite just as the neoclassical approach argues [11].

However, in the Mass Production, prices are set in the course of planning investment and are independent of the level of current demand; however, they are dependent of the growth of demand. Prices have to be set to cover the costs of the investment necessary to construct the capacity for the new demand. The balance of current supply and demand has little, sometimes not, impact on prices. Prices tend to stay near the benchmark levels [11].



Fig. 2. Adjustment in the craft economy [7].

Nell suggests that in the Mass Production, the economy is characterized by a straight line rising from the origin, showing constant marginal returns, as shown in Figure 3. This makes consumption can be identified with wages and salaries, while investment can be taken as exogenous in the short run; therefore, as employment rises, the wage bill and consumption spending also will rise at a constant rate. The wage bill is represented by a straight line rising to the right from the origin and its angle is naturally the wage rate. Aggregate demand will then be the line C+I and its slope will be the wage rate. It is obvious from the graph that employment will depend on effective demand and there is no marginal productivity. In other words, the growth of demand will not be constrained by the growth of supply and cannot be derived from supply-side valuations. A demandside account is required to establish equilibrium for prices in which the growth of demand equals the growth of supply [11].



Fig. 3. Adjustment in the mass production [7].

In the Neoclassical labor market, wages are flexible; however, prices are more flexible than wages. So, if there are fluctuations in demand, this will be met by slowing down production rather than employment. So, if there is unemployment, money wages will fall with proportional decrease in the rate of unemployment. With lower demand, the prices will have to fall further. This leads to a balance between wage bill and the lower demand. Nevertheless, Nell shows that higher levels of employment and output were associated with lower real wages statistically. For instance, in 20th century, decrease in real wage lead to an increase in employment level. These results are not consistent with neoclassical approach of growth theory.

## III. CONCLUSION

Solow's model argued that technological change was to make capital and labor more productive and variations in relative prices, factor substitution lead to economy to a full employment steady state growth path and investment equals to savings, no problem of effective demand arises in the model; however, Kaldor was critical of the use of neoclassical aggregate production function and steady-state growth of productivity. He put forward his alternative approach based on a dynamic production relationship, relating the growth of productivity to the growth of the capital-labour ratio. Consequently, both Solow and Kaldor assume that a supply-side account determines the adjustment. However, as Nell pointed although forced saving mechanism, price adjustment, work out in a craft based economy, it does not work in mass production economy because employment in such an economy will depend only on effective demand; there is no marginal productivity adjustment. If there is a deficiency in demand due to the low investment or wages, unemployment can be reduced by increasing investment or wages and this result can be observed from the most empirical studies of the post-war era, in which real wages and employment are positively related. As a consequence, the neoclassical argument that the growth of supply will generate an equivalent growth of demand cannot be considered as a plausible mechanism.

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