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# **A Macrodynamic Model for a Monetary Production Economy: beyond short-period equilibrium of Keynes's General Theory**

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# **A Macrodynamic Model for a Monetary Production Economy: beyond short-period equilibrium of Keynes's General Theory**

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**Abstract:** This article presents a dynamic model for determining the level of output, employment, capital stock, real wage, investment, marginal capital efficiency and the capital-output/capacity utilization relationship. Thus, initially, the article develops the short-period solution of the model, in which the capital stock is kept constant. In short-period equilibrium, the endogenous variables are the level of production, the level of employment, the real wage rate, and the general price level. In short-period equilibrium there is no mechanism that can ensure that all workers who wish to work at market wages will be able to find employment. Subsequently, the model is extended to consider the effects of the investment made in each short-period on the capital stock of the subsequent period and, therefore, on the initial conditions of the subsequent short-period. After presenting the structure of the extended model, it is calculated its steady-state solution. It is shown that both employment and capacity utilization are below the full employment levels in the steady state. Finally, a new extension of the model is presented in which monetary wages are not constant, but react to prevailing conditions in the labour market, being flexible. It will be shown that wage flexibility is incapable of creating a convergence to an equilibrium position with full employment because of the negligible effect such flexibility has on firms planned investment.

**Key-Words:** John Maynard Keynes, General Theory, Monetary Production Economies, Macroeconomic Dynamics.

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## 1. Introduction.

Few months before the publication of the *General Theory of Employment, Interest and Money* (GT, hereafter, Keynes wrote a letter to Bernard Shaw where he told that “I believe myself to be writing a book on economic theory which will largely revolutionize – not, I suppose, at once but in the course of the next ten years – the way the world thinks about economic problems” (CWJMK, Vol XIII, p. 492). After 90 years of the publication of the GT, we must ask what this revolution on economic thought was about? In the period between the transition from the *Treatise on Money* (TM, hereafter) to GT, Keynes realized that there is a fundamental flaw in traditional economic theory, both classical or marginalist economics, the idea that the fundamental theorems about the behaviour of both agents and economic system can be explained without any reference to monetary factors. In the summer of 1932 after a manifesto written by Richard Kahn, Joan and Austin Robinson with many criticisms to the course of lectures on “The pure theory of money” given by Keynes on the spring of that year (Pasinetti, 2007, p.10), Keynes decided to resume his lectures and change the title for “The Monetary Theory of Production”, saying to many eyewitnesses that the change of name meant a “change in attitude” (Ibid, p. 11).

From 1933 to 1936 Keynes was working in a new vision of economics in which “money plays a part of its own” and “affects motives and decisions”, In his words:

"In my opinion the main reason why the problems of crisis are not solved, or at least why this theory is so unsatisfactory, is to be found in the lack of what might be termed a *monetary theory of production* [...] What I would like to deal with is to deal [...] with an economy in which money plays a role of its own and affects motives and decisions and is, in short, one of the operational factors of the situation, so that the course of events cannot be predicted, either in the long period or in the short term, without a knowledge of the behavior of money between the first state and the last. And this is what we must mean when we speak of monetary economy" (CWJMK, Vol. XIII, pp.408-409).

Such a framework should be able to explain a fundamental feature of capitalist economies which is the long-term trend of underutilization of labour and productive resources. In Keynes words:

"(...) It is a striking feature of the economic system in which we live that, although it is subject to serious fluctuations in production and employment, it is not violently unstable. Indeed, it seems capable of remaining in a chronic condition of subnormal activity for a considerable period, without any market tendency towards recovery or complete collapse" (Keynes, 1936, p.249).

Ninety years after the GT was published, how succeed Keynes was in achieving his revolution in economic theory remains an unresolved question. For a hard-core Keynesian economist like Pasinetti (2007), the “revolution in economics” was yet to be accomplished. For mainstream economists as Hicks (1937), Pigou (1943), Modigliani (1944) and Patinkin (1948) there was never any revolution in economic thought, Keynes GT just analysed the implications of some imperfections in labour market – as wage rigidity – or of a some extreme situation like the liquidity trap over the efficiency of self-regulating mechanisms of a market economy. The “classical” and the “Keynesian” models were combined in a more general model, the IS/LM model that was used as the main model for teaching economics in all over the world for more than 40 years after the publication of GT.

Much ink and paper had been used since the mid 1970's to argue that Keynes made a theoretical revolution with his GT, Davidson (1978) and Minsky (1975) being the seminal works that started the literature on the “Economics of Keynes” or “Post-Keynesian Economics”. After Fernando Carvalho 1992 book the principles of a *monetary production economy* had been well stablished and understood, and a lot of theoretical and empirical work had been done to translate Keynes “vision” of a monetary economy in “economic analysis”. But up to now little or no effort had been done to check if the model that Keynes presented in his GT could deliver the results that was expected, mainly the explanation of a “chronic condition of subnormal activity for a considerable period, without any market tendency towards recovery or complete collapse”.

According to the *Principle of Effective Demand*, the equilibrium level of employment is determined in the point where the expected proceeds of a certain level of employment is equal to the supply price of this employment level. In a short-period equilibrium expected proceeds must be equal to realized proceeds, so there no expectation disappointment. But the short period is a very short time span in chronological time, since it encompasses the period between the decision of entrepreneurs of hire workers and buy intermediate goods and the moment in which the finished goods are sold in the

market. A revolution in economic thought clearly demands a model that is capable to analyse beyond any short period, to look the dynamics of the economic through a succession of short periods to determine the long run trend of output and employment. This clearly demands a model that takes in consideration the effect of investment decisions over the stock of capital and how the dynamics of the stock of capital affects the inducement to invest. The pieces for building such a model were presented in Keynes GT but are never assembled in a consistent dynamic macroeconomic model.

Throughout this article we will gather all these in a mathematical model capable of determining the dynamics over *historical time* of the level of income and employment, as well as the evolution of the capital stock and its impact on the marginal efficiency of capital and the incentive to investment in subsequent periods. In other words, *the model presented here will go beyond the analysis of the conditions for determining the short-period equilibrium position* and will seek to evaluate how the equilibrium values of a given short period affect the initial conditions of the subsequent short-period and how this interferes with the equilibrium values of the next short period. Thus, instead of focusing our attention on analysing the determination of the level of economic activity at a given point in time, we will analyse how this level of activity moves over a *sequence of short periods*.

In this context, we will be particularly interested in two issues. First, if the economy tends to converge to some long-term resting position, that is, if the values of endogenous variables converge to a vector in which they are constant over time. If so, what is the nature of this position of equilibrium? We will assess whether the resting position to which the economy eventually converges in the long run is an equilibrium position with involuntary unemployment of the labour force.

Secondly, what are the possible self-feeding effects between endogenous variables and model parameters? We are interested in analysing what are the possible effects between involuntary unemployment and the nominal wages, which we consider to be given at the beginning of each short period. An extensive literature developed in the period after the publication of Keynes' General Theory, according to which equilibrium with unemployment would be the result of the hypothesis of rigidity of nominal wages (Pigou, 1943; Modigliani, 1944; Patinkin, 1948). The curious fact about this literature is that it apparently ignores chapter 19 of the General Theory where Keynes, having once presented his static model of determining the level of short-term employment in the

previous chapter, analyses the repercussions of unemployment on nominal wages. In chapter 19, Keynes rejects the idea that nominal wage flexibility can eliminate involuntary unemployment, on the contrary, Keynes concludes that wage flexibility can put the economy into a deflationary spiral that will increase, rather than reduce, involuntary unemployment (Oreiro, 1997). This issue will also be dealt with in this article.

## 2. The Structure of Model Equations in the Short-Period.

We will consider a closed economy without governmental activities that produces a homogeneous good, which can be used for both consumption and investment. The population and the workforce are constant. The capital stock is given in the short-period but will increase over time based on the net investment made in each short-period. Production technology is described by a Cobb-Douglas type production function<sup>1</sup> with constant returns to scale, so that the amount of goods and services that can be produced in each short period is given by:

$$Y_t = K_t^\alpha N_t^{1-\alpha} \quad (1)$$

As discussed in Oreiro (2025, chapter 2), the market structure is perfect competition, so the first principle of the classical theory applies, i.e., the real wage is equal to the marginal productivity of labour. Under these conditions the coefficient of the factor of production labour in equation (1) will be equal to the share of wages in the national income, while the coefficient of capital will be equal to the share of profits. In this context, income distribution is exogenous to the process of determining the level of income and employment, being determined by factors related to technology.

If entrepreneurs formulate correct expectations about the point of effective demand, then the short-period equilibrium income level will be given by:

$$Y_t = \frac{I_t}{1 - c_w \omega} = \frac{I_t}{1 - c_w(1 - \alpha)} \quad (2)$$

Where  $\omega = (1 - \alpha)$  it is the share of wages in income.

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<sup>1</sup> This assumption can be seen as problematic since the Capital Controversy in the 1950's between Cambridge (UK) and Cambridge (Massachusetts) is well know the impossibility of building a aggregate production function based on the principle of substitution between labour and capital and on the decreasing marginal productivity of production factors. In this chapter, however, we decided to employ the same technological assumptions of the neoclassical models to avoid the criticism that "Keynesian results" depends on the assumption of perfect complementarity between labour and capital, as Solow (1956) against the so-called Harrod-Domar model. As it will be show in this chapter the substitutivity between labour and capital, allowed by a neoclassical production function, reinforces, rather than weaken, the equilibrium with unemployment in a sequence of short-period equilibrium.

According to Asimakopulos (1991, p. 77) it is necessary to distinguish between planned and realized investment. Following Oreiro (2025, chapter 3) we will suppose that investment made in the current short-period corresponds to a weighted average between the planned investment in the two previous short-periods, that is:

$$I_t = \theta I_{t-1}^P + (1 - \theta) I_{t-2}^P \quad (3)$$

Due to the *irreversibility of time*, decisions made in previous periods are a given from the point of view of the current period. Thus, the investment made in the current short period is taken as given, determined by decisions that were made in past periods.

Within each short period, the capital stock, labour power, technical coefficients of production, and investment are given or predetermined variables. The endogenous variables are the level of production and employment and the level of real wages.

To calculate the short-period equilibrium employment level we will initially rewrite equation (1) as follows:

$$N_t = \left[ Y_t^{\frac{1}{1-\alpha}} \right] \left[ K_t^{-\frac{\alpha}{1-\alpha}} \right] \quad (4)$$

Equation (4) shows that the amount of labour employed is a direct function of the level of production, but inverse of the size of the capital stock. This last result, apparently counterintuitive, needs to be better explained. Given the size of the capital stock, the higher the level of employment will be the higher the level of production, which, according to equation (2), depends on the volume of effective demand, determined by the investment made and the multiplier. Given the effective demand and therefore the level of output that firms know they can sell profitably in the market, the level of employment offered by firms will depend on the amount of capital employed per worker. The higher the capital intensity, the higher the productivity of labour, and therefore fewer workers will be needed to produce the same amount of output. It follows that capital accumulation, as labour productivity increases, reduces the level of employment that firms are willing to provide. For firms to want to hire an additional number of workers, they must be willing to increase their production, which will only occur if they anticipate an increase in effective demand.

Under perfect competition and constant returns to scale, the real wage will be equal to the marginal productivity of labour. Thus, the short-term equilibrium real wage will be given by:

$$V_t = \frac{\bar{w}}{p_t} = (1 - \alpha)K_t^\alpha N_t^{-\alpha} \quad (5)$$

Where:  $V_t$  is the real wage in the current short-period, and  $\bar{w}$  is the nominal wage determined contractually.

### 3. Short-Period Equilibrium

In the short period, the capital stock and investment are predetermined variables, that is, determined in previous periods. The share of wages in income, the propensity to consume out of wages, and the monetary wage are exogenous variables or parameters. The level of employment, the level of production, the real wage and the general level of prices are endogenous variables.

The model is given by the following system of equations:

$$Y_t = \frac{I_t}{1 - c_w(1 - \alpha)} \quad (2)$$

$$N_t = \left[ Y_t^{\left(\frac{1}{1-\alpha}\right)} \right] \left[ K_t^{-\left(\frac{\alpha}{1-\alpha}\right)} \right] \quad (4)$$

$$V_t = \frac{\bar{w}}{p_t} \quad (5a)$$

$$V_t = (1 - \alpha)K_t^\alpha N_t^{-\alpha} \quad (5b)$$

In the system formed by equations (2), (4), (5a) and (5b) we have *four linearly independent equations and four unknowns*, namely:  $Y_t$ ,  $N_t$ ,  $V_t$  e  $p_t$ . An important characteristic of this model is that it is block-recursive (Sargent, 1987), that is, the interdependence between the equations of the model is not general, allowing the system of equations to be solved in a sequential manner. In effect, the equilibrium level of output is determined by equation (2). Once the equilibrium level of output has been determined, the short-period equilibrium employment level will be determined by substituting equation (2) into (4), taking the short-period capital stock as a given. Once the equilibrium employment level has been determined by means of the equation resulting from the substitution of (2) in (4), the short-term equilibrium real wage can be determined by substituting this resulting wage in equation (5b). Finally, given the short-period equilibrium real wage level by the equation resulting from the last substitution, one can determine the short-period equilibrium price level by substituting this resultant into equation (5a).

Be  $\bar{N}$  the number of workers available in the short period. Except by a *happy coincidence*, there is no mechanism that guarantees that the level of short-term equilibrium employment will be equal to the number of available workers. In general, we will have  $N_t^* < \bar{N}$ , that is, we will have *involuntary unemployment* of the workforce. Note that the only variable that can be affected by a change in the wage money rate at short-period equilibrium is the general price level: the lower the wage money rate, the lower the general price level will be, with no effect on real wages or short-period equilibrium employment. In other words, the short-term equilibrium with involuntary unemployment of the labour force does not depend on the value of the monetary rate of wages and is therefore independent of any hypothesis about the degree of rigidity of nominal wages. **This is the result that Keynes obtained in his General Theory.**

#### 4. Dynamic analysis and the persistence of involuntary unemployment

In the previous section we presented a formal model in which the short-period equilibrium values of the level of production and employment were determined. Within the short period there is no mechanism by which the level of employment is required to make all individuals who wish to work at market wages get a job. This result does not depend on errors in expectations or on nominal rigidity of wages or prices. It is, therefore, a model in which involuntary unemployment represents a situation of equilibrium, given its parameters and predetermined variables.

This, however, is not enough to explain the *persistence* of involuntary unemployment over a sequence of short periods. Contrary to what is preached by macroeconomics textbooks, Keynes was not interested in explaining the determination of the level of employment at a given point in time<sup>2</sup>, but because capitalist economies have fluctuations in economic activity around a level that is chronically insufficient to provide full employment of the labour force (Keynes, 1936, p. 249). In this context, short-term equilibrium is not enough. We must analyse how the economy moves between short-period equilibrium positions and whether this movement generates some kind of long-term "norm" or "trend", understood as a resting position of the system, in which it is devoid of endogenous dynamics (Vercelli, 1991, pp. 14-16). If this norm is such that, once the endogenous dynamics are exhausted, the level of economic activity is insufficient to provide full employment of the labour force, then involuntary unemployment will be

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<sup>2</sup> This interpretation is endorsed by Lucas (1981).

persistent and the paradigm of the monetary economy of production will have been successful in terms of "changing the way the world thinks about economic problems".

To do so, it will be necessary, initially, to take into account the effects of the investment decision on the capital stock and, thus, on the "scarcity of capital", which is the origin of the flow of quasi-rents expected from capital equipment throughout its useful life and, therefore, one of the determining factors of the marginal efficiency of capital (Oreiro, 2025, chapter 3). The investment made in the current short period is the result of investment decisions made in previous periods when the capital stock was lower than the capital stock in the present. The implementation of these investment decisions will increase the capital stock in subsequent periods, impacting the marginal efficiency of capital and thus the planned investment in the future. This relationship between *stocks and flows creates a dynamic intrinsic to the model*<sup>3</sup>, that is, a dynamic that results from the interaction between these variables instead of being imposed on an *ad-hoc basis*.

The dynamics of the capital stock is given by the following equation:

$$K_t = (1 - \delta)K_{t-1} + I_t \quad (6)$$

Where:  $\delta$  is the depreciation rate of the capital stock and  $I_t$  is the gross investment made in the short-period  $t$ .

Following Oreiro (2025, chapter 3), planned investment is given by the following equation:

$$I_t^P = \theta_0 + \theta_1(d_t - i_{lp}) \quad (7)$$

Where:  $\theta_0$  is autonomous investment,  $d_t$  is the marginal efficiency of capital in the short-period  $t$  and  $i_{lp}$  is the long-term interest rate.

In accordance with nature of the expected quasi-rents from which entrepreneurs calculate the marginal capital efficiency of their investment projects, we will assume that:

$$d_t = d_0 + d_1 v_{t-1} \quad (8)$$

Where:  $d_0 > 0$ ;  $d_1 > 0$ ;  $v_{t-1} = \frac{Y_{t-1}}{K_{t-1}}$  It is the output-capital ratio (or capacity utilization) in the previous short-period, which will be considered as an *index of scarcity of capital*,

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<sup>3</sup> This is the fundamental characteristic of macroeconomic models with consistency between stocks and flows developed from the pioneering work of Godley and Lavoie (2007). The approach of this chapter follows, in part, this methodology of construction of macroeconomic models.

the lower this index the less scarce the capital will be in comparison with the size of the market and, therefore, the greater will be the expected flow of quasi-incomes.

Finally, following Oreiro (2025, chapter 4), the long-term interest rate is given by:

$$i_t^{lp} = \bar{i} + \delta^{LP} \quad (9)$$

Where:  $\bar{i}$  is the safe and  $\delta^{LP}$  is the liquidity premium of long-term securities relative to short-term securities.

Substituting (8) and (9) for (7), we have that:

$$I_t^p = \theta_0 + \theta_1(d_0 + d_1 v_{t-1} - \bar{i} - \delta^{LP}) \quad (10)$$

Substituting (9) in (3) we have that:

$$I_t = \theta[\theta_0 + \theta_1(d_0 + d_1 v_{t-2} - \bar{i} - \delta^{LP})] + (1 - \theta)[\theta_0 + \theta_1(d_0 + d_1 v_{t-3} - \bar{i} - \delta^{LP})] \quad (11)$$

Simplifying the equation (11) we have:

$$I_t = \theta_0 + \theta\theta_1 d_1 (v_{t-2} - v_{t-3}) + \theta_1 d_1 v_{t-3} - (\bar{i} + \delta^{LP}) \quad (12)$$

The dynamical system is composed of the following equations:

$$Y_t = \frac{I_t}{1 - c_w(1 - \alpha)} \quad (2)$$

$$N_t = \left[ Y_t^{\left(\frac{1}{1-\alpha}\right)} \right] \left[ K_t^{-\left(\frac{\alpha}{1-\alpha}\right)} \right] \quad (4)$$

$$V_t = \frac{\bar{w}}{p_t} \quad (5a)$$

$$V_t = (1 - \alpha) K_t^\alpha N_t^{-\alpha} \quad (5b)$$

$$K_t = (1 - \delta) K_{t-1} + I_t \quad (6)$$

$$d_t = d_0 + d_1 v_{t-1} \quad (8)$$

$$v_t = \frac{Y_t}{K_t} \quad (8a)$$

$$i_t^{lp} = \bar{i} + \delta^{LP} \quad (9)$$

$$I_t = \theta_0 + \theta\theta_1 d_1 (v_{t-2} - v_{t-3}) + \theta_1 d_1 v_{t-3} - (\bar{i} + \delta^{LP}) \quad (12)$$

We saw in section 3 that the short-period equilibrium values are determined by the subsystem formed by equations (2), (4), (5a) and (5b). These values, however, depend on a series of *predetermined variables* such as the capital stock inherited from the previous period and the *investment decisions made in other* periods, which depend on the past short-period equilibrium values. We thus have a system whose present depends on the past and in which the future will be shaped in the present. In short, we have an *economy that moves through historical time*.

The solution of this system of equations involves the use of *recursive methods*. We need to define the values of the initial conditions of the system and the values of the parameters to then calculate the short-period equilibrium values one by one over a sequence of periods.

To facilitate this process, it is convenient to calculate the *steady state of the system*, i.e., the values of endogenous variables in a context where the system is devoid of endogenous dynamics, in such a way that endogenous variables are constant over time.

At steady state, our system of equations is composed of:

$$Y = \frac{I}{1 - c_w \alpha} \quad (2a)$$

$$N = Y^{\left(\frac{1}{1-\alpha}\right)} K^{-\left(\frac{1}{1-\alpha}\right)} \quad (4a)$$

$$V = \frac{\bar{w}}{p} \quad (5c)$$

$$V = (1 - \alpha) K^\alpha N^{-\alpha} \quad (5d)$$

$$I = \delta K \quad (6a)$$

$$d = d_0 + d_1 v \quad (8b)$$

$$v = \frac{Y}{K} \quad (8c)$$

$$i^{LP} = \bar{i} + \delta^{LP} \quad (9a)$$

$$I = \theta_0 + \theta_1 d_1 v - (\bar{i} + \delta^{LP}) \quad (12a)$$

The above system is formed by 9 linearly independent equations and 9 endogenous variables  $(Y, N, K, V, p, d, v, I, i^{lp})$ . The parameters are  $(c_w, \alpha, \bar{w}, \delta, \bar{i}, \delta^{LP}, d_0, d_1, \theta_0, \theta_1)$ . We have, therefore, a *specific system*.

Substituting (6) in (2) we get:

$$\frac{Y}{K} = \frac{\delta}{1 - c_w \alpha} \quad (13)$$

Substituting (13) for (8c), we have that

$$v^* = \frac{\delta}{1 - c_w \alpha} \quad (14)$$

Equation (14) determines the steady-state value of the output-capital relationship (or capacity utilization).

Substituting (14) for (8b) we have:

$$d^* = d_0 + d_1 v^* = d_0 + d_1 \left( \frac{\delta}{1 - c_w \alpha} \right) \quad (15)$$

Equation (15) determines the steady-state value of the marginal efficiency of capital.

Substituting (14) for (12) we get:

$$I^* = \theta_0 + \theta_1 d_1 v^* - (\bar{i} + \delta^{LP}) = \theta_0 + \theta_1 d_1 \left( \frac{\delta}{1 - c_w \alpha} \right) - (\bar{i} + \delta^{LP}) \quad (16)$$

Equation (16) determines the steady-state value of the investment expenditure.

Substituting (16) for (6) we have:

$$K^* = \frac{I^*}{\delta} = \frac{\left[ \theta_0 + \theta_1 d_1 \left( \frac{\delta}{1 - c_w \alpha} \right) - (\bar{i} + \delta^{LP}) \right]}{\delta} \quad (17)$$

Substituting (16) for (2a) we have that:

$$Y^* = \frac{I^*}{1 - c_w \alpha} = \frac{\left[ \theta_0 + \theta_1 d_1 \left( \frac{\delta}{1 - c_w \alpha} \right) - (\bar{i} + \delta^{LP}) \right]}{1 - c_w \alpha} \quad (18)$$

Equation (18) determines the steady-state value of the economy's output level. This is probably the most interesting result of the model. The level of steady-state economic activity is determined by autonomous investment, the propensity to consume out of wages, the share of wages in income, the safe interest rate, and the liquidity premium of long-term bonds. Except by a happy coincidence, the steady-state level of output will not be equivalent to the level of output compatible with the full employment of the labour force. In addition, the reader should note that the steady-state level of

production depends exclusively on the demand conditions of the economy, the supply side does not interfere in determining the level of utilization of existing resources. **The validity of the principle of effective demand is not, therefore, restricted to the short period.** Finally, the public's preference for liquidity directly interferes in determining the level of economic activity: a greater perception of uncertainty on the part of decision makers will be reflected in a higher liquidity premium for long-term bonds or a higher level of the safe interest rate, thus reducing investment and the level of production in the steady state.

To find the steady-state employment level, simply replace the equations (17) and (18) into (4). We get:

$$N^* = \left\{ \frac{I^*}{1 - c_w \alpha} \right\}^{\left(\frac{1}{1-\alpha}\right)} \left\{ \frac{I^*}{\delta} \right\}^{-\left(\frac{\alpha}{1-\alpha}\right)} = I^* \delta^{\left(\frac{\alpha}{1-\alpha}\right)} (1 - c_w \alpha)^{-\left(\frac{1}{1-\alpha}\right)} =$$

$$\left[ \theta_0 + \theta_1 d_1 \left( \frac{\delta}{1 - c_w \alpha} \right) - (\bar{i} + \delta^{LP}) \right] \left[ \delta^{\left(\frac{\alpha}{1-\alpha}\right)} (1 - c_w \alpha)^{-\left(\frac{1}{1-\alpha}\right)} \right] \quad (19)$$

In equation (19) we can observe that the situation of the labour market has no influence on the level of steady-state employment, which depends only on the determinants of the effective demand for goods and services, particularly the level of investment made by firms.

Once the steady-state values of the capital stock and the level of employment have been determined, we can determine the steady-state value of the real wage. To do so, simply replace the equations (17) and (19) into (5d). We have, then, that:

$$V^* = (1 - \alpha)(K^*)^\alpha (N^*)^{-\alpha} =$$

$$(1 - \alpha) \left( \frac{\left[ \theta_0 + \theta_1 d_1 \left( \frac{\delta}{1 - c_w \alpha} \right) - (\bar{i} + \delta^{LP}) \right]}{\delta} \right)^\alpha$$

$$\left( \left[ \theta_0 + \theta_1 d_1 \left( \frac{\delta}{1 - c_w \alpha} \right) - (\bar{i} + \delta^{LP}) \right] \left[ \delta^{\left(\frac{\alpha}{1-\alpha}\right)} (1 - c_w \alpha)^{-\left(\frac{1}{1-\alpha}\right)} \right] \right)^{-\alpha} \quad (20)$$

Equations (17) -(19) show that an increase in investment demand will result in an increase in the steady-state values of the output level, the capital stock, and the employment level.

Finally, the general level of prices at steady state can be determined by substituting equation (20) in (5c), thus obtaining the following expression:

$$p^* = \frac{\bar{w}}{V^*} = \frac{\bar{w}}{\left\{ (1-\alpha) \left\{ \left( \frac{[\theta_0 + \theta_1 d_1 (\frac{\delta}{1-c_w \alpha}) - (\bar{i} + \delta^{LP})]}{\delta} \right)^\alpha \right\} \left\{ \left( [\theta_0 + \theta_1 d_1 (\frac{\delta}{1-c_w \alpha}) - (\bar{i} + \delta^{LP})] \left[ \delta^{\frac{\alpha}{1-\alpha}} (1-c_w \alpha)^{-\frac{1}{1-\alpha}} \right] \right)^{-\alpha} \right\} \right\}} \quad (21)$$

For an analysis of the dynamic properties of the model, a *numerical simulation is required*, which requires the definition of the values of the initial conditions and the parameters of the system of equations presented above.

Table 1 below presents the values of the parameters and initial conditions assumed in the simulation exercise.

**Table 1 Values of the Parameters and Initial Conditions of the Model for the Simulation**

<b>Paramater</b>	<b>Value</b>
$\alpha$	0,5
$c_w$	1
$\bar{w}$	10
$\delta$	0,10
$d_0$	0,03
$d_1$	0,1
$\bar{i}$	0,015
$\delta^{LP}$	0,005
$\theta_0$	100
$\theta_1$	50
$L$	100
$K_0 = K_1$	100
$I_0 = I_1$	100
$Y_0 = Y_1$	100

Source: Elaborated by the author.

Based on the values presented in Table 5.1 above, we can use them in the system formed by equations (14)-(21) to calculate the steady-state values of the product level, the capital stock, the employment level, the investment volume, the product-capital ratio, the marginal capital efficiency, the real wage, and the general price level. These values are presented in Table 2 below:

**Table 2: Steady-State Values of Endogenous Variables**

Variable	Stationary State Value
$Y^*$	203,0
$K^*$	1015
$N^*$	40,6
$I^*$	101,5
$v^*$	0,2
$d^*$	0,05
$V^*$	2,5
$p^*$	4,0
$U^*$	0,59

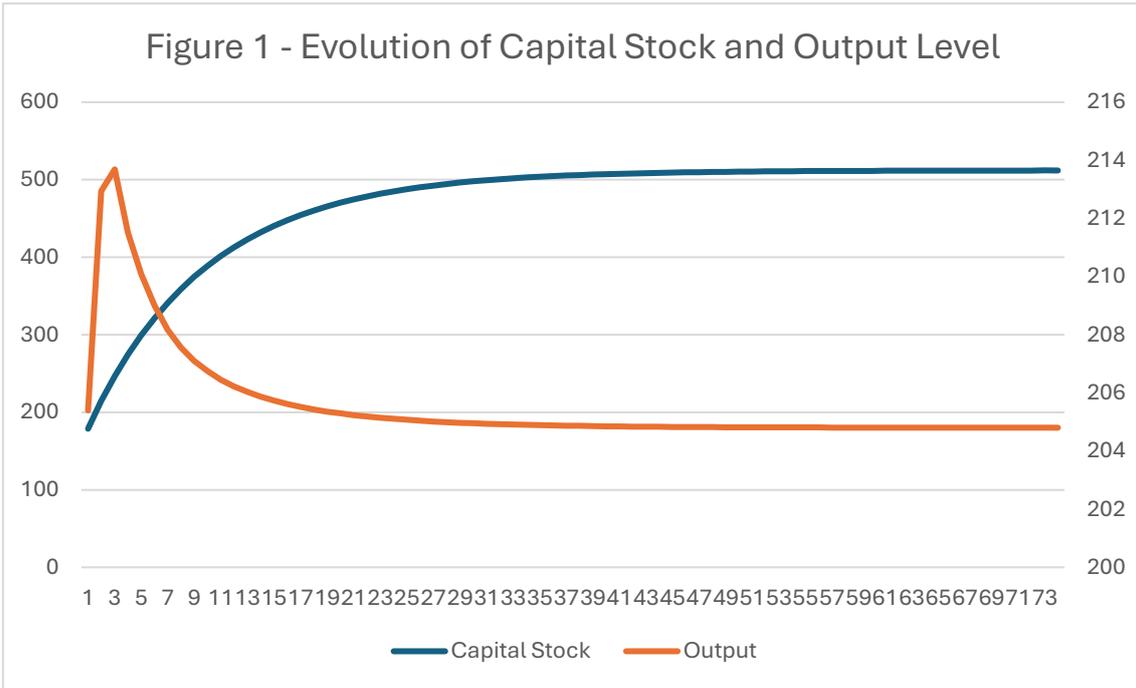
Source: Elaboration by the author based on the EXCEL software.

Two things that draw attention in table 2 are the steady-state values of the product-capital ratio and the unemployment rate, the first because it is extremely low and the second because it is very high. About the steady-state value of the output-capital relationship, equation (14) shows that it is equal to the product between the depreciation rate of the capital stock,  $\delta$ , and the investment multiplier,  $\left(k = \frac{1}{1-c_w\omega}\right)$ . In the numerical simulation we are assuming a value of 10% per period for the depreciation rate, which is far from being a low value, and the investment multiplier is equal to 2.00 for the values considered of the propensity to consume from wages and the share of wages in income. A multiplier between 1.7 and 2.3 is consistent with the existing empirical literature on the subject (Oreiro, 2025, chapter 3). In this context, the reduced value of the capital-output ratio must be the result of the absence of an autonomous component of demand other than investment. More specifically, in the model presented here, **there is no autonomous component of demand that does not create productive capacity**. The addition of

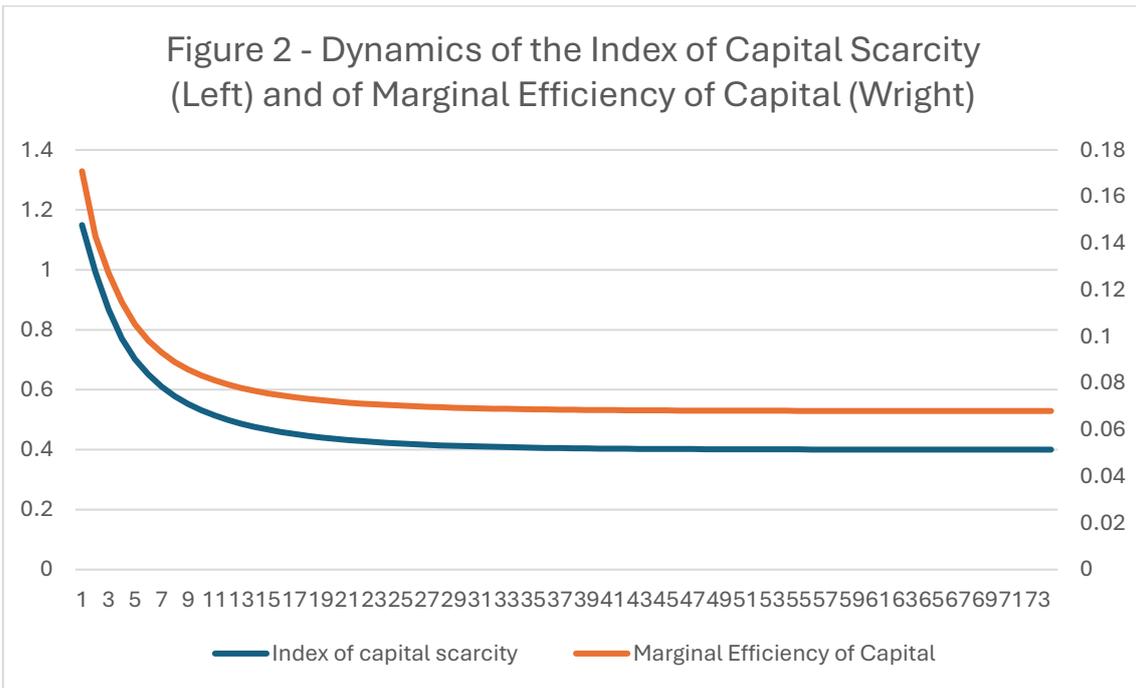
autonomous consumption should have the effect of stabilizing the steady-state product-capital ratio at a higher level.

A steady-state figure of 59.4% for the unemployment rate appears to be unrealistically high. In fact, even if we consider discouraged and underutilized workers as part of the official unemployment statistics, a level above 30% does not seem to be consistent with the experience of developed or developing countries, except in periods of severe economic crisis. This extremely high value for the unemployment rate is, in fact, the result of the hypotheses we are adopting about technology and the composition of autonomous demand.

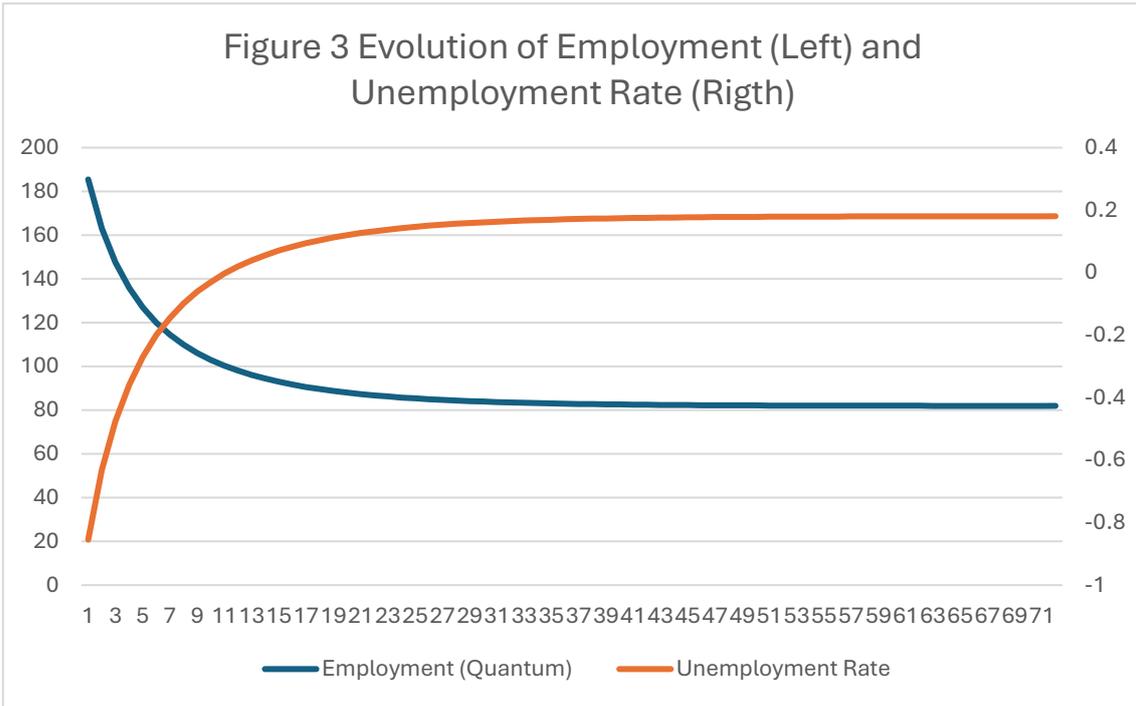
When describing the production technology, we decided to use a Cobb-Douglas type production function with constant returns to scale. This option was due to a deliberate strategy of *minimizing divergences with respect to traditional economic theory*, to highlight the generality of the results presented here. A Cobb-Douglas production function assumes that capital and labour are substitutable for each other, i.e., the same amount of product can be produced from different combinations of capital and labour. This hypothesis is unacceptable to most, if not all, of the world's heterodoxy; But the theoretical issue to be emphasized is that persistent involuntary unemployment does not require technical complementarity between the factors of production. Thus, according to *Occam's principle of simplicity*, we must use the simplest hypothesis – in this case the most accepted – about technology, that is, a technology in which the factors of production can be substitutable for each other.



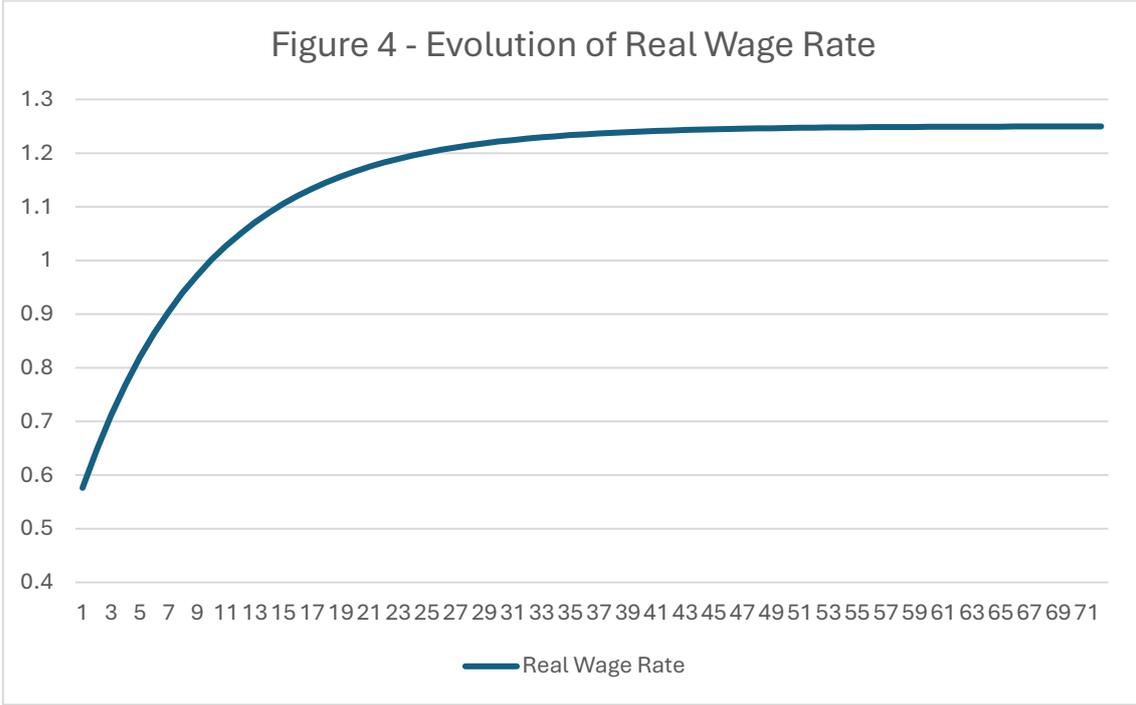
Source: Elaboration by the author using Excel software.



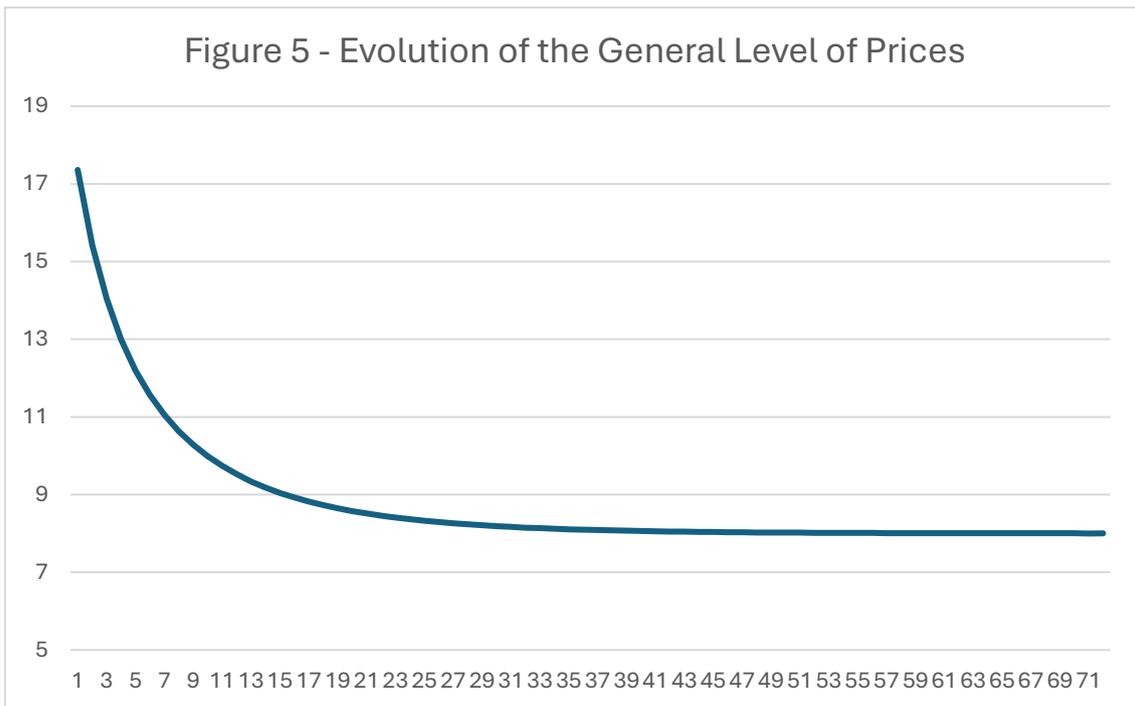
Source: Elaborated by the author from the Excel software.



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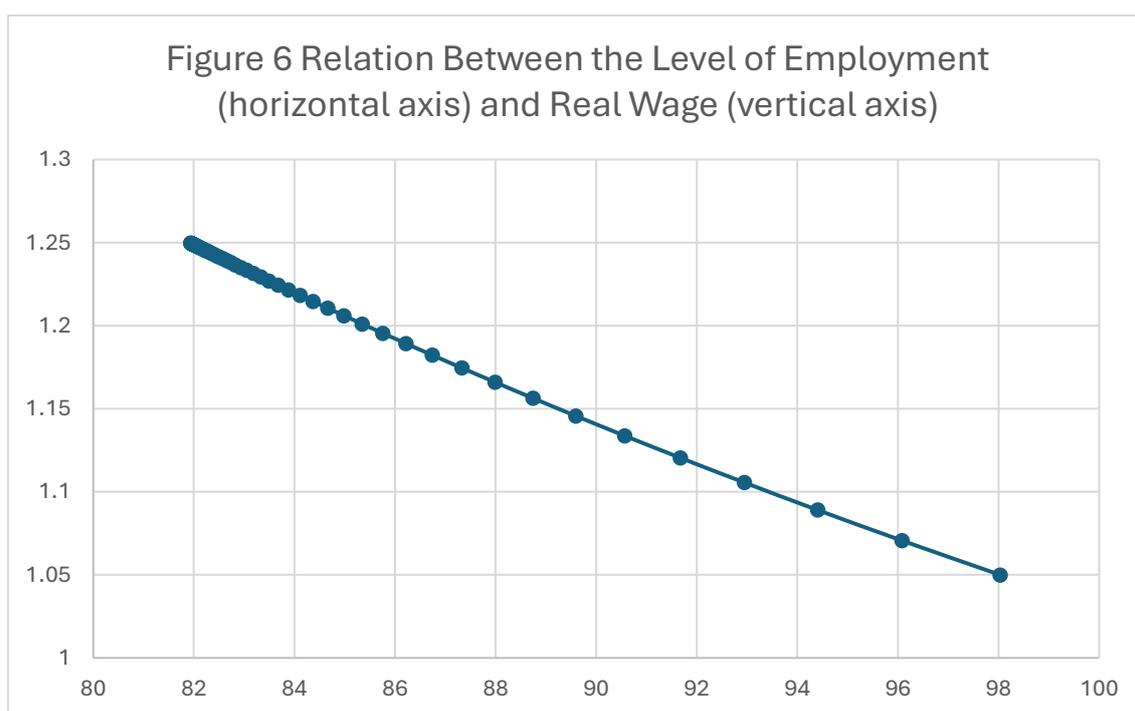


Source: Elaborated by the author from the Excel software

Figures 1 to 5 show that the dynamics of endogenous variables are compatible with asymptotic convergence to their steady-equilibrium values. However, some comments are necessary.

The first concerns the dynamic behaviour of the marginal efficiency of capital presented in Figure 2, in which a clear downward trend in the marginal efficiency of capital is observed over a sequence of short periods. According to Asimakopulos (1991) and Oreiro (2025), Keynes, by not making a distinction between the investment decision and its implementation, ends up making a mistake in considering that, in the investment decision, entrepreneurs would take into account the effect of the implementation of their investment decisions on the *scarcity of capital*, which would result in a decreasing marginal efficiency with the volume of planned investment. In the model we are presenting, the tendency to decrease the marginal efficiency of capital is the *ex-post result* of investment decisions, which result in an increase in the capital stock that is more than proportional to the increase in the level of economic activity, thus reducing the scarcity of capital. Moreover, it is the tendency of the marginal efficiency of capital to fall over historical time, not at a given point in time, that ultimately leads the economy to a stationary state in which capital accumulation is interrupted.

The second comment concerns the relationship between employment level and real wages over time. From the trajectories presented in Figures 3 and 4, we can see the existence of a negative correlation (equal to  $-0.99$ ) between the level of employment and the real wage (Figure 6). As it is well known, Keynes accepted the first postulate of the classical theory according to which the real wage is equal to the marginal productivity of labour. Because of the existence of diminishing marginal returns, given the capital stock, an increase (reduction) in the level of employment will inevitably be associated with a reduction (an increase) in the level of real wages. This does not, however, establish a labour demand function in which the number of workers employed is a decreasing function of the real wage level, since labour demand is determined by the number of workers needed for firms to be able to meet the effective demand for the goods they produce. The reduction in real wages is the consequence rather than the cause of the increase in the level of employment.



Source: Elaborated by the author from the Excel software

The relation presented in Figure 6 above is not, however, the static relation between employment and real wages of the first postulate of the classical theory. This is because the capital stock is not constant but grows over time because of the implementation of investment decisions. In this context, this inverse relationship between employment and real wages results from the increase in labour productivity resulting from

the substitution of labour by capital that we mentioned earlier. As the share of wages in income is constant, all the increase in the productivity of the worker will be appropriated by the workers in the form of higher wages. Thus, it is not correct to say that the excessive increase (sic) in real wages is the cause of the low level of employment, since wages only follow productivity growth.

One final comment concerns the evolution of the price level. As we can see in figure 5, *the economy tends to deflation*. This stems from the combination of a constant monetary wage and an increase in the marginal productivity of labour. Deflation is, however, a temporary phenomenon because in the steady state the general price level is constant and the rate of deflation is zero.

At the beginning of this article, we saw that the literature that followed the publication of Keynes's *General Theory* attributed the persistence of unemployment to a supposed rigidity of the monetary rate of wages. In other words, the so-called *neoclassical synthesis* - originating from the seminal articles of Pigou (1943), Modigliani (1944) and Patinkin (1948) – stated that the equilibrium with unemployment was the result of the hypothesis of rigid monetary wages, that is, insensitive to the level and/or variations in the unemployment rate. Although it was recognized that wage rigidity was a phenomenon observed in the real world, from a theoretical point of view it would only be a *market imperfection*; and, as such, something that had already been predicted by pre-Keynesian theory as capable of preventing the natural tendency of market economies to operate with full employment of the labour force. In this way, Keynes would have failed to promote "a revolution in the way the world thinks about economic problems", although he analysed in a correct and detailed way the implications in terms of economic policy of the *de facto* existence of market imperfections such as wage rigidity.

In this context, a compromise was established that would mark the development of post-Keynes macroeconomics: on the one hand, economists with empirical inclination or macroeconomic policy formulation should recognize Keynes' failure to develop a consistent alternative to classical theory, on the other hand, economists with theoretical inclination should recognize the imperfections and rigidities that Keynes emphasized in his *General Theory* are very important in the real world and, therefore, for the formulation of economic policy (Carvalho, 1992, p. 8)

In the next session we will analyse the implications of the existence of a self-feeding effect between the unemployment rate (an endogenous variable of the model) and the monetary rate of wages (a parameter).

### 5. Flexible Monetary Wage and Planned Investment.

In this section we shall examine the case in which the money-wage rate is not constant over the sequence of short periods but may vary depending on the evolution of the general price level and the state of the labour market. We are interested in analysing whether a reduction in the money wage rate can stimulate the level of economic activity as it is presented in traditional macroeconomics textbooks.

In these textbooks, the student is presented with an *aggregate demand curve* that is defined as the locus of the combinations between the general price level and the level of production for which the market for goods is in equilibrium, that is, companies are able to sell all their production, so that the involuntary variation of inventories is equal to zero. In the short run, the general price level is seen as an exogenous variable because it reflects the rigidity of the nominal wage rate. Generally, in more modern manuals such as Blanchard (2011, p. 111), the general price level is determined based on a *mark-up* rate on the unit cost of production, which is equal to the ratio between the monetary wage rate and labour productivity. Thus, the market structure assumed in the most modern macroeconomics manuals is *imperfect competition*, which allows firms to have pricing power. This, however, is not the market structure that Keynes assumed in his General Theory. Keynes considered an economy operating under conditions of perfect competition, where the general price level was adjusted in such a way as to equalize the real wages of workers with the marginal productivity of labour calculated at the point of effective demand.

In this context, a reduction in the price level can only occur because of a fall in the money wage rate, which may be the result of involuntary unemployment of the labour force. Workers, with or without union representation, may be willing to reduce the nominal wage in the hope of getting a job. Reducing money wages will reduce firms' unit cost of production, allowing them to be able to reduce the prices of their products without reducing their *mark-up* margins. *A process of deflation of wages and prices begins.*

How can wage and price deflation stimulate economic activity? Modigliani (1944) defined two mechanisms.

The first, which we can call the *Keynes effect*, considers that the fall in the general price level will produce a reduction in the transactional demand for money which, assuming the supply of money to be constant, will reduce the interest rate, stimulating investment and the level of production, through the multiplier. The problem with this effect is that for its operation it is necessary that the economy is not operating in a situation of liquidity trap, as Modigliani (1944) supposes to be the case considered by Keynes in his *General Theory*. Thus, for a deflation of prices and wages to stimulate the economy, the operation of another mechanism is necessary.

The second, which we can call the *Pigou effect or the real liquidity effect*, presupposes the existence of an autonomous component in consumption demand, and that this autonomous consumption depends on the stock of wealth of households. Money is part of the stock of wealth of households, but only that part that consists of paper money in the possession of the public. Bank deposits are an asset for households, but a liability for banks and, therefore, for households that own banking institutions. Since the assets of one household are the liabilities of another, then the *net effect on the wealth of households will be zero*. In the aggregate of the volume of means of payment – equal to the sum between paper money held by the public and demand deposits – paper money held by the public constitutes a very small fraction, which tends to decrease over time due to the development of new payment technologies such as debit cards, *internet banking* and PIX.

The share of paper money held by the public in the stock of wealth of families is very low, not to say irrelevant. This small detail was disregarded by Modigliani (1944) who assumed that price deflation would result in an increase in the value of household wealth and, therefore, in their propensity to consume. If the price deflation is large enough, then the corresponding increase in consumption will put the economy in a position of equilibrium with full employment. It follows that the **rigidity of the monetary rate of wages is a necessary and sufficient condition for equilibrium with unemployment** (Modigliani, 1944, p. 223).

Both mechanisms pointed out by Modigliani (1944) depend on a critical hypothesis, that is, that the quantity of money is constant or exogenous. Although Keynes assumed in his *General Theory* a vertical money supply, the practice of central banks is to set the policy interest rate, that is, the interest rate of the interbank market, making the monetary base an endogenous variable. In this case, a deflation of wages and prices will

result in a contraction of both the monetary base and the volume of means of payment, leaving short- and long-term interest rates unchanged.

Moreover, even if paper money held by the public can be considered, at least in the short run, a constant, the effect of a price deflation on households' propensity to consume would be negligible. As an example, let us consider that the propensity of families to consume from wealth is 5% and that paper money represents 10% of the stock of wealth of families. A 10% deflation in one year would result in an increase of only 1% in household wealth in real terms and a measly 0.05% increase in planned consumer spending. It would take 10 percent a year of deflation for decades for there to be any discernible effect on consumer spending and employment. By then, as Keynes would say, we will all be dead.

Based on the above, we have no reason to believe that the deflation of prices and wages resulting from involuntary unemployment will be able to eliminate this problem.

To resolve any doubts, we will introduce in the model presented in the previous session the possibility of variation in monetary wages because of the evolution of the state of the economy over historical time.

To do so, let's assume that the money wage in the current short period is given by the following equation:

$$w_t = \beta_0 p_{t-1} - \beta_1 (U_{t-1} - U_{t-2}) \quad (21)$$

Where:  $\beta_0$  and  $\beta_1$  are positive constants.

Some clarification is needed about the equation (21). In the first place, workers do not suffer from monetary illusion because the nominal wage desired by workers depends on the perceived purchasing power of wages and therefore on the general price level. Secondly, the state of the labour market is represented by the change in the unemployment rate in the two periods prior to the current period. If the unemployment rate is rising, then this should lead workers to accept, in their dealings with firms, a lower than desired money wage; The opposite should occur if the unemployment rate is increasing over time. The reader should realize that in equation (21) **there is no natural value for the unemployment rate**, that is, a value such that the monetary wage will be equal to that desired by the workers. Any unemployment rate, if it is kept constant over

time, is compatible with a monetary wage equal to the desired one<sup>4</sup>. Finally, the level of wage flexibility is given by the coefficient in the equation (21), the higher the value of this coefficient, the more flexible, that is, the more sensitive the variations in the unemployment rate will be the monetary rate of wages.  $\beta_1$

How can wage flexibility affect output and employment dynamics? The only way is through a change in the investment planned by firms, i.e., wage deflation must be able to stimulate entrepreneurs to increase investment in fixed capital. If this occurs, the dynamics of the level of output and employment may be favourably affected in the direction of a possible convergence in relation to the full employment of the labour force.

The deflation of prices and wages affects the interest rate of capital assets by generating an expectation of capital loss in comparison with the currency's own interest rate. In this context, the interest rate of capital assets will be given by:

$$q_K - c_k + a_k = l_m \quad (22)$$

Given the money's liquidity premium,  $l_m$ , The gap between the expected quasi-incomes of capital equipment ( $q_K$ ) and its carrying cost ( $c_k + a_k$ ) is expected to widen, which requires a reduction in the price of these assets in the spot market. If the reduction in the price in the spot market is greater than the reduction in the supply price of capital equipment, the result of price and wage deflation will be a reduction in investment and, therefore, in the level of economic activity.

The introduction of the possibility of capital losses makes it necessary to redefine the interest rate of long-term bonds. Thus, we get

$$r^{lp} = i^{LP} - \pi^e = (\bar{i} + \delta^{LP}) - \pi^e \quad (23)$$

Where:  $\bar{i} = q_b$ ;  $\delta^{LP} = l_b$ ;  $\pi^e = -a_b$

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<sup>4</sup> Another way to understand this result is to suppose that due to the existence of strong *hysteresis mechanisms* in the labour market, the natural rate of unemployment depends on the unemployment rate of previous periods (Carlin and Soskice, 2015, pp. 565-568). In this way, the natural rate of unemployment becomes dependent on the temporal trajectory of the unemployment rate. Hysteresis is defined as the tendency of a system to retain its properties in the absence of a stimulus that generated them ([Hysteresis – Wikipedia, the free encyclopedia \(wikipedia.org\)](https://en.wikipedia.org/wiki/Hysteresis)). About the labour market, hysteresis refers to a situation in which a *temporary demand or supply shock* generates a permanent increase in the unemployment rate, because temporary shocks affect the natural rate of unemployment. Among the factors that can generate hysteresis in the labour market, we can highlight the loss of workers' skills due to prolonged unemployment and the scrapping of capital, which is due to a drop in the level of activity that depresses investment in fixed capital below the replacement of capital depreciation.

Under conditions of Keynesian uncertainty, decision-makers adopt conventions or practical rules of decision-making, one of which consists in assuming that the present is a good guide to the future. Thus, the expected capital gain/loss can be approximated by the inflation/deflation that occurred in the immediately preceding period, i.e.,  $\pi^e = \pi_{t-1}$ . Thus, we have that:

$$r^{lp} = (\bar{i} + \delta^{LP}) - \pi_{t-1} \quad (24)$$

The planned investment equation will be given by:

$$I = \theta_0 + \theta_1 d_1 v - (\bar{i} + \delta^{LP} - \pi_{t-1}) \quad (25)$$

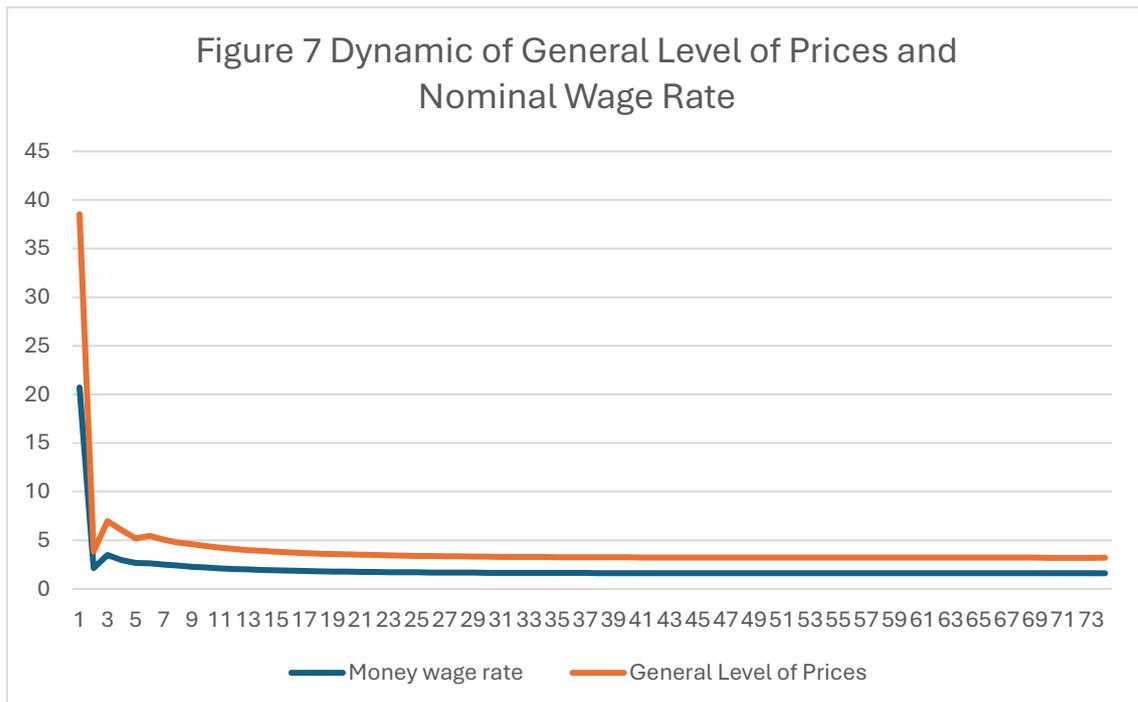
For the numerical simulation exercise, we will assume that:

**Table 3 Parameters of the equation (21)**

Parameter	Value
$\beta_0$	0,4
$\beta_1$	1

Source: Elaborated by the author.

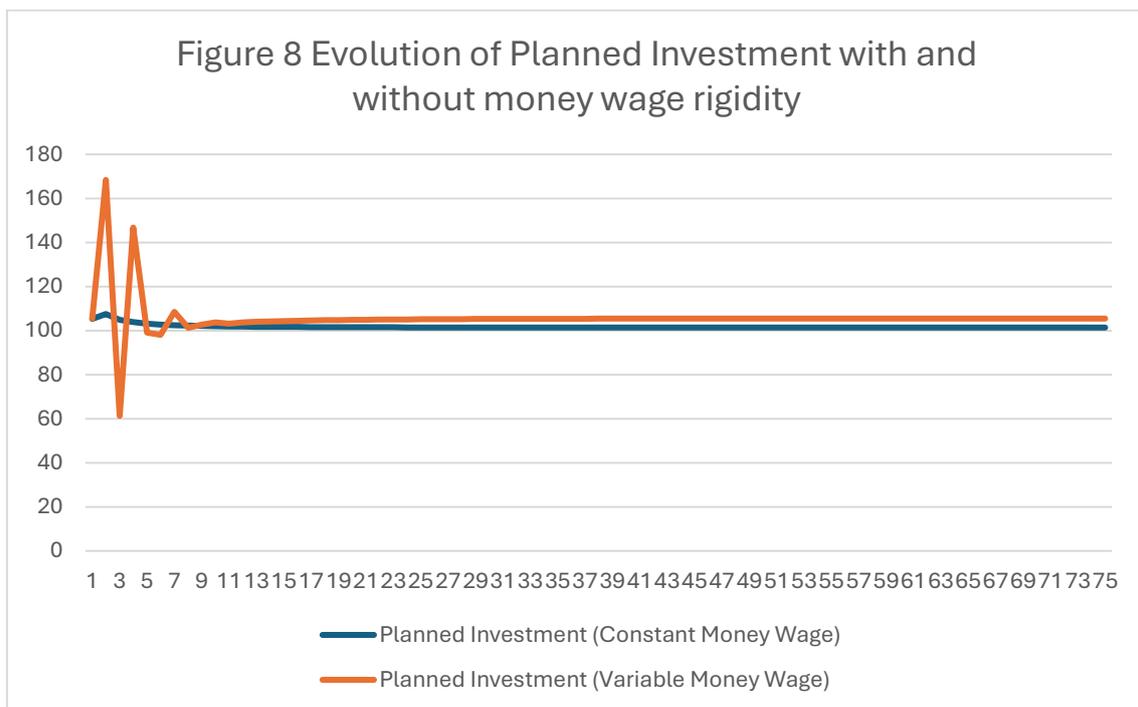
The dynamics of the general price level and the monetary rate of wages is represented by Figure 7 below:



Source: Elaborated by the author from the Excel software

In Figure 7 above, we see that both the general price level and the monetary rate of wages are undergoing a violent process of deflation due to the existence of high involuntary unemployment of the labour force. There is no price or wage rigidity: both react to prevailing conditions in the labour market.

Figure 8 shows the dynamics of planned investment in two distinct situations, with and without rigidity of the wage money rate. As we can see in the figure below, wage flexibility generates a high initial instability of planned investment in relation to the situation in which nominal wages are constant over time. This is due to the volatility of the deflation rate that occurred in the first ten short periods. After a certain number of short periods, however, the behaviour of planned investment is similar in cases with and without wage flexibility.



Source: Elaborated by the author from the Excel software

## 6. Final Remarks

In this article we present a dynamic model for determining the level of output, employment, capital stock, real wage, investment, marginal capital efficiency, and the capital-output relationship or capacity utilization. Initially, we found the short-period solution of the model, in which the capital stock is kept constant. In short-period equilibrium, the endogenous variables are the level of production, the level of

employment, the real wage rate, and the general price level. In short-period equilibrium there is no mechanism that can ensure that all workers who wish to work at market wages will be able to find employment, i.e., short-period equilibrium will be characterized by the existence of involuntary unemployment of the labour force.

Subsequently, the model was extended to consider the effects of the investment made in each short-period on the capital stock of the subsequent period and, therefore, on the initial conditions of the subsequent short-period. In other words, we incorporated into the model a relationship between flows and stocks that was absent from the theoretical framework presented by Keynes (1936). Once this relationship was incorporated, it was also possible to analyse the impact of capital accumulation on the marginal efficiency of capital and, therefore, on the incentive to invest. In this extended model, the flows determine the change in inventories, and the change in inventories influences the flows in subsequent periods. An intrinsic dynamic is thus created in the model, eliminating the existence of *black holes* (Godley and Lavoie, 2007).

Once we have presented the structure of the extended model, we calculate its steady-state solution. The most important result is that even taking into account the interrelationship between investment and capital stock, that is, leaving aside the Marshallian short-term, the economy tends to operate with involuntary unemployment of the labour force in the long run, that is, once the internal adjustments of the model are exhausted, it is devoid of endogenous dynamics. The extremely high value of the steady-state unemployment rate is explained, on the one hand, by the hypothesis adopted regarding technology, which allows the substitution between capital and labour. In this context, the accumulation of capital by increasing the productivity of labour generates a reduction in the number of workers needed to produce the quantity of goods that firms can sell in the market, given the effective demand for their products. On the other hand, the absence of an autonomous component of demand that does not create capacity, such as autonomous consumption or exports, causes effective demand to be relatively low with respect to the steady-state capital stock, thus reducing job creation per unit of capital.

Finally, a new extension of the model was presented in which monetary wages are not constant, but react to prevailing conditions in the labour market, being flexible. It has been shown that wage flexibility is incapable of creating a convergence to an equilibrium position with full employment because of the negligible effect such flexibility has on firms planned investment.

In short, *equilibrium with unemployment is an emerging property* of any capitalist economy that is based on the principles of *laissez-faire* and is thus not a result restricted to the Marshallian short-run or dependent on the assumption of price and wage rigidity.

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