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The Taylor Rule and Speculative Bubbles in a Keynes-Minsky Model of Cyclical Fluctuations

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Abstract

This paper aims to extend the model of cyclical fluctuations developed by Fazzari, Ferri, and Greenberg (2008) through the incorporation of a monetary policy rule (Taylor rule) and a Markov process for the dynamics of speculative bubbles in the value of consumers' financial wealth. In this context, we show that introducing a Taylor rule in the framework developed by Fazzari, Ferri, and Greenberg (2008) has the effect of dampening the cyclical fluctuation of the macroeconomics series (growth, unemployment, investment. and debt level) and preventing the persistence of cyclical fluctuations, which would result from the interaction between the accelerator and multiplier effects. The persistent and irregular character of fluctuations on the output growth rate observed in actual economies can be generated by the introduction of a Markovian generation process of speculative bubbles in the value of financial wealth and its corresponding impact on consumption expenditures.

Key words: macroeconomic dynamics, cyclical fluctuations, Hyman Minsky.
JEL **Classification**: E12, E32, E43.

Introduction

Capitalist economies tend to grow over time, although irregularly, presenting fluctuations around a long-run trend. These fluctuations can occur not only in real variables such as investment, Gross Domestic Product (GDP), and employment, but also in monetary and financial variables such as interest rates, prices, and debt.

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The causes of these aggregate fluctuations have been the subject of important discussions in macroeconomics. The theory of real business cycles emphasizes technological shocks in the context of competitive Walrasian equilibrium as the source of cyclical fluctuations in output and employment levels. In these models, business cycles are a by-product of economic agents' optimal responses to technological shocks, and there is no room for welfare improvement through the implementation of anti-cyclical policies. Furthermore, aggregate demand plays no role in explaining output and employment-level fluctuations. Contrasting with this view, Keynesian models take cyclical fluctuations as a result of aggregate demand dynamics in a context of market disequilibrium.

However, Keynesian models are not as homogeneous as real business cycle models. As a matter of fact, Keynesian models can be classified into two types: impulse-response and perpetual movement models (see Frisch, 1933). Impulse-response models specify a source of exogenous shocks (on aggregate demand) to the system, as well as a mechanism for those shocks to spread throughout the economic system, creating economic fluctuations. In general, in this family of models, the propagation mechanism is some type of nominal rigidity (staggered wages, menu costs, quasi-rationality, etc.) that make firms respond to an exogenous shock to aggregate demand by adjusting output instead of prices. In perpetual movement models, endogenous interaction among economic variables (the *multiplier* and *accelerator* effects) results in the emergence of regular, persistent fluctuations of economic activity levels, independently of any exogenous shock to the system.[1]

An important issue in the context of Keynesian perpetual movement models is the role of financial variables in generating fluctuations in economic variables. In the first Keynesian models, financial variables played no important role in cycle dynamics. The cycles were merely the result of the interaction between multiplier and accelerator effects. However, financial variables have always played a fundamental role in the macroeconomic dynamics in the Keynesian literature of a more appreciative character, especially in Minsky's writings (1982; 1986). Minsky presented the so-called financial instability hypothesis, which stated that actual output and employment fluctuations were the result of the endogenous evolution of firms' liabilities structures toward increasingly fragile positions, making a financial crisis and the consequent fall in investment and production levels inevitable.

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[1] Some examples of models in this tradition are Samuelson (1939), Hicks (1950), and Kalecki (1954).

Extensive literature began to be produced in the mid-1980s that attempted to present Minsky's ideas regarding cyclical fluctuations through mathematical models that clearly and precisely describe the mechanisms that explain the occurrence of endogenous and persistent output and employment fluctuations.

The seminal work in this literature was written by Taylor and O'Connell (1985). They introduce a linear macro-dynamic model to show the possibility of a financial crisis starting from an asset-deflation process caused by an exogenous reduction of confidence. The asset deflation occurs as a result of the endogeneity of aggregate financial wealth, which results from agents' portfolio allocation. Jarsulic (1989) presents a non-linear macro-dynamic model in which the interaction between investment and financing conditions in the economy creates regular fluctuations in the form of a limit cycle. Some years later, Keen (1995) developed a "predator-prey" model in which the interaction between debt and equity creates regular fluctuations in debt levels and income functional distribution.

More recently, Fazzari, Ferri, and Greenberg (2008) built a model (FFG model) in which economic activity fluctuations are the result of investment and debt variations in a framework in which income distribution remains constant over time. The core of the FFG model is the incorporation of the *financial accelerator*, in which decisions about fixed capital investment are positively affected by firms' cash flow, which depends, in turn, on the financial services due to the debt stock, among other variables. Thus, the evolution of the nominal interest rate begins to have fundamental importance in investment dynamics and, consequently, in the dynamics of economic activity levels. By relating the inflation rate to economic activity levels through a modified version of the Phillips equation, FFG build a predator-prey relationship between investment and debt levels. As a matter of fact, increased investment generates a rise in the level of economic activity, which, in turn, results in higher inflation and nominal interest rates. The increase in the interest rate causes higher firm debt-service payments, thus reducing their cash flows. The reduction in cash flow will lower the incentive to invest, initiating a contraction in economic activity. This movement, in turn, induces a reduction of the inflation rate, causing the interest rate and the relative financial services related to companies' debt to drop.

However, the FFG model has some important limitations as a theoretical framework for the study of cyclical fluctuations. The first is the assumption that the nominal interest rate is independent of monetary policy, determined by the

Fisher equation, in which the nominal interest rate is the sum of a real interest rate (assumed to be constant over time) and the inflation rate (that oscillates according to the Phillips equation). Thus, monetary policy plays no part in the determination of the interest rate, eliminating *ex ante* the possibility of using monetary policy as an instrument for output and employment stabilization. Considering this, it is not possible to infer if the persistence of the cyclical fluctuations observed in the FFG model results simply from the inexistence of any anti-cyclical policy mechanism.

A second limitation refers to the source of the fluctuations in the FFG model. In fact, the FFG model's macroeconomic series presents regular fluctuations (constant periodicity and amplitude) around these variables' steady-state values. The problem with this type of fluctuation is that, in the real world, the macroeconomic series presents basically irregular fluctuations; that is, the periodicity and amplitude of the fluctuations are variable over time.

To address these issues, this article proposes to extend the FFG model by introducing a Taylor rule for the interest rate, and a Markovian process of generating speculative bubbles on the value of consumers' financial wealth, which influences aggregate consumption dynamics. These extensions are intended not only to make the model more compatible with Hyman Minsky's ideas about the financial dynamics of business cycles, but also to permit the evaluation of the role monetary policy and speculative bubbles play in the persistence of cyclical fluctuations.

This article will show that introducing a Taylor rule in the framework proposed by Fazzari, Ferri and Greenberg (2008) has the effect of generating damped cyclical fluctuations in the macroeconomic series (growth, unemployment, investment, and debt level). Under these conditions, the persistence of cyclical fluctuations cannot be explained just by the interaction between multiplier and accelerator effects. To get these fluctuations, a Markovian process is introduced into the generation of speculative bubbles for the value of financial wealth. These bubbles affect households' consumption expenditures, causing a macroeconomic dynamic characterized by persistent, and also irregular, fluctuations of the output growth rate.

The presence of speculative bubbles also allows for the theoretical possibility of a sharp fall in the level of economic activity (a depression), caused by their burst and the effects on families' consumption expenditures due to a sudden shrinkage in the value of their financial wealth.

It is important to stress that the objective of the present article is to make two amendments in Fazzari, Ferri, and Greenberg's model, not to develop a full and complete formal model of Hyman Minsky's theory of business cycles. This means that many aspects of Minsky's theory will not be dealt with in the model developed here, and some hypotheses adopted in the modified "Keynes-Minsky" model may have no relationship to Minsky's writings about business fluctuations. The modified Keynes-Minsky model presented here is thought to be a *useful device* for showing the role of monetary policy in stabilizing capitalist economies and the role of financial markets –and speculative bubbles– in creating instability and distress in such economies.

The article is organized in six sections, including this introduction. In the following, we present the original version of the FFG model, and we try to explain the endogenous cyclical fluctuations of output based on the elements of Minsky's theory. Then, we incorporate a Taylor rule into the model, while in the other section we discuss the compatibility between the Taylor rule and Keynes/post-Keynesian macroeconomic models. We shall argue that the main difference between post-Keynesian and new consensus macroeconomic models lies not in the specification of monetary policy rules but in the nature of long-term equilibrium outcomes, mainly the existence of path-dependence. In the penultimate section, we extend the model by including a Markovian generation process of speculative bubbles and their corresponding effect on aggregated consumption due to the wealth effect. This extension introduces a strong element of path-dependence in the Keynes-Minsky model, which is absent in its original formulation. The last section corresponds to the conclusions of the article.

The Fazzari, Ferri, and Greenberg Keynes-Minsky model

The core of the FFG model is the link between the investment function and expected output growth and cash flow. As is well known, Hyman Minsky bases his own theory on Kalecki's financial risk theory, in which the larger the firm's cash flow, the smaller the dependence that firm has on external financing sources, and, therefore, the smaller the borrower's and the lender's risk. Since borrower and lender risks act to determine the demand and supply prices of capital equipment, it follows that the larger the cash flow, the larger will be the ratio between supply and demand prices, and, therefore, the larger will be investment in fixed capital. This establishes a relationship known as financial accelerator, according to which an increase in cash flows –due, for example, to an increase of sales revenues– induces increased investment.

Another important characteristic of the FFG model is that its equations are built in a way that makes possible the calibration of all the parameters used in the model with real world data.

Formal model

Investment and finance

Equation [1] describes the behavior of the investment, where I_t is the real level of investment in period t; Y_{t-1}, is the real output in the previous period; $\hat{g}_t$, the expected growth rate of output between period $t-1$ and t; p_t, the price level, and $\hat{CF}_t$, expected nominal cash flow in period t.

$$I_t = \eta_0 Y_{t-1} + \eta_1 \hat{g}_t Y_{t-1} + \eta_2 \left(\frac{1}{p_t}\right) \hat{CF}_t \qquad [1]$$

The first term of equation [1] can be interpreted as investment to replace stocks; these stocks depend on the previous period's level of production; the second term is associated with the accelerator, in which firms invest to meet sales expectations; in other words, investment is induced by expectations of output growth.[2] Finally, the last term represents the influence that the expected cash flow $\hat{CF}_t$ –deflated by price levels p_t–, has on the real level of investment. Prices in period t are pre-determined and therefore known when firms choose period t investment. Cash flow, however, depends on period t output, which in turn depends on period t investment. Nominal cash flow therefore appears as an expected variable in the investment function.

$$\hat{CF}_t = p_t \hat{Y}_t - \hat{W}_t - R_t D_t \qquad [2]$$

That is, $\hat{CF}_t$ is equal to the expected nominal revenue in period t ($p_t \hat{Y}_t$) less the sum of the expected wage bill in t ($\hat{W}_t$) with the product of the pre-determined

2 The second term of the equation can also be thought of as investment to increase capacity, which depends on the variation of expected production.

nominal interest rate (R_t) that impacts over the pre-determined nominal stock of outstanding debt (D_t) at the beginning of period t.

To invest, firms use both internal resources and borrowed capital. Assuming that income distribution between wages and profits is given, we consider constant wage share in the expected nominal aggregate income (ω). Thus, equation [2] can be written as follows:

$$\hat{CF}_t = (1-\omega)\, p_t \hat{Y}_t - R_t D_t \qquad [2']$$

Now, we substitute [2'] in [1], obtaining:

$$I_t = \eta_0 Y_{t-1} + \eta_1 \hat{g}_t Y_{1-t} + \eta_2 (1-\omega) \hat{Y}_t - \eta_2 R_t \left(\frac{D_t}{p_t} \right) \qquad [3]$$

This new investment equation defines the real investment as a function of the nominal interest rate. Notice that the classical dichotomy does not play any role here. To analyze the economy's growth path, it is convenient to obtain the investment equation in its intensive form, which can be done by dividing equation [3] by Y_{t-1}. Perceive that $d_t = \dfrac{D_t}{P_{t-1} y_{t-1}}$ is the ratio of the beginning-of-period nominal debt to the lagged nominal income and $\dfrac{P_t}{P_{t-1}} = (1+\pi_t)$ is the inflation rate. Thus,

$$i_t = \eta_0 + \eta_1 \hat{g}_t + \eta_2 (1-\omega)(1+\hat{g}_t) - \eta_2 \frac{R_t d_t}{(1+\pi_t)} \qquad [4]$$

Observe that equation [4] captures several key features of Minsky's theory. First, it incorporates accelerator effects through the growth term $\hat{g}_t$, *i.e.*, the impact of growth over investment through the accelerator. Second, income distribution affects investment; that is, the investment rate depends on the wage share in income. Particularly, if the wage share is reduced, *ceteris paribus*, investment will increase, due to a rise in cash flow; this characterizes a profit-led accumulation regime. Third, the stock of accumulated debt from past financing activities affects current investment because the larger the indebtedness inherited from past financing activities, the smaller the cash flow, and consequently, the investment, will be.

Debt dynamics

Debt accumulation is given by the following equation:

$$D_{t-1} = D_{t-1} + [W_{t-1} + p_{t-1}I_{t-1} + R_{t-1}D_{t-1} - p_{t-1}Y_{t-1}] \quad [5]$$

where the term in brackets is the private sector's financing needs. If it is positive, it indicates the amount of new loans that the private sector wants to take out in period t. Dividing the debt accumulation equation by lagged nominal income $P_{t-1}Y_{t-1}$, yields the intensive-form debt equation:

$$d_t = \left[\frac{1+R_{t-1}}{(1+g_{t-1})(1+\pi_{t-1})}\right]d_{t-1} + \frac{i_{t-1}}{(1+g_{t-1})} - (1-\omega) \quad [6]$$

We can see in the equation above that wage-share variable ω affects the dynamics of debt accumulation. Equation [6] shows the dynamics of the debt, where the debt in the current period depends on that of the last period and on investment. In this equation, *ceteris paribus*, a lower wage share still reduces the accumulation of debt.

Consumption, aggregate demand, and output

Aggregate consumption in the FFG model depends as much on the income families obtained in the previous period as on the expectation they have regarding their income level in the current period. Thus, we have:

$$C_t = \lambda_1(1+\hat{g}_t)Y_{t-1} + \lambda_2 Y_{t-1} \quad [7]$$

where the coefficients λ_1 and λ_2 represent, respectively, the marginal propensity to consume based on expected income in the present period and in the previous period. This formulation assumes that consumers can be classified into two groups. The first behaves in an eminently "forward looking" manner, so that their consumption expenses are based on their expected income growth. These consumers can take out loans in capital markets to finance their current consumption based on their expectations of income increases in the future. The behavior of the second group can be described as "rule-of-thumb", in which consumption depends on the income obtained in the past, once these consumers are restricted by liquidity.[3] They do not have access to capital markets and, therefore, cannot take out loans to finance their consumption.

Output (aggregate supply) is determined by the principle of effective demand, being dependent, in a closed economy without government, on consumption and investment expenditures. In this way, we have the following:

$$Y_t = I_t + C_t \quad [8]$$

If we substitute equation [7] in equation [8], and divide equation [8] by lagged output (Y_{t-1}), we obtain aggregate supply in its intensive form, so that we can express the current economy's growth rate through the following equation:

$$1+g_t = \frac{Y_t}{Y_{t-1}} = i_t + \lambda_1\left(1+\hat{g}_t\right)+\lambda_2 \quad [9]$$

The labor market, wages, and prices

The price and nominal wage rates of inflation are both dependent on a Phillips curve and productivity growth. Wage inflation (π_t^w), or the rate of variation of the nominal wages, results from multiplying labor productivity growth (τ) by a term that depends on labor market conditions, as can be observed below in the equation:

$$1+\pi_t^w = (1+\tau)\left[1+\hat{\pi}_t - \sigma_1\left(u_{t-1}-u^*\right)-\sigma_2\left(u_{t-1}-u_{t-2}\right)\right] \quad [10]$$

This equation tells us that wage inflation depends on the growth rate of labor productivity, on expected price inflation ($\hat{\pi}_t$), on the difference between the previous period's unemployment rate and the unemployment rate at which wage inflation is unchanged (u^*), and on the variation of the unemployment rate in the two previous periods. The final term, $\sigma_2(u_{t-1} - u_{t-2})$ captures the unemployment "hysteresis." In other words, wage inflation does not depend only on the current situation in the labor market (represented by the lagged unemployment gap and the unemployment rate at which wage inflation is unchanged), but also on the history of unemployment.

[3] Regarding the impact of the liquidity restriction on the dynamics of the consumption, see Deaton (1992: Chapter VI).

Let l_t be the ratio of employment to the (constant) labor force:

$$l_t = l_{t-1}\left(\frac{1+g_t}{1+\tau}\right) \quad [11]$$

The employment ratio will evolve over time depending on the ratio of output growth to productivity growth. Fazzari, Ferri and Greenberg (2008) supposes technical progress to be exogenous in such a way that labor productivity is supposed to grow on a constant rate over time.

The firms in this economy form prices based on a fixed *mark-up* over unitary production costs. Since labor is the only variable input, it follows that prices' rate of variation is equal to wage inflation minus productivity growth:

$$\pi_t = \frac{1+\pi_t^w}{1+\tau} - 1 \quad [12]$$

Expectations

We assume *bounded rationality* and the existence of a competence-difficulty gap.[4] In this context, rationality in expectations formation requires that expectations be consistent with the results achieved in the model (consistency is defined as a high correlation between the expected result and the achieved result). This consistency can be obtained by the simplest possible static expectations rule:

$$\hat{X}_t = X_{t-1} \quad [13]$$

Computer simulation

Since the finite difference equations that make up the FFG model are non-linear, performing numeric simulations is required to explore their behavior. The simulation time span is 100 quarters (25 years). For the model simulations, we used the same parameter values used by FFG (2008).

[4] The idea of the competence-difficulty gap, or competence-difficulty gap, is that agents do not have enough cognitive capacity for solving an optimization problem. Thus, they are not capable of making decisions guided by the maximization of an objective function and are forced to make their decisions based on simple rules and routines. See Vercelli (1991: Chapters 4 and 5).

In the simulations, the initial conditions have to represent a stationary state in order to avoid time trends in variables, which distort the effects that we want to observe. Thus, when the model simulation begins with variables assuming their stationary values, these values remain constant over time. To begin the cycles, Fazzari, Ferri and Greenberg (2008) introduce an exogenous shock of 0.005 in the investment variable, in the third period, which is approximately 2.4 percent of the steady-state investment. The simulations begin in period zero, with the parameters used by Fazzari, Ferri and Greenberg (2008), obtained from the empirical literature and representing realistic values for the US economy (see table 1).

Table **1**

Parameter values chosen for the standard model simulation

η_1	0.15	λ_1	0.4	τ (año)	0.03
η_2	0.35	λ_2	0.4	π^* (año)	0.02
W	0.80	σ_1	0.05	u^*	0.04
r (año)	0.01	σ_2	0.15	g^* (año)	0.03

The variable values in each simulation period are calculated from the values they had in the previous period, or their expectations, according to the equations that describe the model, presented previously.

Based on the parameters presented above, Fazzari, Ferri and Greenberg (2008) calibrate the model to ensure the integrity of the equations in stationary state. The economy growth rate, price-inflation, and the nominal interest rate are chosen exogenously, so it is necessary to calculate investment and debt in the intensive form stationary values that equate aggregate demand and aggregate supply. The calculations are made from equations [9], [6], and [4], resulting in the following stationary values:

$$i^* = 1 + g^* - \lambda_1(1 + g^*) - \lambda_2$$

$$d^* = \frac{i^* - (1-\omega)(1+g^*)}{g^* - r^*} \qquad [14]$$

$$\eta_0 = i^* - \left[\eta_1 g^* + \eta_2 (1+g^*)(1-\omega) - \eta_2 d^* \frac{R^*}{(1+\pi^*)}\right]$$

It is important to note that to obtain a steady state, labor productivity growth τ and steady-state real output growth (g_t) have to be the same. This is true for all the simulations presented in this article. We used and presented quarterly rates in all calculations, obtained from the division of the annual rate by 4. This simulation's results are presented in figure 1.

The FFG model simulation results show the occurrence of regular and persistent fluctuation for the macroeconomic series (growth, unemployment, prices-inflation, nominal interest rate, investment, and debt level). The fluctuation range is compatible with the values observed for the US economy. The dynamics of the investment and the interest rates show a typical "predator-prey" pattern for the variables under consideration.

Extension of the model to include monetary policy

The original FFG model assumes that the nominal interest rate is independent of monetary policy, which may restrict the model's ability to generate persistent fluctuations in a context in which monetary policy is an instrument to stabilize the level of activity.

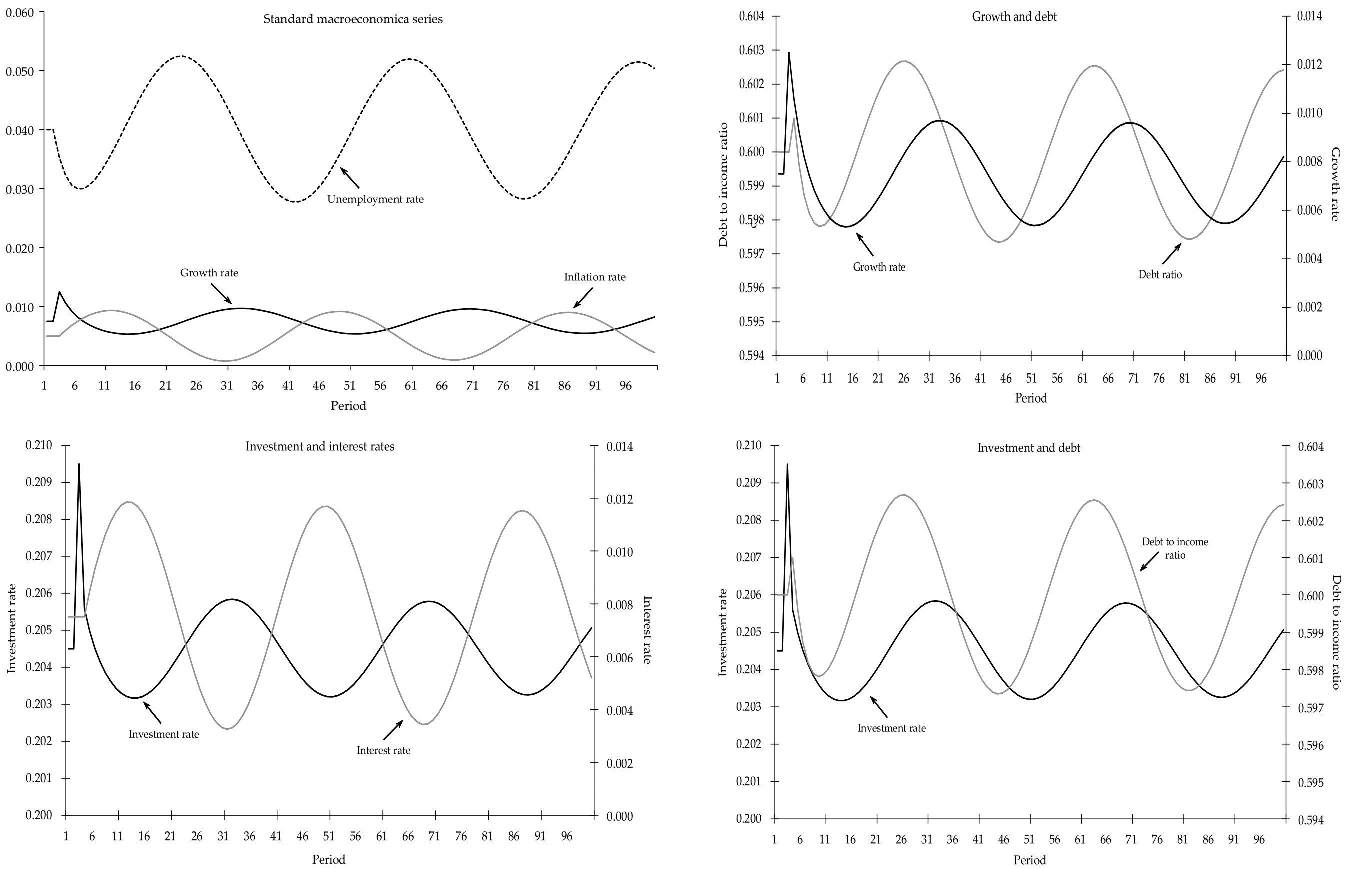
Monetary policy will be introduced in the context of the FFG model by using a Taylor rule –proposed by Taylor (1993)–, which states that the short-term interest rate is fixed by the central bank in order to get an inflation rate that allows the economy to expand at the potential growth rate. The nominal interest rate proposed by the rule depends on the equilibrium value of the real interest rate, on the period output (annualized) deviation from the full employment output, and on the annual price-inflation rate deviation from the target for inflation. The interest rate calculated by the rule is higher than equilibrium's value when inflation is above its target, and is lower than equilibrium's value when either inflation is below its target or output is lower than the full employment level.

It is important to notice that this rule is not incompatible with Keynesian/post-Keynesian views about the operation of monetary policy in sophisticated monetary economies. Indeed, in the post- Keynesian amendment of the new consensus macroeconomic model made by Lavoie (2004), it is explicitly supposed that monetary policy is conducted according to a Taylor rule. In the words of Lavoie, "The standard central bank reaction functions [...] look reasonable to me" (Lavoie, 2004: 24).[5]

[5] A similar opinion about the compatibility of the Taylor rule and post-Keynesian models is found in Setterfield (2004).

FIGURE 1

FFG original model macroeconomic series dynamics



The Taylor rule is expressed as follows:

$$R_{T,t} = \pi_t + r + \alpha_\pi \left(\pi_t - \pi^*\right) + \alpha_y \left(\frac{\hat{Y}_t - Y_{f,t}}{Y_{f,t}} \right) \quad [15]$$

In [15], $Y_{f,t}$ is the full employment output, calculated from a previous period output; r is the equilibrium real interest rate; α_π and α_y, weights for inflation rate and output growth, respectively; π_t, the period t prices' inflation rate; π^*, the target for the price inflation rate; and $Y_t = \left(1 + \hat{g}_t\right) Y_{t-1}$.

When this rule is embedded in the original model, the nominal interest rate is determined by price-inflation rate from $t - 1$ to t, and also by output growth from $t - 1$ to t. The price-inflation rate from $t - 1$ to t is already known at the beginning of the period t, but output growth is not. For this reason, one uses the expected value of output growth $\hat{g}_t$, which is equal to g_{t-1}, according to the naive forecasting model adopted here. The full employment output is the product that would be obtained if the economy grew at full employment. This growth, $g_{f,t}$, is calculated from [11], considering that production is linear and that $l_t = 1$ (full employment):

$$g_{f,t} = \frac{1+\tau}{1-u_{t-1}} - 1$$

Thus,

$$Y_{f,t} = \frac{1+\tau}{1-u_{t-1}} Y_{t-1}$$

Which leads to the equation for the nominal interest rate target (annualized rates):

$$R_{T,t} = \pi_t + r + \alpha_\pi \left(\pi_t - \pi^*\right) + \alpha_y \left(\frac{\left(1-u_{t-1}\right)\left(1+\hat{g}_t\right) - (1+\tau)}{(1+\tau)} \right) \quad [16]$$

In equations [4] and [6], the nominal interest rate obtained from [16] replaces the nominal interest rate adopted in the original model:

$$i_t = \eta_0 + \eta_1 \hat{g}_t + \eta_2 (1-w)\left(1+\hat{g}_t\right) - \eta_2 d_T \frac{\max\left(R_{T,t};0\right)}{1+\pi_t} \quad [4a]$$

$$d_t = \left(\frac{1 + \max\left(R_{T,t-1};0\right)}{\left(1+g_{t-1}\right)\left(1+\pi_{t-1}\right)} \right) d_{t-1} + \frac{i_{t-1}}{1+g_{t-1}} - (1-w) \qquad [6a]$$

In both equations above, it is assumed that the interest rates $R_{T,t-1}$ (or $R_{T,t}$) are non-negative.

Simulation of the model incorporating the monetary policy rule

The behavior of the model extended to include monetary policy, according to the Taylor rule, was simulated following the same principles adopted in the simulation of the original model, using equations [16], [4a], and [6a]. For the purpose of comparison with the original model, the same values for the parameters and variables used in the original model simulation were utilized. The weights for inflation and output were chosen following Taylor (1993), who recommends that one use $\alpha_\pi = \alpha_y = 0.5$. To calibrate the model, the following steady state values are calculated:

Steady state nominal interest rate:

$$R_T^* = \pi^* + r + \alpha_y \left(\frac{\left(1-u^*\right)\left(1+g^*\right)}{(1+\tau)} - 1 \right)$$

Investment and debt in the intensive form, and replacement rate of capital per output unit:

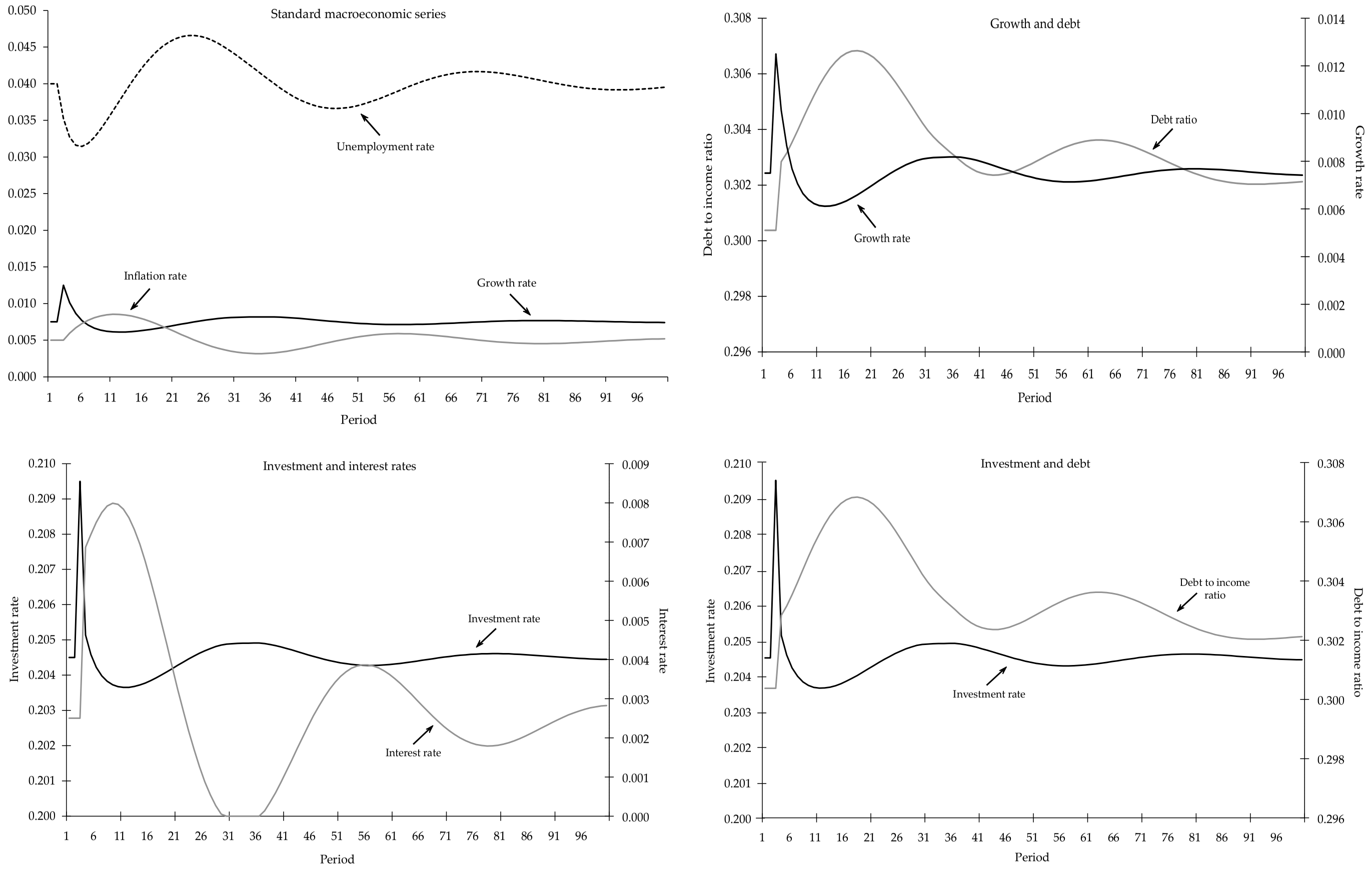
$$i_T^* = 1 + g^* - \lambda_1 \left(1+g^*\right) - \lambda_2$$

$$d_T^* = \frac{\left[i_T^* - \left(1+g^*\right)(1-w)\right]\left(1+\pi^*\right)}{\left(1+g^*\right)\left(1+\pi^*\right) - 1 - R_T^*}$$

$$\eta_{T0} = i_T^* - \left[\eta_1 g^* + \eta_2 \left(1+g^*\right)(1-w) - \eta_2 d_T^* \frac{R_T^*}{\left(1+\pi^*\right)} \right]$$

The figure 2 presents the results of this simulation.

FIGURE 2
Macroeconomic dynamics into the extended model



The Taylor rule incorporation in the original FFG model dampens the fluctuations observed in the macroeconomic series, which disappear in the long term. This suggests that monetary policy contributes decisively to the stabilization of the economic activity level, even if it is implemented by a simple rule, like the Taylor Rule.[6] This dampening of fluctuations comes from the impact that the new nominal interest rates have on debt: when the price-inflation increases (decreases), the Taylor rule recommends an increase (reduction) in the interest rate, which influences debt fluctuations, which then follow the inflation rate oscillations. In addition to this, unemployment fluctuations cause adjustments almost in-sync with that originated from the inflation rate. Debt increases when investment decreases and vice-versa, which dampens investment fluctuations. Another important aspect to note is the magnitude of the correction made by the Taylor rule to the interest rate that results from the sum of the inflation rate to the real interest rate: the greater the weight values α_π and α_y, the greater is that correction. In figure 2, investment and interest rates we can see that the nominal interest rate reaches zero between periods 30 and 36. This allows us to conclude that, if the weight values are high enough, the Taylor rule's effect on the economy may not be able to lead it to stabilization, once the effect is asymmetrical due to the nominal interest rates having a lower bound equal to zero.

In this model, the adoption of the monetary policy rule eliminates cyclical fluctuations in the long term. However, in the real world, these fluctuations are observed despite the presence of an active monetary policy; hence, other factors may exist that contribute to the existence of these fluctuations, in addition to the interaction between the multiplier and the accelerator. The US economy is an example of one in which these fluctuations persist simultaneously with the adoption of an active monetary policy.

Is the Taylor rule compatible with the Keynes/Minsky model?

A very common objection to the adoption of a Taylor rule in Keynesian macroeconomic models is that it means the implicit recognition of inflation control as monetary policy's most important or sole objective. Although such a rule

[6] This result is also in accordance with the new consensus view about the adoption of a monetary policy rule such as the Taylor rule within the scope of a standard macroeconomic model (see Lavoie, 2004: 20).

was originally thought of as a description of the actual behavior of monetary policy rather than a normative guide for policy makers, its acceptance by the new macroeconomic consensus as a building block for macroeconomic models gives the –wrong– impression that its acceptance also means the acceptance of the other elements of the new consensus, in particular the adoption of a inflation-targeting regime (ITR).

The new consensus on macroeconomics establishes that a low and stable inflation rate is of paramount importance for long-term growth (Arestis and Sawyer, 2006b: 5) and that there is no long-run trade-off between inflation and unemployment (Fontana and Palacio-Vera, 2007). Another feature of the new consensus is that discretion in monetary policy operation should be limited in order to ensure a low, stable inflation rate and to minimize the variability of output growth. Although the adoption of a simple k-percent rule, as suggested by Friedman (1968), may not be an optimal monetary policy in an uncertain environment (Walsh, 2001: 467-72), the mainstream literature on monetary policy argues that central banks' discretion must be institutionally restricted –by making the central bank independent– in order to reduce the problem of *inflationary bias* that arises when monetary policy is conducted in a discretionary fashion. "Constrained discretion", to use Bernanke's famous terminology (Bernanke *et al.*, 1999), can be attained by the adoption of a monetary policy framework in which the central bank's actions and goals are transparent and accountable.

Transparency and discipline in the operation of monetary policy require it have a nominal anchor. In the 1990s, a growing number of countries adopted an inflation-targeting regime (ITR). The ITR is a framework for monetary policy in which: 1) a numerical target or range for inflation rate is defined as the most important or the sole goal of monetary policy; 2) the target rate of inflation is supposed to be achieved by means of appropriate changes in nominal short-term interest rates set by the central bank, and 3) monetary policy is conducted by an independent central bank (Sawyer, 2006). The widespread use of an ITR has been partially due to the failure of the other nominal anchor strategies to control the rate of inflation. Alternative nominal anchors are exchange-rate targeting and monetary targeting. In the case of monetary targeting, the problem was due to the fact that the empirical relationship between inflation and monetary aggregates became very tenuous in the 1970s, probably due to the direct result of financial innovations that occurred from that time on, which produce a remarkable instability in the circulation velocity of money.[7] The exchange-rate target was in most cases abandoned in the 1990s after the emergence of a great number of successive currency crises in several countries (Argentina, Brazil, Russia, East Asian countries) as a result of the perverse combination between a fixed-exchange-rate regime with liberalized capital accounts.

So, the new consensus on macroeconomics establishes that ITR is a good institutional framework to assure and maintain low inflation rates and to minimize output fluctuations.[8] The reason is that ITR is supposed to produce a "constrained discretion" that combines some flexibility and credibility in an ideal way, permitting the central bank to react to unforeseen recessions by means of the appropriate change in short-term interest rates in order to minimize output fluctuations around the long-run trend of output (Bernanke *et al.*, 1999); it also reduces the degrees of the central bank's freedom to produce "inflation surprises" in order to explore the short-run trade-offs between inflation and unemployment.

This optimism about the virtues of ITR is not shared by post-Keynesian and other heterodox economists. For most post-Keynesians, ITR cannot be considered an appropriate framework for monetary policy given that:

1) It is based on the axiom of money neutrality,[9] since it assumes the existence of a *natural rate of unemployment,* determined by the supply side of the economy and largely independent of monetary policy (Arestis and Sawyer, 2005; Palley, 2006a);
2) It assumes that inflation is largely the result of excess aggregate demand, that is, a situation where aggregate demand is higher than equilibrium output determined by the supply side of the economy.

Post-Keynesian economics, on the other hand, assumes that money is non-neutral in the short and in the long run, which means that there is no long-run equilibrium for the economy that is independent of monetary policy (Carvalho,

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[7] As Carlin and Soskice (2006) pointed out, in the United Kingdom it was common that when monetary authorities tried to control a particular monetary aggregate, there was a sequential response from the financial system that generated close substitutes to money, hence getting rid of the target established. Instability in money demand (or the instability of money transaction velocity) undermines the link between the monetary growth target and inflation. These problems led to the end of this practice in United States, Canada, and the United Kingdom.

[8] About this consensus, see among others Woodford (2003).

[9] About the importance of the axiom of money neutrality for mainstream economics, see Davidson (2002: 41) and Carvalho (1992: 32).

1992: 38). Furthermore, it posits that the economy cannot be understood without reference to the level of aggregate demand, important not only in the determination of the level of economic activity but also through its influence on the rate of investment (Arestis and Sawyer, 2005: 966). Changes in the level of investment expenditures affect not only the level of aggregate demand through the standard Keynesian investment multiplier, and hence the current level of unemployment, but also the equilibrium rate of unemployment –that is, the level of unemployment for which inflation is constant through time– due to its effects on the level of capacity utilization and, through this variable, the level of real wages that firms are ready to pay their workers.

A fall in investment expenditures due to a tight monetary policy, will result in an increase in current unemployment and in the level of unemployment for which inflation is constant over time.[10] So, the equilibrium rate of unemployment depends on the time path of the current level of unemployment, becoming an equilibrium that is *path-dependent*. The time path of current unemployment, on the other hand, is determined by the dynamics of aggregate demand, which is largely influenced by the operation of monetary policy (Arestis and Sawyer, 2005: 967).

Money is non-neutral over the long-run equilibrium configuration of the system. As a direct corollary of money's long-run non-neutrality, there is no sense in defining price stability as the most important or sole goal of monetary policy as required by an ITR.

Another disagreement of post-Keynesians with the inflation targeting framework involves the nature of the inflationary process. For post-Keynesians, an excess of aggregate demand can only produce pressure for increased prices in spot markets (see Davidson, 2006: 693-4). If *spot prices* are higher than forward prices, then a quantity adjustment will occur in order to assure the elimination of inflation produced by excess demand (Davidson, 2006: 697). Forward prices, however, are not influenced by demand conditions, but determined by flow-

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[10] Rowthorn (1999) developed a wage bargaining model where the target real wage by labor unions and desired mark-up by firms depend on the ratio between capital and effective labor. This means that a decrease in the rate of capital accumulation relative to natural rate of growth will produce a decrease in that ratio and a change in the unemployment rate for which target real wage and desired mark-up are compatible with each other. For realistic values of the parameters of the model (more precisely, an elasticity of substitution between capital and labor less than one), a decrease in the rate of capital accumulation will be followed by an increase in the equilibrium rate of unemployment.

supply prices of goods and services, which depend upon the profit margins desired by entrepreneurs and real wages desired by labor unions. This means that a persistent increase in the level of prices could only occur as a result of a distributive conflict between wages and profits (Davidson, 2006: 699).

This is the basis of the so-called *structuralist view of inflation*, according to which inflation is the result of a conflict between workers and capitalists over the distribution of income[11] and of cost factors, such as the prices of raw materials, especially oil (Arestis and Sawyer, 2005). In this framework, if workers' *target wage* and firms' *target mark-up* are exogenously determined, then the inflation rate is insensitive to central bank changes in the short-term interest rate (Palley, 1996: 182). In the general case, however, where the *target real wage* and the *target profit margin* are both sensitive to changes in the unemployment rate, a tight monetary policy can induce unions to accept a lower target for real wages and/or entrepreneurs to accept a lower profit margin, restoring the equilibrium in income distribution and stopping the acceleration of inflation. The costs of such a policy, however, are high, as monetary policy by the central bank are implicitly indorsing an incomes policy based on "fear" of loss of jobs and sales revenues for firms that produce goods and services domestically (Davidson, 2006: 701).

For post-Keynesians, a more reasonable policy to control inflation in the case of a distributive conflict between profits and wages would be to adopt some sort of income policy that encourages the conciliation between capitalists' and workers' demands by other means than increased unemployment (Davidson, 2006: 700).[12] Although a tight monetary policy can be used to reduce the inflation rate in a setting where target real wage and target mark-up rates

[11] According to Rowthorn (1999), who can be considered one of the founding fathers of the theory of conflict inflation, this theory can be summarized as follows: 1) unanticipated inflation is the outcome of inconsistent claims on total output; 2) unanticipated inflation cannot be permanently sustained because it leads to accelerating and ultimately explosive price increases; 3) to prevent unanticipated inflation, *ex-ante* claims on total output must be mutually consistent and add up to *ex-post* total output. Consistency is brought about through variations in the level of economic activity, in particular through unemployment and its influence in wage (price) formations; 4) the non-accelerating rate of unemployment (NAIRU) is that level of unemployment which eliminates unanticipated inflation (Rowthorn, 1999: 3).

[12] One possible example of income policy is the tax-based incomes policy (TIP) suggested by Weintraub (1958). TIP required the use of the corporate income tax structure to penalize the largest domestic firms in the economy if they agreed to wage increases in excess of some national productivity improvement standard (see Davidson, 2006: 702).

are sensitive to changes in the unemployment rate, reduced inflation should be pursued by means of an income policy that equalizes both targets at a very low unemployment levels.

More recently, some post-Keynesian economists have begun to reconsider the theoretical compatibility between ITR and Post-Keynesian economics. One example is Palley (2006a; 2006b). In Palley's view, ITR could make sense for post-Keynesian economics if one postulates the existence of a *backward bending* long-run Phillips curve. The logic of his reasoning is based on the idea that for very low inflation levels, workers have some kind of "money illusion," since inflation can help grease the wheels of labor market adjustment by facilitating relative wage and price adjustment in a sector with unemployment, which creates a negative ratio between inflation and unemployment over a limited range of the long-run Phillips curve. For that range, monetary policy should be conducted to achieve an inflation rate that minimizes the unemployment rate. In order words, monetary policy should be guided by minimum unemployment rate of inflation, which represents the point where inflation's overall labor market greasing effect is optimal. Once inflation rises above a threshold level, workers resist real wage reductions, so inflation loses its labor market greasing effect (Palley, 2006a: 248). In this approach, an ITR is a desirable framework for achieving the lowest level of unemployment compatible with a stable rate of inflation (Palley, 2006a: 248-9).

Another example of the issue at hand is Setterfield (2005). He developed a macroeconomic model with post-Keynesian features, where output is demand-determined, inflation results from a distributive conflict between workers and capitalists, and the central bank defines an explicit target for the rate of inflation as well as a target for real output. In other words, his model involves policy-making that "explicitly recognizes both the importance of aggregate demand conditions for real economic activity and the 'conflicting claims' basis of the inflation process" (Setterfield, 2005: 15). In this framework, it is possible to show that the system's long-run equilibrium is stable, which demonstrates the potential desirability of an ITR for the stability of an economy with post-Keynesian features. Policy implications of this approach include that 1) it is high rates of inflation (in excess of 10% or more) that policy should seek to address, and 2) real economic performance should be given priority by monetary authorities.

As is well known, the empirical literature about the success of ITR in fighting inflation is still controversial.[13] In a review of recent empirical literature about the relationship of interest rates and inflation, Arestis and Sawyer (2006b) found that the macro-econometric models for the Euro zone (the ECB area-wide model) showed a small effect of interest rate changes over the rate of inflation. More precisely, they found that a 1% increase in the short-term interest rate in the Euro zone for two years produced a peak reduction of 0.16 percentage point in the second year, which is reduced to only a 0.08 percentage reduction in inflation in the fourth year and reversed to the benchmark level of the simulation in the fifth year. However, the impact of interest rate changes on investment expenditure is substantial. They report that a 1% increase in short-term interest rates for two years reduced investment expenditure by 0.39 percentage points after five years.

This evidence suggests that interest rate variations can have long-lasting effects on investment and capital stocks, showing the long-run non-neutrality of monetary policy (Arestis and Sawyer, 2006b: 16). This result shows that monetary policy should be implemented to produce *moderate changes* in short-term interest rates in order to avoid huge (negative) effects on capital accumulation and the equilibrium rate of unemployment.[14] The low elasticity of inflation to interest rates also calls into question the possibility of controlling inflation rates only by means of an interest rate policy, as is supposed by the ITR framework. In face of this empirical evidence, Arestis and Sawyer (2006a) suggest that some form of "prudential credit controls" should be adopted in cases in which it is necessary to limit the expansion rate of aggregate demand.

All these considerations show that the adoption of a Taylor rule is not incompatible with Keynes/post-Keynesian ideas about the implementation of monetary policy. In fact, moderate changes in short-term interest rates –such as the

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[13] Comparing seven Organisation for Economic Co-operation and Development (OECD) countries that adopted inflation targeting in the early 1990s to 13 that did not, Ball and Sheridan (2003) find that, on average, there is no evidence that ITR improves performance –as measured by the behavior of inflation–, output, and interest rates. They conclude that "the formal and institutional aspects of targeting –the public announcements of targets, the inflation reports, [and] enhanced independence of central banks– are not important. Nothing in the data suggests that convert targets would benefit from adopting explicit targets" (Ball and Sheridan (2003: 29). See also Angeriz and Arestis, 2007.

[14] Due to the long-run effects of capital accumulation on the unemployment rate, moderate changes in short-term interest rates are required for the central bank's to accomplish their double mandate: keeping inflation low and stable and maximizing the rate of economic growth.

ones obtained by the use of a Taylor rule– are compatible with inflation control and maintaining a strong pace of capital formation and economic growth. The true difference between post-Keynesian and new consensus macroeconomic models lies not in the specification of monetary policy rules, but rather in the nature of long-run equilibrium positions. In the new consensus macroeconomic models, long-run equilibrium is supply-determined and independent of the sequence of short-run outcomes, so that history does not matter. In the post-Keynesian models, however, the long run is nothing less than the result of the historical sequence of short-run outcomes.

This path-dependent property of post-Keynesian models will be achieved in the Keynes-Minsky model developed so far by a new amendment: the introduction of Markovian bubbles.

A further extension: Markovian bubbles and the wealth effect

In this section, we will check if the occurrence of a usual event, such as speculative bubbles, could explain the persistence of cyclical fluctuations in economies with an active monetary policies.

Speculative bubbles are associated to sudden changes in agents' expectations concerning the future cash flow of some of their assets, affecting the value assigned to these assets, and, hence, the values assigned to the portfolios to which they belong.

In an optimistic phase, the agents assign their asset prices higher than those that would be assigned if a less optimistic evaluation of their expected returns were made. If we add to this the fact that the agents tend to assess the assets using the most recent information about the economy (adaptive expectations), we find a progressively increasing optimism, with corresponding rises in asset prices characteristics of a bubble-growth phase. These hikes do not cause financial crises until the bubble bursts, *i.e.*, when some event leads a significant group of agents to change their expectations more pessimistically. Expecting losses, investors try to unwind their position in these assets before the expected losses materialize, which leads to a new price drop. This price-reduction process becomes cyclical and accelerates the fall, which generates the crisis, once there is an increase of debt associated to the bubble-growth process, for investing purposes (to face the increase in demand) and for consumption purposes. The actual cash flow becomes inferior to what was expected, leading to the default of an agents' share, which, in turn, reduces the cash flow received by other agents and propagates the crisis.

Therefore, an extension of the FFG model is proposed by including a deterministic Markovian bubble (Salge, 1997), which affects agents' wealth, thus impacting consumption expenses through the wealth effect. As seen before, in the original model, agents' consumption depended on parameters λ_1 and λ_2 which represented their marginal propensity to consume based on expected and past income, respectively. Including the wealth effect adds a new element to agents' consumption functions. This wealth is uniformly distributed among them, and consists of the aggregated share value, *i.e.*, of the overall capital of the firms in the model in the initial period. This value is subjected to a Markovian bubble. In each period, the wealth value can grow at a fixed rate, when the bubble grows, or fall suddenly to the initial value, if the bubble bursts. The bubble dynamics are exogenously defined: its parameters are the annual growth rate and the likelihood that it burst in each period.

The model's assumptions are:

a) Firms do not have stocks in their portfolios.
b) Stocks are not sold in the primary market during the simulation.
c) Non-enterprise consumers own the stocks. In the beginning of the simulation, their actual value is obtained from $\eta_0 = \delta\varphi$, where δ is the annual depreciation rate and φ is the output/capital ratio.
d) The initial agents' wealth value is these stocks' value, given by the capital value at the beginning of the simulation $V_0^s = Y_0\eta_0 / \delta$, where Y_0 is the output in the period zero.
e) The wealth effect in consumption is linear, resulting in the independence of the global effect of the agents' wealth on consumption from the wealth distribution among them.
f) The wealth effect is backward-looking: consumers take into account the wealth owned at the beginning of the period, which is equal to that owned at the end of the previous one, instead of taking into account the wealth they will own at the end of the present period.
g) The bubble behavior is described in real terms (not in nominal terms) by an annual growth rate b and by the bubble bursting probability in each period of the simulation P_b. Hence:

$V_t^s = V_{t-1}^s(1+b)$ with probability $(1 - P_b)$ – if the bubble grows.

$V_t^s = V_0^s$ with probability P_b – if the bubble bursts

For bubble growth, it is required that $b > g_t$. The new stock's value after the bubble's evolution is known at the end of each period t.

In Markovian bubble modeling, the initial agents' wealth is obtained from the output-capital ratio: it is the aggregate value, unaffected by bubbles, of the firms' stocks. After the bubble bursts, the agents' wealth is modeled exogenously: it is assumed that the firm's capital comes back to this value, *i.e.*, $V_0^s = Y_0 \eta_0 / \delta$.

Consumption is calculated from the wealth effect coefficient λ_3 by:

$$C_t = \lambda_1 \left(1 + \hat{g}_t\right) Y_{t-1} + \lambda_2 Y_{t-1} + \lambda_3 V_{t-1}^s$$

From [9], using the intensive form of the agents' wealth and consumption, one gets:

$$g_t = i_t + \lambda_1 \left(1 + \hat{g}_t\right) + \lambda_2 - 1 + \lambda_3 v_{t-1}^s \qquad [9a]$$

This equation replaces equation [9] in the original model. The bubble motion equations are obtained from:

$$v_t^s = \frac{V_t^s}{Y_t}, \; v_{t-1}^s = \frac{V_{t-1}^s}{Y_{t-1}} \text{ and } V_t^s = V_{t-1}^s \left(1 + b\right)$$

The intensive form is: $v_t^s = v_{t-1}^s \dfrac{(1+b)}{\left(1+g_t\right)}$.

Thus, the bubble motion equations are:

$$\begin{cases} v_t^s = v_{t-1}^s \dfrac{(1+b)}{\left(1+g_t\right)} & \text{with probability } (1 - P_b) \\ vt = v_0^s & \text{with probability } P_b \end{cases} \qquad [17]$$

Simulation of the model with bubbles, wealth effect, and monetary policy

For simulating this model, we used equations [16] and [17], replacing equations [4], [6] and [9] with [4a], [6a], and [9a]. The same parameters adopted in previous simulations were used with the addition of those associated to the bubble and to the wealth effect, which follow:

Table **2**
Extended model additional parameters

(λ_3)[15]	0.0001	δ (año)[16]	0.035
(b)[17]	0.4	P_b (periodo)[18]	0.125

As in previous cases, the model calibration requires the calculation of steady state[19] values for both investment and debt in the intensive form. The steady state values are calculated from those obtained for the model that included monetary policy without wealth effect. The steady state nominal interest rate expression remains the same as previously. The intensive form values for investment and debt, and the capital replacement rate by output unit are obtained from:

$$i_{Tw}^* = i_T^* - \frac{\lambda_3 \eta_{Tw0}}{\delta}$$

$$d_{Tw}^* = d_T^* - \frac{\lambda_3 \left(1+\pi^*\right) \eta_{Tw0}}{\delta\left[\left(1+g^*\right)\left(1+\pi^*\right)-1-R_T^*\right]}$$

$$\eta_{Tw0}^* = \eta_{T0}^* \Big/ \left\{1+\frac{\lambda_3}{\delta}+\frac{\eta_2 \lambda_3 R_T^*}{\delta\left[\left(1+g^*\right)\left(1+\pi^*\right)-1+R_T^*\right]}\right\}$$

Figure 3 presents some results for this simulation. Initially, the authors present the steady *state values* for the nominal interest rate (R_T^*), intensive form investment (i_t), intensive form debt (d_t), and the corresponding value for the capital replacement rate by output unit η_0 for each model simulated:

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15 Stiglitz (1992) suggests the value of 0.0006; however, for this value, the steady state debt is negative.

16 As in Romer (2001).

17 Value consistent with the appreciation of the Bovespa Index between March 2003 and June 2008.

18 That is, the mean period between bubble bursts is 2 years.

19 The steady-state values calculation for the model with bubble and wealth effect is performed for a constant agent's wealth. This is done by setting the probability of a bubble burst in a period equal to 100 percent.

Table 3
Steady state values comparison for the original and extended versions of the FFG model

Model	R_T^* *(year)*	i^*, i_T^*, i_{Tw}^*	d^*, d_T^*, d_{Tw}^*	$\eta_0, \eta_{T0}, \eta_{Tw0}$
Standard (no monetary policy, no wealth effect)	–	0.2045	0.6000	0.1344
With monetary policy	0.01	0.2045	0.3004	0.1331
With monetary policy and wealth effect	0.01	0.2030	0.1499	0.1315

The growth rates for the real interest rate, unemployment, and labor productivity in equilibrium are the same in all three simulations. Including a Taylor rule –despite not affecting the investment rate and having little influence on the capital replacement rate by output unit– causes a noticeable reduction in firms' indebtedness, once the nominal interest rate obtained from the Taylor rule is lower than that which results from the composition of the real interest rate with the price-inflation rate. This happens in steady state equilibrium in the simulation because the output level is lower than that obtained at full employment. When the debt balance is corrected with a relatively low nominal interest rate, the economy reaches the same growth and investment level with less indebted firms. The same happens, to a higher degree, in an economy in which the wealth effect in agents' consumption is taken into account.

In a steady state, the agent's wealth increases consumption, contributing to a small reduction in the investment needed for maintaining the growth rate of the equilibrium output. This reduction leads to an additional decline in firms' indebtedness, if compared to what occurs only with the adoption of a monetary policy at the same growth rate.

The following tables present events associated to a specific growth path and the bursting of a bubble that led to a recession. The recession-related events caused by this bubble bursting are the same for other particular bubbles bursting with recessions, so that one can consider that the facts presented below are stylized. For this presentation, a bubble was selected that grew more before bursting, the bubble in which consumers' wealth grew from period (quarter) 55 to 80.

FIGURE 3

Macroeconomic dynamics in an extended model with bubbles, wealth effect and monetary policy

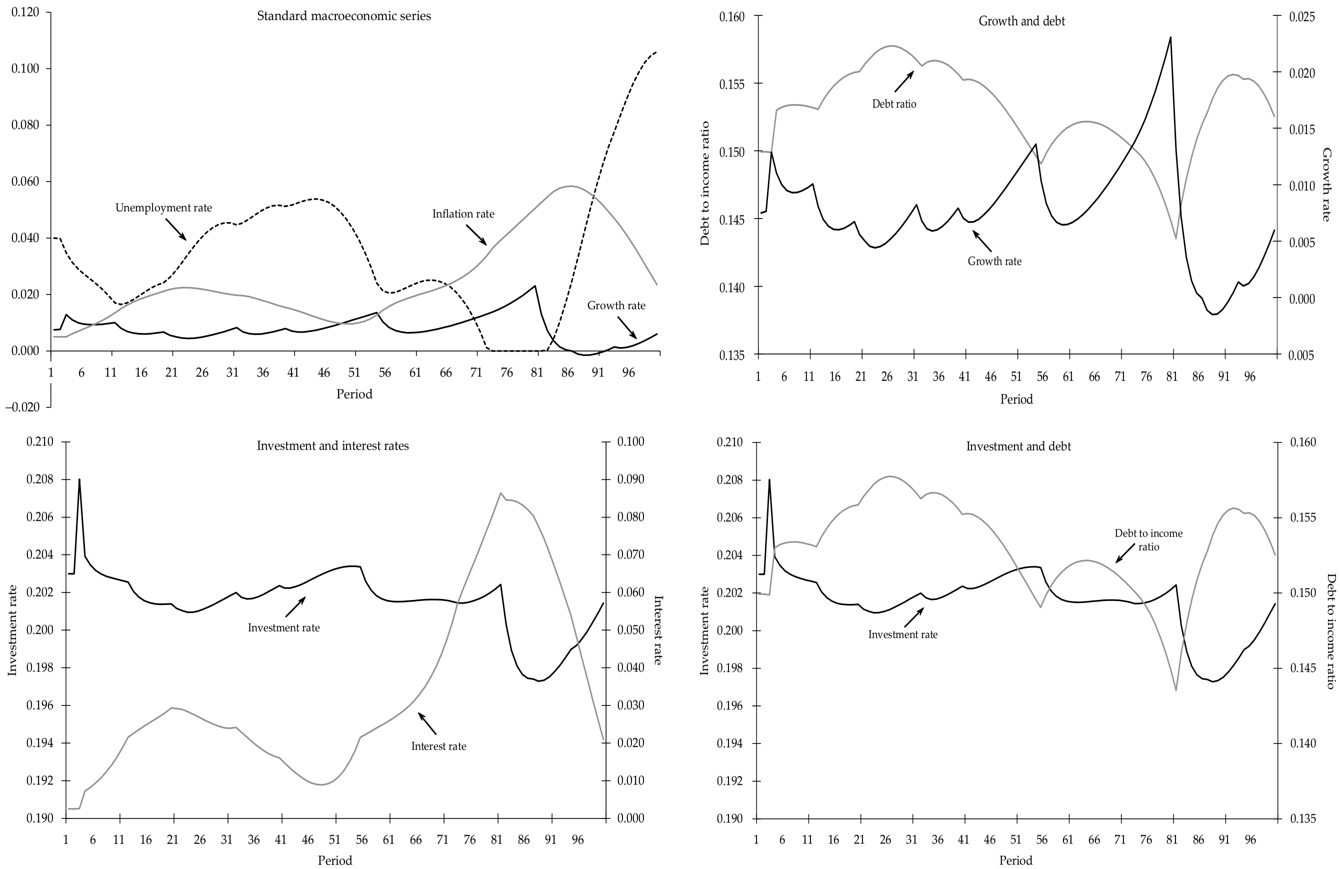

Figure 3, continuation...

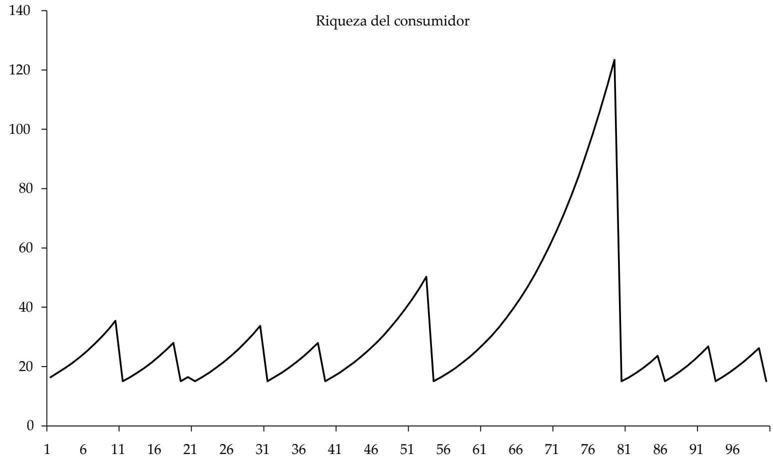

Table 4
Events related to a particular bubble

Event	*Simulation period (quarter)*
Beginning of bubble growth	55
Bubble bursts	80
Agents' wealth loss related to the bursting of the bubble that originated the crisis	Intensive: 108.4 Percentage: 87.8%
Beginning of the spread to the economy of the effects of the bubble bursting	81
Recession term	86 a 91
Output loss accrued in the recession term	0.6 %

Table 5
Reaction of the economy to a specific bubble

Variable	*A*	*B*	*C*	*D*	*E*	*F*
g	0.0075	↑	0.0231	↓	–0.0015	7
u	0.04	↓	0	↑	0.106*	19
i	0.203	↑ o ↓	0.202	↓	0.197	7
Ø	0.005	↑	0.053	↑ ψ ↓	0.058	5
r	0.0025	↑	0.086	↓	0.021*	19
d	0.150	↓	0.144	↑	0.156	11

Notes: Rate values for *g*, *i*, Ø, *r*, *d* are not in percentages and are on a quarterly basis. A is the steady state value; B, the trend before bursting; C, the value when the bubble burst; D, the trend after bursting; E, the peak value after bursting; F, the number of periods from bursting to peak. (*)At the end of the simulation, this variable had not peaked yet.

The figures presented above show that introducing bubbles into the model, affecting consumption through the wealth effect, causes the presence of irregular fluctuations of the variables that describe the economy. The behavior of the economy with this particular bubble is similar to that observed in simulations with other bubble growth paths, when the bubble growth period is similar to the one in this particular bubble.

At the beginning of the bubble-growth phase, the observed behaviors are a composition of effects due to a previous bubble burst with those from the present bubble growth. On the other hand, in a subsequent section of the bubble growth phase, the effects due to a previous bubble bursting are weak compared to those from present bubble growth. The economy increasingly grows and unemployment is reduced, making it possible to achieve full employment, as in the present simulation, as a consequence of the consumption increase made possible by the appreciation of consumer-owned stocks. The unemployment reduction leads to increased wage inflation, through the Phillips curve, which affects price inflation via mark-up.

In the bubble-growth phase, the nominal interest rate proposed by the Taylor rule is remarkably high: inflation is above its target and the economy is overheated, producing above the full employment level. This high interest rate reduces the increase that consumption would cause in the investment rate by using resources for servicing the debt, which rises despite the growing reduction of indebtedness during bubble growth. Usually, one expects that firms' indebtedness would rise as a consequence of increased consumption expectations in the boom phase, but this does not really happen due to the drop in the investment rate required for the growth of the economy at a given rate.

The bubble burst is associated with the sudden wealth loss by agents, which reduces their consumption immediately. The sharp consumption drop leads to a fall in output, which in turn leads to a sharp fall in the economic growth rate. This decline persists for a long period of time, causing recession five quarters after the bubble bursts; the recession lasts for six quarters. The drop in growth sparks a sharp, persistent increase of unemployment; however, wage inflation, in accordance with the Phillips curve, falls (more smoothly than the fall in growth) due to a "hysteresis" related to unemployment. Price inflation is also reduced more smoothly than wage inflation (it is calculated by a mark-up in wage inflation), and the economy goes into stagflation.

The sharp fall in price inflation and in the economy's growth rate provokes a drop in the nominal interest rate, as calculated by the Taylor rule. Investment, even favored by a decline in the service of the debt, also experiences a sharp drop due to the contraction of output growth rate associated with the recession. Firms' indebtedness increases suddenly after the bubble bursts, as a consequence of the increase of the investment rate/growth rate ratio.

In this model, the magnitude of the effect of a wealth loss caused by a bubble burst increases drastically as the agents' wealth effect increases. This wealth effect can be increased by a rise in the capital depreciation rate or in the wealth effect coefficient.

All these results are specific to a particular bubble history, *i.e.*, the one represented in figure 3. But this is only one of all possible Markovian processes generating the bubble. For each Markovian process, there will be one particular bubble history, and, as a consequence, a particular path for output growth, unemployment, and inflation. This means that in the extended model presented here, history matters in the sense that the model's outcomes depend on the bubble history. Path-dependence is the real issue that separates post-Keynesian macroeconomic models from the new macroeconomic consensus. This means that the Keynes-Minsky model modified with a Taylor rule and a Markovian process for speculative bubbles is fully compatible with Keynes/post-Keynesian thinking.

Conclusions

This article presents some extensions of the model of Fazzari, Ferri, and Greenberg (2008). Initially, monetary policy was included in the model by using a Taylor rule for calculating the nominal interest rate to be adopted. Then, the effects that bubbles in asset prices cause in consumption were included. The bubble dynamics were assumed to be exogenous, following a Markovian deterministic process.

It was seen that introducing monetary policy into the model resulted in a continuous dampening of fluctuations due to the influence of nominal interest rates on indebtedness determined by the Taylor rule. Since the inclusion of a monetary policy rule in the model extinguishes the cyclical fluctuations in the long term, while, in the real world, these fluctuations are observed in economies subject to active monetary policies, it was concluded that other factors that contribute to the persistence of these fluctuations must exist, beyond the interaction between multiplier and accelerator effects.

The introduction of asset price bubbles affecting aggregate demand through the wealth effect caused the appearance of irregular, persistent cycles, closer in qualitative terms to the ones observed in the US economy. Many stylized facts associated with the presence and bursting of bubbles were observed, like increased economic growth and interest rates before the burst, and after the burst, recession, and decreased investment, interest rate, and employment levels. However, the extended model looks more like an impulse-propagation model than a perpetual movement model in the old Keynesian tradition.

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