

Banking System and Financial Fragility in a Post Keynesian Model*

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Abstract: This paper develops a Post Keynesian model with Minskyan insights that places emphasis on the interaction between the banking sector and the real economy and investigates the conditions under which the latter is likely to be brought into financial fragility. The analytical framework used to describe the banking sector explicitly incorporates the impact of banks' 'animal spirits', of firms' creditworthiness and of banks' expectations on the provision of loans. The financial fragility of the economy is defined by drawing on Minsky's taxonomy and is assumed to rely both on the fragility of firms and on the fragility of the banking sector. Our dynamic analysis investigates how the interaction between the fragility ratio of the banking sector and the real output can generate financial structures that are susceptible to financial fragility. Furthermore, it briefly assesses the effect of institutional changes in the banking sector and of monetary policy on the emergence of financial fragility in the economy.

JEL-Classification: E12, E44, E51, G21

Keywords: financial fragility, banking sector, Minsky

This draft, October 15, 2009

* Paper prepared for the 13th Conference of the Research Network Macroeconomics and Macroeconomic Policies, *The World Economy in Crisis - The Return of Keynesianism?*, Berlin-Germany, 30-31 October 2009.

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1. Introduction

In the recent decades there has been a great deal of interest by Post Keynesian economists for the investigation of the potential destabilizing forces inherited into the modern capitalist economies. The research on this issue has been greatly inspired by the seminal contributions of Hyman Minsky (1982, 1986) and, in particular, by his financial instability hypothesis.

Minsky's financial instability hypothesis reveals "how a capitalist economy endogenously generates a financial structure which is susceptible to financial crises, and how the normal functioning of financial markets in the resulting boom economy will trigger a financial crisis" (Minsky, 1982, p.68). Minsky depicts that during periods of tranquility the role of euphoric expectations is decisive in bringing the economy into financial fragility. It is argued that during the boom firms' euphoria makes them overoptimistic about the success of their investment plans inducing them to turn to debt finance at an increasing rate. This implies that there is a point of time at which firms' debt commitments rise more rapidly than their profits. At this point, cash inflows on the firms' balance sheets turn insufficient to the cash outflows and financial fragility finally emerges in the economy.

The analytical tool underpinning Minsky's hypothesis is the cash flow of firms. Minsky suggests firms to be categorized into hedge, speculative and ponzi units according to their ability to repay their initial debt obligations from their cash flow¹; this notion is further used in order to define financial fragility. Minsky pinpoints that the greater the weight of ponzi financing in the economy the higher the financial fragility.

Since Minsky's original contributions, his financial instability hypothesis has been further developed and explored in the context of Post Keynesian modelling. Most of the scholars that have relied on Minsky's analysis (see e.g. Taylor and O'Connell,

¹ Following Minsky "a unit that expects its cash receipts to exceed its cash payment commitments in each time period is enlarged in what we will call hedge finance. On the other hand, an organization from which the contractual cash flow *out* [emphasis in the original] over a time period exceeds its expected cash flow *in* [emphasis in the original] is engaged in either speculative or ponzi finance" (Minsky, 1986, p.79).

1985; Fazzari et al., 2008; Charles, 2008a, 2008b) have emphasized the role of firms' expectations and the role of debt interest payments during the boom. However, the way that this hypothesis has been analyzed and implemented seems to put aside or, at least, to undervalue the crucial role of the banking sector in the generation of financial fragility. The aim of the paper is to offer a remedy and extend the financial fragility models by introducing two innovations. First, it adds an active banking sector where bank's expectations and creditworthiness criteria play a decisive role in the loan provision. Second, it defines banking sector's fragility and uses it in order to categorize the former into hedge, speculative and ponzi. What then follows is a new categorization of financial fragility that takes into account not only the fragility of the firms but also the fragility of the banking sector.

The structure of the paper has as follows. In section 2 the conceptualization of the banking sector in the financial fragility models is critically reviewed. Section 3 describes the structure of the model along with the determination of equilibrium output. Section 4 analyzes the formalization of the Minskyan taxonomy for the firms and for the banking sector and defines financial fragility. Section 5 explores the dynamic stability properties of the model. In this section we also investigate the potential impact on financial fragility of monetary policy and of changes in the banking sector behavior. A few concluding remarks follow in section 6.

2. The missing role of the banking sector within the financial fragility models

The Post Keynesian models that incorporate aspects of Minsky's financial instability hypothesis have often ignored the banking sector completely². For example, Taylor and O'Connell (1985) and Downe (1987) develop models that concentrate attention on the wealth of the rentiers and on changing expectations in the financial market. In these models the rentiers are assumed to hold money, equity and bonds but there is no mention to the loans provided by the banking sector. In another group of models which includes, among others, Lavoie (1986-1987), Semmler (1987), Jarsulic (1990,

² See, Dos Santos (2005) for a further critique.

1996), Keen (1995), Fazzari et al. (2001, 2008), Lima and Meirelles (2007) and Charles (2008c) the banking sector is incorporated in the analysis but its role is deemed passive. Some of these models implicitly assume that the banking sector accommodates the amount of loans demanded so as to cover the amount of investment and interest payments that is in excess of the internal finance of the firms.

Other contributions develop a more sophisticated conceptualization of the borrowing procedure, even though the formalization of the banking sector remains limited. In Skott (1994) loans are provided up to a credit ceiling that is set by banks. In Taylor (1994) rentiers' demand for borrowing is diminished by the amount that is credit rationed. Delli Gatti, Gallegati and Minsky (1994) depict that the provision of loans is proportional to the amount of the required reserves that the banking sector holds. Palley (1994) combines into his analysis both borrowers' and lenders' willingness to borrow and lend in periods of economic expansion. Franke and Semmler (1989) argue that the banking sector provides loans to the borrowers according to their expected gross profit rate and the amount of accumulated debt. Jarsulic (1989) combines the demand for credit with the supply of credit whereby the latter takes into consideration the risk aversion with respect to output that the bankers are free to dispose. For Setterfield (2004), the fragility in the economy fluctuates within the business cycle; furthermore, the course of a cumulative expansion of income depends on the reaction of the commercial banks, namely whether they will be accommodative or whether they will ration the credit.

In the present paper we attempt to fill the gap that exists in the aforementioned literature by developing a model that allows for an explicit role for the banking sector in the financial instability hypothesis. In our conceptualization we attempt to integrate not only overoptimistic firms but also overoptimistic banks into the financial instability hypothesis. As it turns out, Minsky himself pinpoints the importance of the banking sector³ for the emergence of financial fragility although it was not central to his analysis. Put it simply, financial fragility “occurs because the acceptable and the desired liability structures of business firms *and the organizations acting as*

³ Minsky develops an interesting role for the bankers sketching them as “specialists in making loans on the basis of their ‘hard reading’ of private information which they obtain in the process of deciding whether and on what terms to accommodate a potential borrowing client” (Minsky, 1994, p.20).

middleman in finance [emphasis added] change in response to the success of the economy” (Minsky, 1986, p.193). Therefore, the increased indebtedness of the private sector in the boom presupposes that the banking sector shares to a great extent the expectations of firms or, at least, that there are reasons (e.g financial innovation) that make the banking sector willing to provide the demanded loans. This implies that the increased proportion of ponzi firms in the boom is of the responsibility of both the entrepreneurial and the banking sector. Therefore, overall financial fragility must take into consideration both firms’ fragility and banking sector’s fragility.

Our attempt to define financial fragility with the help of banking sector’s fragility prompts us to apply the Minskyan categorization of firms into hedge, speculative and ponzi to the banking sector. Our suggestion is that the banking sector can also be categorized as hedge, speculative and ponzi. It is noteworthy that Minsky has already claimed that “a commercial bank cannot be a hedge financial unit...commercial banks, are the prototypical speculative financial organization” (1986, pp.230-231).

3. The model

We now proceed to present our macroeconomic model which endogenously generates dynamic paths of output and of fragility ratio of the banking sector. We consider a closed economy consisting of households, firms and the banking sector. Households supply labor and demand consumption goods, equities and money (deposits). Firms supply final goods and demand labor, investment goods and finance. The banking sector supplies liabilities in the form of deposits and demand assets in the form of loans.

The wage bill of households is equal to:

$$W = \Omega \cdot Y \tag{1}$$

where W is workers’ wage bill, Ω is the wage share in nominal aggregate income and Y is output.

Equation (2) gives the gross profits of firms which are equal to output after subtracting the workers' wage bill:

$$PF^G = Y - W \quad (2)$$

where PF^G are the gross profits of firms.

Firms are assumed to distribute a part of their gross profits being given by:

$$PF^D = \theta \cdot PF^G \quad (3)$$

where PF^D are the distributed profits and θ is the distributed share of total profits.

The net profits of the firms are equal to the undistributed profits held by the firms minus the interest payments:

$$PF = (1 - \theta)PF^G - i_L L \quad (4)$$

where PF are the net profits, i_L is the interest rate on loans and L is the loans of firms.

Banking sector's profits (PB) are given by:

$$PB = i_L L - i_{DB} DB \quad (5)$$

where i_{DB} is the interest rate on deposits and DB is the amount of deposits of the households.

As far as the interest rates are concerned, we have that:

$$i_{DB} = d \cdot i \quad (6)$$

$$i_L = l \cdot i \quad (7)$$

where $0 < d < 1, l > 1$; d is the mark-down and l is the mark-up over the interest rate of the central bank, i . Note that d and l are exogenously given in our analysis.

In order to discuss financial instability hypothesis within a Post Keynesian model, we first have to investigate the building blocks of our model. Therefore, we will first explain the investment decision taken by the firms as well as the consumption schedule of the households; second we will describe the way that the banking sector provides loans to firms and third we will define the equilibrium output.

3.1 The behavior of the economy

Our investment function is expressed as:

$$I = a_0 + a_1 PF \quad (8)$$

where $a_i, i = 0, 1$ are positive parameters. The investment function is based on animal spirits a_0 and on the net profits of the firms, PF as in Charles (2008a). An increase in animal spirits or an increase in net profits increases the amount of investment.

Let us assume we have the standard consumption function with different propensities to consume from wage income, deposits income, firms' distributed profits and the banking sector's profits⁴:

$$C = c_0 + c_1 W + c_2 i_{DB} DB + c_3 PF^D + c_4 PB \quad (9)$$

where $c_0 > 0, i = 0, 1, 2, 3, 4$ are positive parameters. It is worthy to point out that an increase in the workers' wage bill, an increase in the amount of deposits income, an increase in the distributed profits or an increase in the profits of the banking sector increase consumption expenditures.

3.2 The behavior of the banking sector

The literature summarized in section 2 has not paid enough attention to the fact that there always exists an unsatisfied fringe of borrowers. In other words, it has undervalued the crucial role of credit rationing. The Post Keynesian approach with regard to the supply of credit argues that the latter is equal with the demand to the extent that it is considered eligible to be supplied by the banking sector. Parguez (2001) names it 'effective supply of credit' while other authors have used different terms: Wolfson (1996) refers to it as the 'effective demand', Lavoie (1996) names it 'solvent demand', Grabel (1995) calls it 'demand for loans' as opposed to desired demand for loans, while Rochon (1999) suggests the notion of 'creditworthy demand'.

⁴ The bulk of macroeconomic research on the banking sector such as van Treeck (2009), Lavoie and Godley (2001-2002) and Zezza and Dos Santos (2004) assume that the profits of the banking sector are distributed to the households. It is recognized that a part of the profits of the banking sector can be kept in the banking sector as Lavoie and Godley (2007) or as Le Heron and Mouakil (2008) and Foley and Taylor (2004) assume. More specifically, they argue that the banking sector keeps a part of the profits and increases its capital. In this model we follow, the first method of modelling.

In our analytical framework, the provision of new loans from the banking sector is described by the following function:

$$\dot{L} = b_0 + b_1(PF - \overline{PF}) - b_2(\gamma_0 - \gamma_1 Y^2) \quad (10)$$

where \dot{L} is the change in loans (dL/dt), $b_i, i = 0,1,2$ and $\gamma_i, i = 0,1$ are positive parameters; $PF - \overline{PF}$ is the ‘firms’ creditworthiness’ set by the banking sector, taking into account the net profits of the firms as well as that there must be a ‘lower limit on net profits’ equal to \overline{PF} ; $\gamma_0 - \gamma_1 Y^2$ is the expected risk of default on loans set by the banking sector. Let us analyze equation (10).

b_0 captures the ‘animal spirits’ of banks. Higher animal spirits imply higher provision of loans. These spirits can be assumed to be affected, along other factors, by the level of exogenous confidence of the banking sector, the degree of financial innovations (e.g. securitization) etc. In this sense we apply the notion of fundamental uncertainty proposed by Keynes (1936), Davidson (1991) or Dymski (1992)⁵ into the uncertain environment that the banking sector functions; see Rochon (2001, p.280)⁶ for such a recommendation⁷.

The second term represents the impact that the firms’ creditworthiness may have on the change in loans. The higher the net profits of the firms relative to the lower limit on net profits, the higher is the firms’ creditworthiness and in turn the higher the provision of new loans. This variable captures the Keynesian uncertainty over the borrowers of the banking sector. In such circumstances, “the businessman answers the financier’s question, ‘how will you get the monies to meet the obligations to pay you are accepting?’ by pointing to the prospective cash flows” (Minsky, 1991, p.6). More

⁵ Dymski (1992, p.314) proposes to apply both asymmetric information and Keynesian uncertainty in order to describe banks willingness to supply credit.

⁶ “Typically, banks will face two different sources of uncertainty. On the one hand, banks face uncertainty as to their evaluation of the borrower based on the presence of asymmetric information, although this is perhaps not the best expression to use...On the other hand, banks face their own uncertainty regarding the unknown future.”

⁷ It is worthy to mention Wolfson’s (1996) argument that both borrowers and lenders are subject to the same fundamental uncertainty. Moreover, Tymoigne (2006, p.5) claims that the “expectations are bounded by what is considered to be reasonable/ normal by the most pessimistic economic sector.” Our specific argument follows the latter statement that the animal spirits of the firms and the animal spirits of the banking sector can be different.

specifically, we could argue the banking sector provides loans to all creditworthy borrowers (Rochon, 1999, p.279; Moore, 2001, p.25)⁸ according to their income taking into consideration that they have to repay their loan obligations. Basu (2003, pp.232-235) refers to this notion as the ‘credit standard’ that the borrowers must provide as collateral in the case that their projects fail. He also pinpoints that the value of the credit standard is subject to fluctuation as the state of economy and the individual’s own financial circumstances change.

In this context we take into account that there are some minimum requirements the banking sector assigns in order to supply credit (Wolfson, 1996; Rochon, 1999). Simultaneously, it can be argued that these minimum requirements will fluctuate with banking sector’s animal spirits (Rochon, 1999, p.282). Hence, tighter standards imply a direct form of credit rationing (Wolfson, 1996, p.459). As Dymski (2005, p.450) emphasizes, customers that do not meet these standards will turn to second tier markets, where they will meet substantial credit rationing⁹ or they may turn to informal credit markets (see Basu, 2003, p.239).

The third term reflects the impact of the boom on the banks’ expected risk of default on loans. Following Minsky’s hypothesis regarding the confidence of firms for their profits in the upswing, we argue that banking sector’s expected risk of default on loans (or the level of confidence for the repayment of loans) decreases (increases) with an increasing rate as output becomes higher. This implies that, as the firms become more optimistic within periods of tranquility, it is assumed that the banking sector also becomes more optimistic when output increases. This behavior of the banking sector is based on two aspects. On the one hand, there is the Minskyan analysis. Minsky (1986, p.132)¹⁰, Paula and Alves (2006), Grabel (1995, p.136) and Alves et al. (2008, p.398) pinpoint that over the business cycle both bankers and their borrowing business customers have expectations that change. When they both have

⁸ Dymski (1988) provides a framework where banks are gathering information as far as the creditworthiness of the borrowers. See Wray (1989), Dymski (1989) and Piegay (1999-2000) for further comments.

⁹ This idea rests on what Dymski (2005, p.440) refers as ‘financial exclusion’. It is the failure of the formal banking sector to offer credit and depository services.

¹⁰ “A history of success will tend to diminish the margin of safety that business and bankers require and will thus tend to be associated with increases investment, a history of failure will do the opposite” (Minsky, 1986, p.209).

favorable views about the future the banks become accommodative and they are able to amplify the economic growth, whereas unfavorable views lead bankers and their business customers to contract loans. Palley (1994, p.380) recognizes that increasing prosperity is the culprit that enables borrowers and lenders to become more optimistic while it enables them to take more leverage.

The other aspect is the competitive analysis behavior of the banking sector (Basu, 2003, p.238; Dymski and Pollin, 1992, p.45; Grabel, 1995, p.142; Paula and Alves, 2006). It is suggested that high competition compels banks relax their credit behavior and engage in risky activities in order to cement their institutional position. This ‘asymmetric reward structure’, as Crotty (found in Dymski and Pollin, 1992) names it, rewards more and punish less than cautious behavior of the banking sector.

Let us now turn to another issue that is at the centre of our analysis. Various Post Keynesians have made the remark that the behavior of the banking sector can bring additional financial fragility in the economy. For instance, Wolfson argues in favor of the fragility of the banking sector while he finds econometric evidence that there is an increase of banking sector’s fragility at the peak of the expansion (Wolfson, 1995, p.353). The first step in building our ideas about the banking sector’s fragility is to introduce a ratio for its calculation¹¹. This will immediately shed light on an interesting aspect of the banking sector that has not been yet fully developed within a Minskyan macroeconomic model.

In particular, Minsky (1986) and Wray (1992, p.306) propose the bank leverage, namely the ratio of assets to equity, as the target the banks are considering in keeping while on the same reasoning Lavoie and Godley (2006, p.265) apply a capital adequacy ratio taking into account the capital requirements the banks must satisfy. Others place emphasis on the connection of assets and liabilities that the banking sector must maintain. For example, Heise (1992, p.292) uses a ratio of reserves to liabilities which he calls as the ‘credit margin’; he assumes that banks do not provide credit above a specific limit. Alves et al. (2008) use two ratios in order to pinpoint the

¹¹ A critique is raised by Rochon (1999, p.286) for Wray (1992) and Heise (1992) ratios. He argues that they do not calculate the actual level of the ratios they use and also that within this method they undermine the uncertainty the banks face.

interrelationships of fragility within the banking sector: first, the ratio of reserves to deposits and, second, the ratio of loans to capital. Eichner (1985, quoted in Lavoie and Godley 2006, p.257) proposes the ‘degree of liquidity pressure’ equal with the loan to deposit ratio as the more relevant tool of the banks. Finally Godley (1999) uses the ‘target banking liquidity ratio’ which is equal to the bills to deposit ratio the inverse ratio Eichner proposes. According to these ratios we can see that there is indeed a good indicator of “how much of other units’ debts a bank can make generally acceptable by pledging its ‘good name” (Minsky, 1986, p.262)¹².

In our model we follow one of the last propositions and we associate Eichner’s degree of liquidity pressure with the fragility ratio of the banking sector. Hence we obtain:

$$F = \frac{L}{DB} \quad (11)$$

where F is the fragility ratio of the banking sector. The higher is the above ratio the more fragile is the banking sector since any potential default of loans can have significant depressing effects on the liquidity of the system. This ratio is a non-compulsory secondary ratio that can take values greater than zero and can fluctuate. The advantage of this ratio is that it provides a criterion for distinguishing between the three types of financial structure of the banking sector. This is further explored in section 4.

3.3 The interaction of the economy and the banking sector

The equilibrium requires the adjustment of investment and consumption to the effective demand in the goods market. The equilibrium condition is given by:

$$Y = C + I \quad (12)$$

Upon substitutions we specify equation (12) as a function of Y and F with the help of equations (1)-(9) and (11). Rearranging we take the equilibrium (*) value for output:

$$Y^* = \frac{a_0 + c_0 + (c_2 - c_4) \cdot d \cdot i \cdot DB}{1 - c_1 \Omega - c_3 \theta (1 - \Omega) - a_1 (1 - \theta) (1 - \Omega)} + \frac{(c_4 - a_1) \cdot l \cdot i \cdot DB}{1 - c_1 \Omega - c_3 \theta (1 - \Omega) - a_1 (1 - \theta) (1 - \Omega)} F \quad (13)$$

¹² Others take into consideration the amount of loans as Wolfson (1990, pp.347-349) who uses the loan-loss ratio equal with the ratio of net loan losses to average loan outstanding, Moore (2001, p.15) suggests a loan reserve ratio. Minsky (1986, p.60) suggests a ratio that indicates the relation between the dollar amount of problem loans and the total of bank capital funds. There is also Parguez (2001, p.85) that believes that the banks use the long run increase in the net worth or equity in order to attain growth.

The equilibrium output will be stable provided the denominator of equation (13) will be positive:

$$1 - c_1\Omega - c_3\theta(1 - \Omega) - a_1(1 - \theta)(1 - \Omega) > 0 \quad (14)$$

In order to have only positive values for the equilibrium output it is necessary the nominator to be also positive. In other words, the following inequality must hold:

$$a_0 + c_0 + (c_2 - c_4) \cdot d \cdot i \cdot DB + (c_4 - a_1) \cdot l \cdot i \cdot DB \cdot F > 0 \quad (15)$$

For the rest of the paper, we will assume for simplification reasons that $c_2 = c_4$ or, in other words, that households' propensity to consume out of banking sector's profits is equal to the propensity to consume out of interest income of deposits.

Taking into account this assumption, the partial derivative of equilibrium output with respect to the central bank's interest rate and to banking sector's fragility ratio have as follows:

$$\frac{\partial Y^*}{\partial i} = \frac{(c_4 - a_1) \cdot l \cdot DB \cdot F}{1 - c_1\Omega - c_3\theta(1 - \Omega) - a_1(1 - \theta)(1 - \Omega)} \quad (16)$$

$$\frac{\partial Y^*}{\partial F} = \frac{(c_4 - a_1) \cdot l \cdot i \cdot DB}{1 - c_1\Omega - c_3\theta(1 - \Omega) - a_1(1 - \theta)(1 - \Omega)} \quad (17)$$

It can be easily observed that the sign of the above derivatives is ambiguous. In the case that the propensity to consume out of distributed profits is low and the propensity to invest out of net profits is high, we have that $a_1 > c_4$ and, therefore, the increase in the interest rate and/or in the fragility ratio make the equilibrium output to decrease. This has been called in the literature as the 'normal' case (see Hein, 2006, 2007). In the case the propensity to consume is large and the propensity to invest out of net profits is low, we have that $c_4 > a_1$ and hence, an increase in the interest rate and/or an increase in the fragility ratio will increase the equilibrium output. According to Lavoie (1995), this is the 'puzzling' case.

4. An extended Minskyan taxonomy for the financial fragility of the economy

Minsky emphasizes that the financial fragility of the economy can be determined by the financial conditions of its units. In the spirit of Minsky, we define the financial fragility of the economy based on the fragility of the firms along with the fragility of the banking sector. As Dos Santos and Macedo e Silva (2009, p. 23) point out, the economy is getting more fragile whenever the fragility of firms and/or the fragility of banks are increasing.

Let us first portray the fragility of firms¹³. Following Charles (2008b)¹⁴, the classification of firms as hedge, speculative and ponzi is given by their net profits. In other words, it is the capacity of profits net of wage cost to cover (or not) interest payments on loans which determines the fragility of the firms. Replacing equation (1), (2) and (7) into equation (4) we get:

$$\text{Hedge firms: } (1 - \theta)(1 - \Omega)Y - l \cdot i \cdot L > 0$$

$$\text{Speculative firms: } (1 - \theta)(1 - \Omega)Y - l \cdot i \cdot L = 0$$

$$\text{Ponzi firms: } (1 - \theta)(1 - \Omega)Y - l \cdot i \cdot L < 0$$

We use equation (11) and we substitute it in the previous equations in order to consider the hedge, speculative and ponzi firms in connection with the fragility ratio. After some manipulations we finally obtain:

$$\text{Hedge firms: } F < (1 - \theta)(1 - \Omega)Y / l \cdot i \cdot DB \quad (18)$$

$$\text{Speculative firms: } F = (1 - \theta)(1 - \Omega)Y / l \cdot i \cdot DB \quad (19)$$

$$\text{Ponzi firms: } F > (1 - \theta)(1 - \Omega)Y / l \cdot i \cdot DB \quad (20)$$

It is also possible to derive the corresponding demarcation line in the (Y, F) space:

$$F_{H-P}^F = (1 - \theta)(1 - \Omega) \cdot Y / l \cdot i \cdot DB \quad (21)$$

¹³ Our analysis is confined to the liquidity ratio (Vercelli, 2009) and to the basic Minsky cycle (Palley, 2009).

¹⁴ Charles (2008b) characterizes firms as speculative at the point they are able to pay their debt obligations from their gross profits. Such a mechanism is also used by Foley (2003), Lima and Meirelles (2007) and Arza and Espanol (2008). In order to account for the speculative firms they define them as units that are able to pay their debt obligations from their gross profits but they can not repay the initial level of debt.

where F_{H-P}^F is the level of fragility ratio corresponding to the regime transition from hedge firms to ponzi firms, as shown in figure 1.

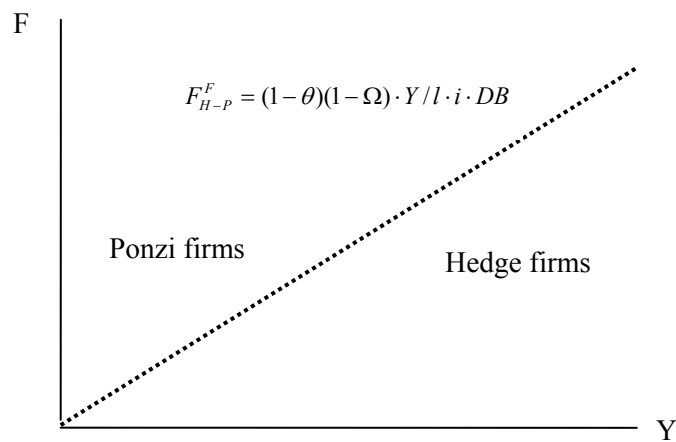


Fig. 1. The classification of firms.

Regarding the banking sector we follow Dos Santos and Macedo e Silva (2009) and we distinguish between a hedge, speculative and ponzi banking sector. If the banking sector holds enough deposits in order to cover the amount of loans on its balance sheet it can be characterized as a hedge banking sector. Accordingly, we can define the speculative banking sector and the ponzi banking sector. More specifically, we have that:

Hedge banking sector: $L < DB$

Speculative banking sector: $L = DB$

Ponzi banking sector: $L > DB$

Then, if we substitute equation (11) in the previous equations we obtain:

Hedge banking sector: $F < 1$ (22)

Speculative banking sector: $F = 1$ (23)

Ponzi banking sector: $F > 1$ (24)

The fragility ratio plays a crucial role in our classification of the banking sector. The basic intuition is that in the case that the fragility ratio is smaller than one then the banking sector can be characterized as hedge. On the contrary, a speculative unit is characterized by a fragility ratio equal with unity. This is the case at which the

deposits are equal with the loans the banking sector provides. A ponzi banking sector is characterized by a fragility ratio greater than unity.

Let us also derive the corresponding demarcation line for the banking sector this time in the (Y, F) space:

$$F_{H-P}^B = 1 \tag{25}$$

where F_{H-P}^B is the level of the fragility ratio corresponding to the regime transition from hedge banking sector to ponzi banking sector, as shown in figure 2.

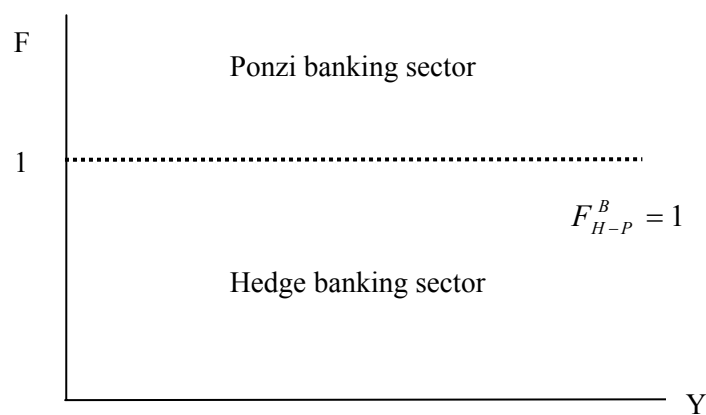


Fig. 2. The classification of the banking sector.

We now turn to put together figures 1 and 2 in order to depict an overall picture of the financial fragility of the economy. It is important to remark that there are four different situations that may emerge regarding the financial fragility of the economy. These are portrayed in figure 3.

There is first the possibility of a 'hedge' economy characterized by a hedge banking sector and hedge firms where output is high and the fragility ratio is low. It is the situation located to the right of the demarcation line of the firms and below the demarcation line of the banking sector. Both sectors do not have any problem in honoring their financial obligations.

The 'semi ponzi type I' economy is the case where the firms are characterized as ponzi and the banking sector is conceived as hedge; both output and fragility ratio are relatively low. This situation is depicted by the area on the left of the demarcation line

of firms and underneath the demarcation line of the banking sector. The financial fragility of the economy is characterized as fragile since the firms are facing problems of repaying their loan obligations from their total profits net of wage cost.

The third possibility is that of a '*semi ponzi type II*' economy where the banking sector is ponzi and the firms are hedge depicted; both output and the fragility ratio are high. This is captured by the zone on the right of the demarcation line of the firms and above the demarcation line of the banking sector. The banking sector in this situation has problems in repaying its loan obligations in case of need and this characterizes the economy as financial fragile.

Our last case is the '*ultra ponzi*' economy where both sectors are characterized by ponzi finance while the economy exhibits low output and high fragility ratio. It is located to the left of the demarcation line of firms and over the demarcation line of the banking sector. This is the case where the financial fragility of the economy is the largest from all the previous ones. There is excessive financial fragility in the economy since both sectors face problems of repayment.

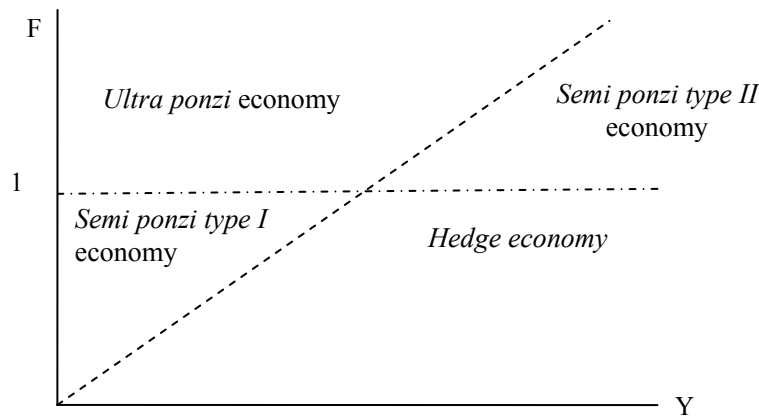


Fig. 3. The overall classification of the economy.

5. The dynamic behavior of the model

This section intends to explore the dynamic interaction between banking sector's fragility ratio and output and to illustrate the conditions under which the financial fragility of the economy is likely to emerge.

The change in output is captured by the following equation that is based on Asada (2004):

$$\dot{Y} = \varepsilon(C + I - Y) \quad (26)$$

where ε is a positive parameter. Replacing C from equation (9), I from equation (8) and making use of equations (1) to (7) we find the mechanism for the motion of output. The next step consists in substituting the loan variable with the fragility ratio from equation (11). After some manipulations we ultimately obtain:

$$\dot{Y} = \varepsilon\{a_0 + c_0 + (c_4 - a_1) \cdot l \cdot iDB \cdot F - [1 - c_1\Omega - c_3\theta(1 - \Omega) - a_1(1 - \theta)(1 - \Omega)]Y\} \quad (27)$$

Having presented the mechanism of output we now turn to present the way that the real economy affects the change in the fragility ratio of the banking sector. Differentiating F with respect to time and assuming that the deposits are constant we get:

$$\dot{F} = \frac{\dot{L}}{DB} \quad (28)$$

We introduce equation (10) into the previous equation and by combining equations (1), (2), (4), (7) and (11) we end up with:

$$\dot{F} = \frac{1}{DB}[b_0 - b_1\overline{PF} - b_2\gamma_0 + b_1(1 - \theta)(1 - \Omega)Y + b_2\gamma_1Y^2 - b_1 \cdot l \cdot iDB \cdot F] \quad (29)$$

Equations (27) and (29) constitute an autonomous two-dimensional system of differential equations, in which the derivatives of Y and F depend on the levels of Y and F , and on the parameters of the system. We can therefore analyze the interaction of the economy with the banking sector by estimating the Jacobian matrix of the system and using a standard phase diagrammatic analysis.

The partial derivatives of the Jacobian matrix have as follows:

$$\mathfrak{T}_{11} = \partial \dot{F} / \partial F = -i \cdot l \cdot b_1 < 0 \quad (30)$$

$$\mathfrak{T}_{12} = \partial \dot{F} / \partial Y = (b_1 + 2b_2\gamma_1 Y) / DB > 0 \quad (31)$$

$$\mathfrak{T}_{21} = \partial \dot{Y} / \partial F = \varepsilon(c_4 - a_1) \cdot l \cdot i \cdot DB \quad (32)$$

$$\mathfrak{T}_{22} = \partial \dot{Y} / \partial Y = -\varepsilon[1 - a_1(1 - \theta)(1 - \Omega) - c_1\Omega - c_3\theta(1 - \Omega)] < 0 \quad (33)$$

Not all of the partial derivatives for this two-dimensional dynamic system can be unambiguously signed. We immediately observe that \mathfrak{T}_{11} and \mathfrak{T}_{22} are negative, \mathfrak{T}_{12} is positive while the sign of \mathfrak{T}_{21} depends on whether we are situated in the ‘normal case’ or in the ‘puzzling case’. The sign of those that can be unambiguously signed can be explained as follows. Equation (30) shows that an increase in the fragility ratio will put downward pressure on the firms’ creditworthiness which makes lower the provision of new loans. Overall, with given deposits the change in the fragility ratio will decrease. Equation (31) indicates that an increase in output will exert an upward pressure on the change in the fragility ratio since it gives rise to firms’ creditworthiness and decreases expected default on loans. Finally, the negative sign in equation (33) implies that when output becomes higher, the change in output is necessary to decrease in order to insure that the equilibrium output will be attained.

Let us now turn to the partial derivative of expression (32) whose sign is ambiguous. An increase in the fragility ratio turns out to have two opposite effects. On the one hand, it decreases the net profits of firms and, hence, makes higher investment expenditures. On the other hand, it gives rise to the profits of the banking sector which exerts upward pressure on households’ consumption. Therefore, the final effect depends on whether the economy is characterized by the ‘normal’ or by the ‘puzzling case’.

We now have the elements to analyze the stability properties of our dynamic system. Following the usual procedures for stability analysis, we find that there exist two cases of stability depending on the sign of $(c_4 - a_1)$. When the conditions of ‘normal case’ prevail we have that $Det(J) > 0$ and $TR(J) < 0$. Thus, the equilibrium point is

stable. In the ‘puzzling case’ $Det(J) < 0$ and $TR(J) < 0$ which implies that a saddle point equilibrium emerges.

We now proceed to construct standard phase diagrams. The first step consists in finding the shape of isoclines $\dot{Y} = 0$ and $\dot{F} = 0$ from equations (27) and (29). As far as the former isocline is concerned, we get:

$$F|_{\dot{Y}=0} = -\frac{a_0 + c_0}{(c_4 - a_1) \cdot l \cdot i \cdot DB} + \frac{1 - a_1(1 - \theta)(1 - \Omega) - c_1\Omega - c_3\theta(1 - \Omega)}{(c_4 - a_1) \cdot l \cdot i \cdot DB} Y \quad (34)$$

$$\frac{\partial F}{\partial Y}|_{\dot{Y}=0} = \frac{1 - a_1(1 - \theta)(1 - \Omega) - c_1\Omega - c_3\theta(1 - \Omega)}{(c_4 - a_1) \cdot l \cdot i \cdot DB} \quad (35)$$

We see that $\dot{Y} = 0$ is a straight line with a positive or negative slope and a negative or positive intercept. We identify two possible cases. In the ‘normal case’ the line has a positive intercept and a negative slope. In the ‘puzzling case’ the intercept of the line is negative and its slope is positive. It should be pointed out that expression (34) must be positive. This implies that under the ‘normal case’ we should have that $a_0 + c_0 > 1 - a_1(1 - \theta)(1 - \Omega) - c_1\Omega - c_3\theta(1 - \Omega)Y$, while the opposite holds under the ‘puzzling case’.

For the fragility ratio isocline we obtain:

$$F|_{\dot{F}=0} = \frac{b_0 - b_2\gamma_0 - b_1\overline{PF} + b_1(1 - \theta)(1 - \Omega)Y + b_2\gamma_1Y^2}{b_1 \cdot l \cdot i \cdot DB} \quad (36)$$

$$\frac{\partial F}{\partial Y}|_{\dot{F}=0} = \frac{b_1(1 - \theta)(1 - \Omega) + 2b_2\gamma_1Y}{b_1 \cdot l \cdot i \cdot DB} > 0 \quad (37)$$

$$\frac{\partial^2 F}{\partial Y^2}|_{\dot{F}=0} = \frac{2b_2\gamma_1}{b_1 \cdot l \cdot i \cdot DB} > 0 \quad (38)$$

Although $\dot{F} = 0$ involves more difficult computations, it can be shown that it is a curve with positive slope and positive second derivative. In order to restrain the possibilities and take a positive output the follow condition is assumed to hold:

$$b_0 < b_2\gamma_0 + b_1\overline{PF} \quad (39)$$

On the whole, we can identify the behavior of the economy by the construction of standard phase diagrams with arrows indicating directions of adjustment. In what follows we present the phase diagrams of the system under the ‘normal case’ and the ‘puzzling case’. In each case we also examine the effect that changes in exogenous variables may have on the conditions related to the emergence of financial fragility in the economy.

Let us consider first the ‘normal case’. Since expression (35) is negative, the phase diagram is that depicted in figure 4. As it has been illustrated above, point E is a stable point. In the context of our analysis, the crucial question is on which area of fragility this point of stability is placed. Based on figure 3, it follows that the more upward the point E is the greater is the possibility (for given DB) this point to be located within the area that corresponds to the ponzi banking sector. Similarly, the more to the left point E is located the higher is the potential (with given Ω, i, θ and DB) to be within the area of ponzi firms.

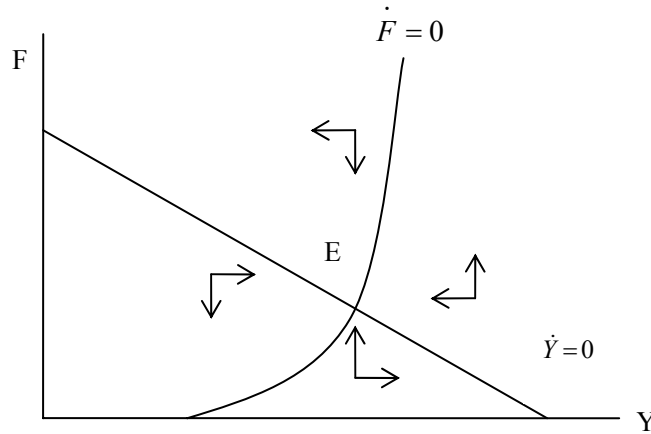


Fig. 4. Phase diagram for Y and F (‘normal case’).

Let us now examine how a decrease in the lower limit of net profits (\overline{PF}) that the banking sector sets is likely to affect the conditions of financial fragility. Note that such a change may be the result of an institutional modification in the functioning of the banking sector which induces banks to relax their creditworthiness criteria. We have that:

$$\left. \frac{\partial F}{\partial \overline{PF}} \right|_{F=0} = -\frac{1}{l \cdot i \cdot DB} < 0 \quad (40)$$

A decrease in the lower limit on net profits shifts up the isocline $\dot{F} = 0$. The new equilibrium point is E_1 (figure 6) which exhibits a higher banks' fragility ratio and a lower output. Furthermore, it should be remarked that, since the demarcation lines in figure 3 have not shifted and the new equilibrium point has been shifted up and leftwards, it follows that the 'ultra ponzi' economy becomes more possible to prevail in the new point. This is the case since less strict criteria for creditworthiness lead to higher indebtedness and hence to more fragile units; at the same time, higher indebtedness makes lower the profits of firms and hence decreases investment and output (since the increase in consumption is less strong in this case).

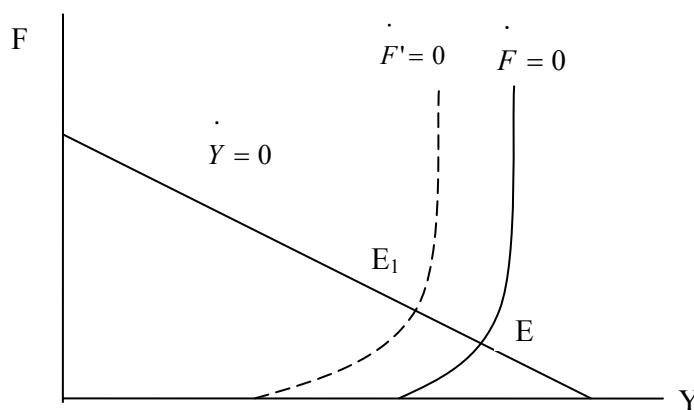


Fig. 5. The impact of a decrease in the lower limit on net profits set by the banking sector ('normal case').

A further step is to examine the impact of an increase in the central bank interest rate.

We get:

$$\frac{\partial F}{\partial i} \Big|_{\dot{F}=0} = -\frac{b_0 - b_2\gamma_0 - b_1\overline{PF} + b_1Y + b_2\gamma_1Y^2}{b_1 \cdot l \cdot DB} \frac{1}{i^2} < 0 \quad (41)$$

$$\frac{\partial F}{\partial i} \Big|_{\dot{Y}=0} = \frac{a_0 + c_0 - [1 - a_1(1-\theta)(1-\Omega) - c_1\Omega - c_3\theta(1-\Omega)]Y}{(c_4 - a_1) \cdot l \cdot i^2 \cdot DB} < 0 \quad (42)$$

By taking into account the restriction depicted in equation (39), it follows that the isocline $\dot{F} = 0$ will shift downwards. This is because the higher central bank interest rate of the central bank will increase the lending interest rate and hence the net profits of firms. As a result, at the same level of output, firms' creditworthiness will shift

down and borrowing will diminish. Furthermore, an increase in the interest rate will shift the isocline $\dot{Y} = 0$ down according to equation (42). This is because the higher central bank interest rate has a negative impact on output and hence the accumulated debt of firms has to decrease in order for the output to remain at the same level.

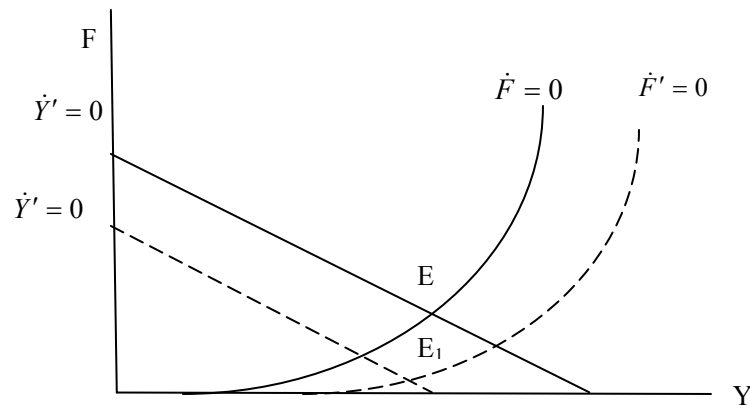


Fig. 6. The impact of an increase in the central bank's interest rate ('normal case').

In the new equilibrium point the fragility ratio of banking sector is lower; however, it is ambiguous whether the output will be higher or lower. This depends on the magnitude of the increase in the lending interest rate and of the negative effect of higher interest rate on the new borrowing. It is also essential to note that the increase in the lending interest rate has an important impact on the slope of the demarcation line that captures the fragility of firms in figures 1 and 3. In particular, the slope of this line will decrease which implies that the area that corresponds to ponzi firms will become larger. It is therefore clear that a contractionary monetary policy shock drives down the fragility of the banking sector but has ambiguous effects on the level of output and on the fragility of firms.

We now move on to consider the 'puzzling case'. This case is depicted in figure 5. Point E has been shown to be a saddle point. It follows that the economy is more likely to exhibit destabilizing forces either towards very low levels of output and of banking sector's fragility ratio or towards very high levels of output and of banking sector's fragility ratio.

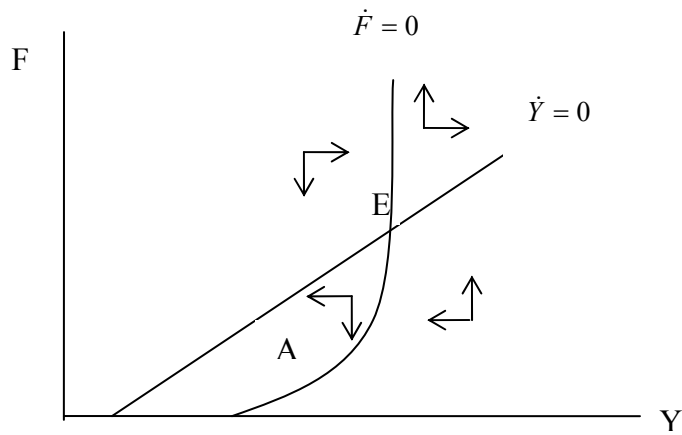


Fig. 7. Phase diagram for Y and F ('puzzling case').

Assuming a decrease in the lower limit on net profits set by banks, the $\dot{F} = 0$ curve shift upwards (see equation 40). The rationale is the same with that of the 'normal case'. However, the results of this shift in the 'puzzling case' are quite different. More precisely, the less strict criteria for creditworthiness have as a result the region A to become shortened. This means that the possibility for the economy to move towards a situation associated with low output and low banks' fragility declines. Instead, there is a higher likelihood the economy to attain a position that exhibits a high output and a bank's high fragility ratio.

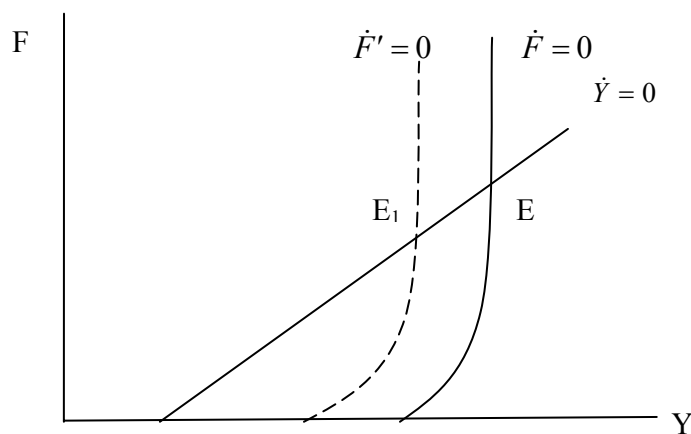


Fig. 8. The impact of a decrease in the lower limit on net profits set by the banking sector ('puzzling case').

Turning to the case of an exogenous rise in the interest rate of the central bank, we obtain the result of a downward shift of isoclines $\dot{F} = 0$ and $\dot{Y} = 0$ (see equations 41 and 42). Recall that the increase in the lending interest rate also makes lower the slope of the demarcation line associated with firms' fragility. The results are not clear-cut since the new equilibrium point can exhibit either higher or lower fragility ratio and output. Furthermore, it is not clear whether the zone A will become larger or smaller. What, however, should be stressed out is that there is now a higher possibility for ponzi firms and thereby for an 'ultra ponzi' economy to prevail.

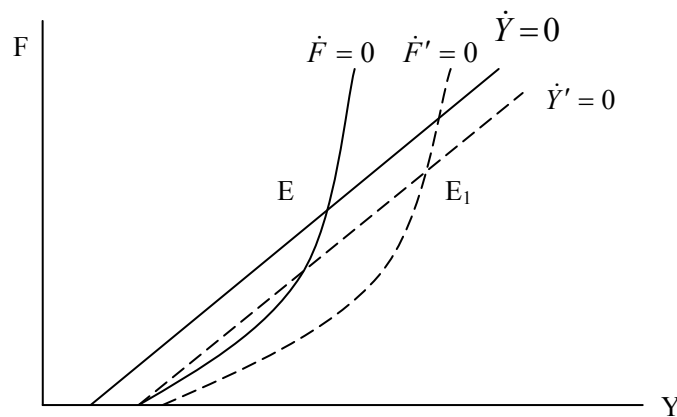


Fig. 9. The impact of an increase in the central banks' interest rate ('puzzling case').

6. Conclusion

This paper attempted to contribute to the Post Keynesian literature on financial fragility by putting forward a macrodynamic model with Minskyan insights that places emphasis on the interaction between the banking sector and the real economy. The innovative features of our model are basically two. First, it incorporates an active banking sector where the banking sector's expectations, 'animal spirits' and creditworthiness criteria play a crucial role in the process of loan provision. Second, it defines banking sector's fragility and uses it in order to categorize the former into hedge, speculative and ponzi as well as in order to define the financial fragility of the economy.

This model permitted us to investigate the conditions under which the economy is likely to be brought into financial fragility. We illustrated that if the propensity to invest out of net profits is high relative to the propensity to consume out of interest income ('normal case') the system converges to a stable equilibrium point. If the opposite holds ('puzzling case'), equilibrium corresponds to a saddle point; this in our model implies that the economy will exhibit destabilizing forces either towards very low levels of output and of banking sector's fragility ratio or towards very high levels of output and of banking sector's fragility ratio.

A further step in our analysis was to explore the impact of a banking sector's institutional change and of a monetary policy shock on the fragility of the economy. Under the conditions of the 'normal case', a relaxation of the criteria for creditworthiness by banks (e.g. because of securitization) was found to make more probable the emergence of an 'ultra ponzi' economy; furthermore, the produced output appears to fall. In the 'puzzling case' the same change was shown to increase the possibility for the emergence of a ponzi banking sector and of high levels of output; it was also shown that the impact on firms' fragility position cannot be unambiguously determined. A decrease in the interest rate of the central bank was shown to increase the likelihood for ponzi firms to prevail. This was illustrated to be true under both the 'normal' and the 'puzzling case'. Furthermore, it was pinpointed that a contractionary monetary policy shock decreases, in the 'normal case', the fragility of the banking sector.

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