GROWTH CYCLES, THE FINANCIAL INSTABILITY HYPOTHESIS AND EVOLUTIONARY EXPECTATIONS*

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Abstract

The paper emphasizes the relationship between financial fragility and economic dynamics. It utilizes the Minskian microeconomic categories based upon the triad: hedge, speculative and Ponzi finance and put them into a macro perspective. In this environment, there can be a sharp distinction between solvent system and crisis equilibria. This dichotomy can be analyzed by means of a regime switching mechanism. The interaction between financial and real aspects is capable of generating persistent fluctuations that are the natural humus in which behavior à la Ponzi can take place and financial instability phenomena are generated.

Key words: financial instability hypothesis, regime switching, endogenous dynamics, debts and learning.

JEL Classification: E00, E 20, E32, E44, E47

March 2009

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**We are particularly grateful to S. Fazzari and E. Greenberg (Washington University) for stimulating suggestions. A financial contribution from the University of Bergamo is acknowledged.*

1. INTRODUCTION: FINANCIAL INSTABILITY AND DYNAMICS

In a strict neo-classical world where there is a clear-cut separation between real and monetary aspects, it is almost impossible to study the impact of financial events on the dynamics of economic fluctuations. In order to study these interactions, it is important to refer to other paradigms where these relationships not only are allowed but are at the core of the analysis. In this perspective, Minsky's contribution becomes essential. There seems to be a strict correlation between the presence of some kinds of financial turbulence in the economy and the rediscovery of Minsky's contribution. In other words, when some extreme financial events occur (using Barro's terminology, 2006), they tend to become Minsky moments.

The objective of the present paper is to insert the Minskian triad, based upon hedgers, speculators and Ponzi agents, into a macroeconomic context where there is a sharp distinction between a solvent regime and a crisis regime. To develop these ideas, a dynamic model is presented with three main characteristics. First of all, aggregate demand, where debts play an important role in the investment function, is integrated with supply aspects. In the second place, agents are boundedly rational and try to learn the values of the parameters of the model in order to forecast. Finally, the presence of regime switching generates complex dynamics that can only be dealt with simulations. The resulting persistence of endogenous fluctuations constitutes a natural humus in which Ponzi phenomena can occur. From this perspective, an extreme event (see also Gabaix, 2008) characterized by Knightian uncertainty (see Caballero and Krishnamurthy, 2007) can become a dynamic possibility that is not excluded by definition, as it is in the rational expectation theory.

The structure of the paper is the following. Sections 2 introduces Minsky's triad. Section 3 defines a macro threshold. Section 4 presents a medium-run, regime-switching growth cycle model, while Section 5 discusses the individual equations. Section 6 shows the steady states for the 2 regimes, and Section 7 illustrates expectations. Section 8 describes the overall dynamics. Section 9 concludes.

2. THE MINSKIAN TRIAD

It is well known that Minsky classified the financial agents into three broad groups: hedgers, speculators and Ponzi agents, according to their financial position. In particular periods of time, a particular "homo economicus" emerges that is more complex than the usual maximizer of the neoclassical tradition. Ponzi, the deus ex-machina agent, engages in some profitable activities by becoming indebted. What is more, for a not well-defined length of time, he pays interest by incurring additional debt in the hope that profits and capital gains will be available to repay the commitments when they become due. This behaviour is not typical of a market economy, but it can emerge in particular environments that turn the financial system into a "Ponzificating" mode (see The Economist, March, 2007). According to Minsky, this kind of deterioration is essentially an endogenous process More in detail, the hedge financing is characterized by the following inequality:

$$CC_t < Q_t$$

Where CCs are the contractual cash payment commitments on debts, while the Qs are the quasi rents that businessmen and their bankers expect.

Speculative finance is characterized by the following relationship:

$$CC_{t-1} > Q_{t-1}$$
$$CC_t < Q_t$$

which implies that the relationship that characterizes the hedgers is not always valid, but it holds only in particular periods of time. Finally, Ponzi finance is characterized by the following inequality:

$$CC_t > Q_t$$

This inequality holds for all periods, except for some future periods where the inequality is hopefully reversed.

According to Minsky (1986, p.341): "An increase in the ratio of Ponzi finance, so that it is no longer a rare event, is an indicator that the fragility of the financial structure is in danger zone for a debt-deflation."

Three observations are worth stressing at this stage of the analysis. First of all, these values can be capitalized at the same rate in order to obtain capital values. In the second place, these values reflect not only the income position of the various agents but they should reflect also the balance sheet position along with their portfolio situation. For instance, the balance sheet of a hedge unit is also characterized by the presence of a liquid asset kicker that is a measure of the margin of safety in assets superfluous to operations. Finally, these relationships must be cast in probabilistic terms, because there is uncertainty underlying these relationships.

3. A MACRO THRESOLD

It is not straightforward to cast these inequalities into macro relationships. In this perspective, one can suppose that specific mixtures of these categories can generate different global situations. In particular, one has to consider the fundamental solvency condition that implies:

$$PR_{t-1} > R_{t-1}D_{t-1}$$

where PR stand for profits, R is the nominal rate of interest, while D stands for debt.. Those system that respect this condition are financially robust, while the others are financially fragile, where most of the agents behave à la Ponzi, at least ex post.

The above inequality can be rewritten in the following way:

$$(1+g_{t-1})(1+\pi_{t-1}) > \frac{R_{t-1}d_{t-1}}{(1-\omega_{t-1})}$$

where g is the rate of growth, π stands for inflation, ω is the labor share, while d is the debt ration and is equal to:

$$d_t = D_t/P_{t-1}Y_{t-1}$$

Three considerations follow. First of all, as appears from the formula, in order to understand the dynamics of this system one has to integrate financial aspects, with real aspects, which include income distribution, growth and the dynamics of prices. In the second place, the behaviour of the economy (and in particular, investment) varies according the prevailing regime. Finally, one can think that the above inequality is expressed in terms of expectations:

$$\left(1+\bar{E}_t\, g_{t+1}\right)\left(1+\bar{E}_t\, \pi_{t+1}\right) > \frac{R_{t-1}d_{t-1}}{(1-\omega_{t-1})} + \varepsilon_t$$

Expectations are not necessarily rational, as will be discussed later on. Furthermore, in this case also the speculative agents can be included into the analysis. This implies that the system can be solvent, but it might have liquidity problems because there can be a temporal gap between cash flows and the debt burden. Furthermore, income distribution can vary in the two steady states. Finally, there is a random term, which is normally distributed. The presence of this term is well explained in Minsky (1986). In what follows, we shall refer to this latter definition of the threshold.

4. THE ANALYTICS OF REGIME SWITCHING

The presence of a threshold divides the economy into two states, characterized by different steady state equilibria and different behavioural equations. In particular, it is assumed that the economy is characterized by a "bad" state (state 1), with a high debt ratio, high rate of unemployment and possibly a lower growth rate, and by a "good" state (state 2), marked by the opposite characteristics.

In order to implement this approach, one needs to identify the equations that undergo changes when the threshold is reached.[1] In the present case, we assume that the investment function undergoes a substantial change. In fact it is equal to

$$i_t = \eta_1 - \eta_3 r_t$$

in regime 1, where $i_t = I_t / Y_{t-1}$, while it becomes equal to the following expression in regime 2 (see Fazzari, Ferri and Greenberg, 2008):

$$i_t = \eta_1 + \eta_2 (1 - \omega_{t-1})(1 + \bar{E}_t \, g_{t+1}) - \eta_2 \frac{R_t d_t}{\left(1 + \bar{E} \, \pi_{t+1}\right)} + \eta_4 \, \bar{E}_t \, g_{t+1}$$

Even though the investment function is not the only equation that changes when the threshold is reached, it is true that it is the equation that undergoes the deepest changes. In fact, other equations can change either because the parameters change or the steady state values change.

5. A DEMAND AND SUPPLY MODEL

The model tries to integrate aggregate demand and supply aspects (see also Asada et al., 2006) in a medium-run perspective, where labor supply has been normalized. The equations try to maintain those nonneutralities that, according to Akerlof (2007), constitute the essential feature of a monetary economy. They are not strictly microfounded, even though they can be justified from both analytical (see Ferri and Variato, 2007) and econometric points of view (see Fazzari, Ferri and Greenberg, 2007).

The dynamics of the model are generated by a nonlinear system of equations supplemented by the regime-switching mechanism just described. Technically, one should present two systems of

[1] Changes can be also smooth as happens in the so called STAR models. See Tong (1990) and Ferri (2008).

equations, one for each state. However, in order to economize space, only the meta system will be presented, indexed by j =1, 2. Steady state values are marked by the subscript 0.

The system will be presented in such a way that it maintain the same recursive structure that has been used in the simulations. It starts from a Taylor rule of the following type:

$$R_t = R_j * + \psi_1 \left(\overline{E_t} \pi_{t+1} - \pi_{0j} \right) + \psi_2 \left(\overline{E_t} g_{t+1} - g_{0j} \right) \tag{1}$$

The monetary authorities are supposed to switch the target inflation rate and growth rate according to j, the prevailing regime.

In this context, the real rate of interest is related to the nominal rate by the Fisher formula:

$$r_t = \frac{(1 + R_t)}{\left(1 + \overline{E_t} \pi_{t+1}\right)} - 1 \tag{2}$$

The debt ratio evolves according to (3):

$$d_t = \frac{d_{t-1}(1 + R_{t-1})}{(1 + g_{t-1})(1 + \pi_{t-1})} + \frac{i_{t-1}}{(1 + g_{t-1})} - \left(1 - \omega_{0j}^*\right)$$

where the labor income share is assumed to be exogenously fixed at the steady states values of the two different regimes. Since debts contracts are predetermined in nominal terms, inflation can affect them. This is why π (the rate of inflation) appears in the denominator.

Investment is represented by the following equation discussed above:

$$i_t = \eta_1 + \eta_{2j} \left(1 - \omega_{oj}^*\right)\left(1 + \bar{E}_t\, g_{t+1}\right) - \eta_{2j} \frac{R_t d_t}{\left(1 + \bar{E}_t\, \pi_{t+1}\right)} - \eta_{3j} r_t + \eta_{4j}\, E_t \bar{g}_{t+1} \tag{4}$$

The macroeconomic equilibrium condition is then introduced:

$$g_t = i_t + c_1 \left(1 + E_t \bar{g}_{t+1} \right) + c_2 - 1 \,. \tag{5}$$

It states that the share of investment and consumption, which is supposed to depend on an average of past and future rate of growth, must be equal to 1 plus the rate of growth.

Turning to the supply side of the model, we introduce the productivity equation.

$$\tau_t = \tau_{1j} + \tau_2 i_t \tag{6}$$

This formulation, which is compatible with different economic theories,[2] states that productivity growth, at least in its autonomous component, is a function of the prevailing regime.
Labor demand is given by the following equation (7):

$$l_t = l_{t-1}\frac{(1+g_t)}{(1+\tau_t)}$$

where l_t represents the employment ratio, referred to a normalized labor supply. It follows that the dynamics of unemployment (u_t) are given by

$$u_t = 1 - l_t \qquad (8)$$

The product and the labor market are characterized by imperfect competition and by non-clearing situations. The inflation equation is represented by a so called new Keynesian Phillips curve:

$$\pi_t = \varphi_1 \bar{E}_t \pi_{t+1} - \sigma_1\left(u_t - u_{0j}^*\right) + (1-\varphi_1)\pi_{t-1} \qquad (9)$$

where u* is the NAIRU that might change in the different regimes.
For given expectations and labour income distribution, each regime contains the following 9 unknowns in 9 equations: [3]

d_t, i_t, g_t, l_t, u_t, π_t, R_t and τ_t

6. THE STEADY STATES

In economics terms, the steady state is defined by the fulfilment of expectations,

$$\bar{E}g_t = g_t$$
$$\bar{E}\pi_t = \pi_t$$

and by the constancy of growth and the main ratios. In this perspective, unemployment is constant and so are the debt ratio and the investment ratio. Form equations (5), (6) and (7), one gets a relationship of type:

$$g_{0j} = \frac{(c_1 + c_2 - 1)\tau_2 - \tau_{1j}}{\tau_2(1-c_1)-1}$$

[2] On the relationship with a Kaldorian hypothesis, see Ferri (2007). For a discussion, see Aghion and Howitt (1998).
[3] In the present formulation, it is more convenient to normalize the value of v. In this case, the depreciation rate becomes endogenous.

While, from equation (2), (3) and (5), one determines:

$$r_{02} = \frac{Dg_{02} - B}{B + D}$$

where capital letters represent combinations of parameters.
For regime 1, on the contrary, the real interest rate is determined by equation (4) and it is equal to

$$r_{01} = \frac{\eta_1 - i_{01}}{\eta_3}$$

It then follows that:

$$d_{0j} = \frac{i_{0j} - (1 + g_{0j})(1 - \omega_{0j})}{g_{0j} - r_{0j}}$$

While the inflation rate is determined in the Fisher equation, given an exogenous nominal rate of interest R*.

7. EXPECTATIONS

We assume that agents do not have a complete knowledge of the model and therefore they use simple rules to forecast the future output growth and inflation. We suppose, as is done in De Grauwe (2008), that the agents can be either optimistic or pessimistic.
The optimists forecast

$$\bar{E}_t^{opt} g_{t+1} = g_{02}$$

In other words they expect that regime 2 is always prevailing. On the other hand, the pessimists forecast the opposite:

$$\bar{E}_t^{pess} g_{t+1} = g_{01}$$

The market forecast is obtained as a weighted average of these two forecast, i:e:

$$\bar{E}_t g_{t+1} = \alpha_{opt,t} \bar{E}_t^{opt} g_{t+1} + \alpha_{pess,t} \bar{E}_t^{pess} g_{t+1}$$
$$\alpha_{opt,t} + \alpha_{pess,t} = 1$$

Following Brock and Hommes (1997), a selection mechanism is introduced. In fact, agents compute the forecast performance by referring to the mean squared forecasting error:

$$U_{opt,t} = -\sum_{k=1}^{\infty} \chi_k \left[g_{t-k} - \bar{E}_{opt,t-k-1}\, g_{t-k} \right]^2$$

$$U_{pess,t} = -\sum_{k=1}^{\infty} \chi_k \left[g_{t-k} - \bar{E}_{pess,t-k-1}\, g_{t-k} \right]^2$$

Where χ represents geometrically declining weights.

The proportion of agents are determined à la Brock and Hommes (1997):

$$\alpha_{opt,t} = \frac{\exp(\gamma U_{opt,t})}{\exp(\gamma U_{opt,t}) + \exp(\gamma U_{pess,t})}$$

$$\alpha_{pess,t} = \frac{\exp(\gamma U_{pess,t})}{\exp(\gamma U_{opt,t}) + \exp(\gamma U_{pess,t})}$$

Where γ measures the intensity of choice.

These formulae indicate that those that had a success in the past will convince more people to follow them in the future.[4]

For inflation, agents are supposed to follow a much simpler rule. They simply expect the steady state value of inflation in their respective regimes.

8. ENDOGENOUS DYNAMICS

The system of structural equations, along with the forecasting rule, is nonlinear and can be solved only by means of simulations. Our exercise is very close to the experiments suggested by Testfatsion (2006). It differs in that the heterogeneity of agents is considered in a macro framework, and it is based upon a functional distinction (consumers, investors, firms, labour) rather than microeconomic heterogeneity.

The parameters of the simulations are presented in Table 1. In order to obtain overall results that mimic the main macroeconomic stylized facts, we have assumed values that are in agreement with econometric results (see Fazzari, Ferri and Greenberg, 2007).

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[4] This selection mechanism can be interpreted as an evolutionary one, as stressed by De Grauwe (2008).

Table 1: The parameters of the simulations

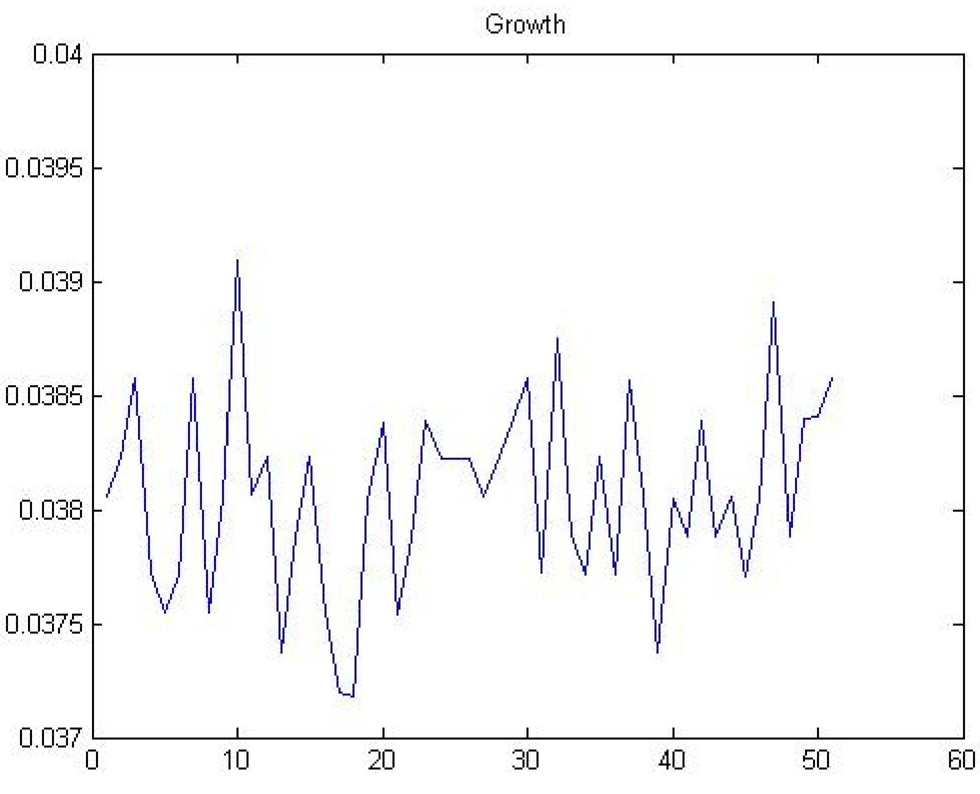
$U_{01}^* = 0.05$ $u_{02}^* = 0.03$	$\varphi_1 = 0.70$	$\sigma_1 = 0.02$	$\tau_{11} = 0.001$ $\tau_{12} = 0.02$	$\tau_2 = 0.10$
$\eta_1 = 0.201$	$\eta_{21} = 0$ $\eta_{22} = 0.1$	$\eta_{31} = 0.3$ $\eta_{32} = 0$ $\eta_{41} = 0$ $\eta_{42} = 0.3$	$c_1 = 0.40$	$c_2 = 0.405$
N=500	$\psi_1 = 2.50$	$\psi_2 = 0.8$	$\omega_{01} = 0.825$ $\omega_{02} = 0.8$	$R_1^*=0.015$; $R_2^*=0.08$;

The threshold is represented by the following inequality discussed above:

$$\left(1+\bar{E}_t\, g_{t+1}\right)\left(1+\bar{E}_t\, \pi_{t+1}\right) > \frac{R_{t-1}d_{t-1}}{(1-\omega_{0j})} + \varepsilon_t$$

The results of the simulations (the last 50 runs over N=500) are illustrated in Figure 1. [5]

Figure 1: The dynamics of the model



[5] In the simulations, the intensity of choice parameter has been set equal to 10.000, while the weights are supposed to decline at a rate equal to 0.5. The simulations have been iterated 100 times.

The dynamics of the model show persistent fluctuations in growth and other related variables. These fluctuations, however, do not explode but remain bounded after 400 simulations. In other words, the switching of the economy is a persistent phenomenon. This result[6] depends on many factors, some of which are worth considering. First of all, it depends on the presence and the nature of the two regimes. In the present case, the values of the parameters guarantee the existence of two steady states with the desired characteristics, as appears from Table 2.

Table 2: The steady state value of the two regimes

Regime	d	u	g	π
1	0.64	0.005	0.0218	0.0396
2	0.53	0.03	0.0420	0.0751

In the second place, the dynamics are a function of the value of the threshold. If the threshold is changed, the relative time spent in the two regimes is different, and this affects the average rate of growth.[7] In the third place, the dynamics are also a function of expectations. Since expected values are very close to the actual, the learning mechanism is working in a satisfactory way.[8]

The dynamics depend on the overall system of equations and cannot be attributed to a specific equation. In this perspective it cannot be exclusively attributed either to the expectations mechanism or to the policy pursued. The dynamics are robust to changes in the parameters of the Taylor equations, which implies that the model is not necessarily policy driven. The fact is that policy can constrain the fluctuations but not eliminate them. The mechanism based upon worker-borrowing is at the root of the results.[9]

The overall result is that the dynamics of the model are compatible with the switching from one state of solid financial position to one of financial distress. In this situation, the dynamics of the economy becomes particularly complex.

6 On the different asymptotic results in the case of nonlinear system, see Kuznetsov (2004).
7 The presence of the stochastic term, however, is not essential for the results.
8 The mean values of g and Eg are practically the same. The same holds true for π and $E\pi$.
9 The importance of investment in housing in the business cycle along with the financial mechanisms has been stressed by Leamer (2007).

9. CONCLUDING REMARKS

The aim of the paper has been twofold. On one hand, we have tried to understand the present evolution of the economy. On the other, we have tried to refer to Minsky analysis in order to have a strategic point of view . The paper has extended Minsky's analysis along two lines. On one hand, it has put his analysis in a dynamic setting by referring to a regime-switching model that is very similar in its essence to the ceiling and floor approach employed by Minsky himself. It is important to stress that the dynamics depend on what happens: i) within each state, ii) between the two states and iii) the time spent in each regime. In this case, history matters (see also Day and Walter, 1989), and this is an important dimension to take into consideration in order to understand the various historical events. On the other hand, we considered the phenomenon of financial instability by means of a particular specification of the investment function. In this environment, where the presence of the "invisible hand" in coordinating markets is not omnipotent, the so-called extreme events find an appropriate environment.

Three lines of enhancement of the analysis become relevant. First of all, the justification of the equations should be pursued in a deeper way with the awareness that uncertainty must play an important role (On this point, see also Giese and Wagner, 2007). In the second place, the financial sector must be extended and integrated with liquidity considerations. Finally, the mathematics of the model can be improved. For instance, the mathematics of heterogeneity (see Di Guilmi, Gallegati and Landini, 2007) and of sudden stops (Mendoza, 2006) must be developed.

There remains the problem of fitting the model to data. The simulations that have been carried out are very similar to the "crisis testing" that is going on in these days. They do not try to mimic the past, but rather they show how the future can be if the values of the parameters change with respect to the past experience.

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