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ΔΡΑΣΤΗΡΙΟΤΗΤΑ: *FINANCIAL FRAGILITY AND BANKING SECTOR IN A MACROECONOMIC MODEL WITH MINSKYAN INSIGHTS*

ΠΑΡΑΔΟΤΕΟ: ΑΝΑΚΟΙΝΩΣΗ Ι

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Financial Fragility and Banking Sector in a Macroeconomic Model with Minskyan Insights*

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Abstract: In light of the recent global financial crisis, the notion of financial fragility has become a cornerstone in current research programs of the dynamics of modern monetary production economies. This paper intends to contribute to the literature that focuses on the macroeconomic modelling of financial fragility drawing on Minsky's theoretical framework. Our aim is to extend this literature whereby considerable emphasis has been placed on the fragility of firms, but much less attention has been paid to the fragility of banks and its impact on macroeconomic performance. The paper develops a simple macroeconomic model that links the fragility of banks with the level of output. We put forward a Minskyan categorization for the economy's financial structure, which takes into account both the fragility of banks and the fragility of firms. Our analysis intends to illustrate under what conditions the interaction between banks and the real economy is likely to lead to financial structures that are susceptible to financial instability.

JEL-Classification: E12, E44, E51, G21

Keywords: financial fragility, banking sector, Minskyan macroeconomic analysis

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1. Introduction

The global economy has recently experienced severe bouts of financial disturbances with devastating feedback effects on macroeconomic performance and stability. In light of this turmoil, the notion of financial fragility has become quite fashionable in the analysis of the causes of the recent financial crisis. It is argued that issues of financial fragility should be at the centre of economy policy if similar turbulence is to be avoided in the future.

The notion of financial fragility dates back to Keynes and Fisher. More recently, Minsky (1982, 1986) developed the financial instability hypothesis, which 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). While Minsky did not develop a formal model of his ideas, several authors took up this task. In the constructed models particular attention has so far been paid to the definition of the fragility of firms and the conditions under which this fragility is likely to emerge (see Dos Santos, 2005 for a survey).

Lavoie (1986-1987) has developed a model whereby the leverage ratio is utilized to capture the fragility of firms. Through an investment function that encapsulates Kaldorian characteristics the author examines the interaction between growth and firms' fragility; it is indicated that the leverage ratio of firms exerts a negative impact on growth. The leverage ratio of firms is also at the centre of Delli Gatti and Gallegati (1990) analytical framework. These scholars have put forward an IS-LM model with an investment function that relies on the two price theory of Minsky; it is shown that financial fragility emerges only under certain conditions associated with the way the profits respond to an increase in the leverage ratio. Fazzari *et al.* (2001) have incorporated the two price theory of Minsky into a macroeconomic framework that emphasizes the optimistic expectations of firms and illustrate how macroeconomic cyclical fluctuations are likely to be generated.

Arena and Raybaut (2001) have developed a Keynesian model of investment where cash flow and expected profit rate play a crucial role in the dynamics of financial

fragility. Within this formulation the authors indicate that business cycles will eventually arise in the economy. Keen (1995) has developed a model based on Goodwin's frame with fragility characteristics captured by the debt to capital ratio. In Setterfield (2004), the fragility of the economy is portrayed as the difference between the accumulated debt and the savings of the private sector (firms and households). The model that is deployed examines the aggregate fluctuations as a result of the interaction among financial, industrial and household sectors. Another specification has been recently proposed by Bellofiore *et al.* (2009) whereby the firms' fragility is associated with the overall financial exposition of the firm; this exposition is linked to the leverage ratio and the relative duration of the financial requirements and debt.

In another group of models explicit emphasis has been placed on Minsky's distinction between hedge, speculative and ponzi firms.[1] Foley (2003) first established the Minskyan categorization in a Kaleckian model. Firms are deemed as hedge when their rate of profit is higher both than the rate of investment and the rate of interest. In the case that the rate of profit is lower than the rate of investment but higher than the rate of interest firms are classified as speculative. Ponzi firms exist in the case that the rate of profit is lower than the rate of interest. In his model the economy reach equilibrium after hovering upon a ponzi situation. In similar lines, Lima and Meirelles (2006, 2007) have defined the three finance regimes according to the capacity of firms to finance their investment expenditures and interest payments from their profits. Their analysis focuses attention on the conditions under which each of these regimes is likely to prevail. Arza and Espanol (2008) have utilized this categorization of Minsky in order to identify whether the firms during 1992-2001 in Argentina were financially constrained. In their analysis the distinction between hedge, speculative and ponzi firms relies on the extent to which the profits of firms cover the interest and short-term debt. Charles (2008b) has applied Minsky's categorization by using the interest payments to profit ratio as a measure of the fragility of firms. Financial fragility

[1] "A unit is hedge financing at a particular date when at that date the expected gross capital income exceeds by some margin the payment commitments due to debts in every relevant period over the horizon given by the debts now on the books and the borrowings that must be made if expected gross capital income is to be earned…A unit speculates when for some periods the cash payment commitments on debts exceed the expected gross capital income…Ponzi units are speculative units with the special characteristic that for some if not all near term periods cash payment commitments to pay interest are not covered by the income portion of the expected excess of receipts over current labor and material costs" (Minsky, 1982, pp.25-28).

appears to be the most likely result in a model where the fragility of firms is allowed to interact with economic growth.[2]

One limitation of the aforementioned models is, however, that no explicit consideration has so far been made to the fragility of banks, which is extremely relevant in the context of the recent financial crisis (see e.g. Dymski, 2010). Furthermore, the active role of banks has to a great extent been neglected (see e.g. Dos Santos, 2005; Kregel, 1997).[3] The aim of this paper is to develop a Post Keynesian macroeconomic model with Minskyan insights that places explicit emphasis on the aforementioned issues.

The distinct features of our model have as follows. First, we explicitly define the fragility of banks and incorporate it in our frame. The fragility of banks is portrayed by relying on the relationship between loans and deposits, which draws on the formalizations of Forman *et al.* (1984), Cozzi and Toporowski (2006) and Dos Santos and Macedo e Silva (2009). Second, we elaborate an extended Minskyan version of the financing situations into which the economy can be located, taking into account both firms' and banks' fragility. Third, we use phase-diagrammatic analysis in order to explore the interaction between the fragility of banks, credit rationing procedures, and output changes.

The paper is organized as follows. In section 2 the structure of the model is set out. Section 3 presents the extended Minskyan financing situations of the economy. Section 4 studies the interaction between banks' fragility and output and explicates the conditions under which the economy is likely to become financially fragile. Furthermore, it addresses the effects of a change in the credit rationing responsiveness of banks to their own fragility. A few concluding remarks follow in section 5.

2. The structure of the model

[2] The above-mentioned analysis of Minsky's financial fragility does not take into account the distinction between liquidity and solvency problems (see Vercelli, 2009 for a related work) and it strictly refers to the 'basic' Minsky cycle (see Palley, 2009).
[3] An exception is the model of Setterfield (2004).

Our economy is composed of households, firms, banks and a central bank. Households are assumed not to get bank loans and to keep their wealth only in the form of bank deposits. Firms are portrayed to finance their investment plans using loans and gross profits. Banks are hypothesized to always accept deposits from the households; their profits are not distributed, implying that their net worth is different from zero.[4] Central bank sets the discount interest rate.

Households receive income in form of wage bill and interest on deposits, and use it in order to buy consumption goods and save. The wage bill of households is given by:

$$W = \Omega \cdot Y \quad \textbf{(1)}$$

where W is workers' wage bill, Ω is the wage share in nominal aggregate income and Y is output. Note that in our model inflation is assumed away and the level of prices is equal to unity.

Firms use sale receipts to pay wages and interest on loans, retaining the rest to finance investment or to repay loans. Equation (2) gives the gross profits of firms, PF^G, which are equal to profits after subtracting workers' wage bill:

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

The net profits of firms, PF, are equal to the gross profits of firms minus the interest payments due to their outstanding debt:

$$PF = PF^G - i_L L \quad \textbf{(3)}$$

where i_L is the lending interest rate and L is the loans of firms (outstanding amount).

Banks' profits, PB, are given by:

[4] This assumption for the retained profits of banks is in line with Le Heron and Mouakil (2008) and Foley and Taylor (2006). An alternative hypothesis would be to presume that the profits of the banks are distributed to the households, as in van Treeck (2009), Godley and Lavoie (2007, ch. 10), Lavoie and Godley (2001-2002) and Zezza and Dos Santos (2004).

$$PB = i_L L + i_B B - i_{DB} DB \quad \textbf{(4)}$$

where i_B is the interest rate on the safe asset, *B* is the amount of the safe assets the banks hold (e.g. treasury bills), i_{DB} is the interest rate on deposits and *DB* is the amount of deposits held by households.

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

$$i_{DB} = d \cdot i \quad \textbf{(5)}$$

$$i_L = l \cdot i \quad \textbf{(6)}$$

where *d* is the mark-down and *l* is the mark-up over the interest rate, *i*, that is set by the monetary policy of the central bank. Note that *d* and *l* are exogenously given in our analysis.

It is presumed that there are two types of households with different propensities to consume out of their disposable income. The first type of household receives only wage income and consumes all of it. The second type of household receives both wage and interest income and has a propensity to consume out of total disposable income lower than one. Consequently, in our consumption function the propensity to consume out of wage income is lower than one. In particular:

$$C = c_1 W + c_2 i_{DB} DB \quad \textbf{(7)}$$

where $0 < c_2, c_1 \leq 1$.

The savings of households are held in the form of deposits in banks (see e.g. Lavoie and Godley, 2006 and Godley and Lavoie, 2007, ch. 7). Thus:

$$\dot{DB} = i_{DB} DB + W - C \quad \textbf{(8)}$$

In our analysis we adopt the distinction between the desired investment of firms, I^D, and the effective one, I (see Le Heron and Mouakil, 2008 for an alternative approach). The latter is equal to the former after subtracting the amount of loans that are credit rationed by banks, $\dot{L}^{CR}$. In particular:

$$I = I^D - \dot{L}^{CR} \quad \textbf{(9)}$$

The above equation implies that an increase in the new amount of loans that are credit rationed diminishes the effective amount of investment. This allows us to pinpoint the negative effect that credit rationing is likely to exert on effective investment.

Following the distinction between the effective and the desired investment, we further distinguish between the desired and the effective change in loans. The latter, $\dot{L}$, is given by the following equation:

$$\dot{L} = \dot{L}^D - \dot{L}^{CR} \quad \textbf{(10)}$$

where $\dot{L}^D$ stands for the demanded change in loans. Overall, the change in the effective amount of new loans adjusts according to the change in demanded loans and the change in credit rationed loans.[5] Since the amount of credit rationed loans is always a fraction of the demanded amount of loans it invariably holds that $\dot{L}^{CR} < \dot{L}^D$. Equation (10) draws attention to the fact that there always exists an unsatisfied fringe of borrowers in the loan market. In other words, it points out the crucial role of credit rationing, which has been neglected in the related Minskyan macroeconomic models whereby the actual amount of new loans has in most cases been conceptualized to be equal to the desired one by firms (see e.g. Lima and Meirelles, 2007). It should be noted that our formalization builds on the recent Post Keynesian literature on credit rationing (see, among others, Dow, 1998; Wolfson, 1996; Grabel, 1995; Lavoie, 1996; Parguez, 2001; Setterfield, 2004; Rochon, 1999; Ramskogler, 2009).

[5] For a similar specification see Taylor (1994).

The desired amount of new loans is given by:

$$\dot{L}^D = I^D - PF \quad \textbf{(11)}$$

Equation (11) shows that firms' demand for external finance is equal to their desired investment expenditures minus the net profits (see Minsky, 1995; Lima and Meirelles, 2007; Charles, 2008b).[6]

Our desired investment function is expressed as:

$$I^D = a_0 + a_1 PF + a_2 Y \quad \textbf{(12)}$$

where $a_i > 0, i = 0,1,2$. The investment function incorporates the animal spirits, a_0, of entrepreneurs, the net profits of firms, *PF*, and the level in the actual output, *Y*.[7] The last term captures the positive impact of euphoric expectations on desired investment, as in Minsky (1982) and Fazzari *et al.* (2008). The higher is the increase (decline) in the level of output, the more (less) firms are willing to undertake more risky investment projects.

The amount of new loans that are credit rationed is captured by the following function:

$$\dot{L}^{CR} = b_0 - b_1 PF + b_2 F^B - b_3 Y \quad \textbf{(13)}$$

$b_i, i = 0,1,2,3$ are positive parameters; b_0 denotes the 'animal spirits' of banks with respect to loan expansion, F^B is the fragility of banks and *Y* the level of output captures the banks' euphoric expectations.

[6] As Minsky (1986, p. 207) emphasizes: "the internal funds that are available to finance investment need to be augmented by outside funds and that in the decision to invest, the availability of outside financing is a key element".

[7] For similar investment functions see Charles (2008a) and Jarsulic (1996).

Higher animal spirits of banks imply lower amount of credit rationing.[8] These spirits are assumed to be affected, among other factors, by the level of exogenous confidence of banks, 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), Dymski (1992)[9] to the uncertain environment in which banks operate (see also Rochon, 1999, p. 280 for such a recommendation).

The second term represents the impact that the firms' creditworthiness may have on the change in credit rationed loans. The higher the net profits of firms, the higher is the firms' creditworthiness and in turn the lower the amount of credit rationing. This variable captures the Keynesian uncertainty over the ability of borrowers to repay their loans. In such circumstances, "the businessman answers the financier's question, how will you get the monies to meet the obligations to pay? by pointing to the prospective cash flows" (Minsky, 1991, p.6). More specifically, the banks provide loans to all borrowers that are deemed creditworthy according to their net income (Rochon, 1999, p. 279; Moore, 2001, p.25; Franke and Semmler, 1989; Bhaduri, 2010).[10]

Moreover, an important point needs to be stressed here. The amount of firms' creditworthiness is subject to fluctuation as the individual's own financial circumstances change (see Basu; 2003, Rochon; 1999, for a similar argument). In this context we could take also into account that banks could keep some minimum requirements with respect to firms' creditworthiness in order to supply credit (Wolfson, 1996; Rochon, 1999). Hence, tighter credit standards would 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

[8] 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 firms and the animal spirits of banks can be different.

[9] Dymski (1992, p.314) proposes to use both asymmetric information and Keynesian uncertainty in order to describe banks' willingness to supply credit.

[10] Dymski (1988) provides a framework where banks are gathering information as far as the creditworthiness of the borrowers. See Wray (1989), Dymski (1989), Heise (1992), van Ees and Garretsen (1993), Dymski (1993) and Piegay (1999-2000) for further comments.

markets, where they will meet substantial credit rationing[11] or they may turn to informal credit markets (see Basu, 2003, p.239). In expression (13) the higher (lower) is b_1 the more (less) banks take account of the creditworthiness of firms in the provision of new loans.

Turning to the third term of function (13), the banks' fragility is defined as the difference between the effective loans and deposits of households:[12]

$$F^B = L - DB \qquad \textbf{(14)}$$

The higher is the amount of loans in excess of deposits in the balance sheet of banks the greater is the risk of illiquidity and insolvency. Hence, it is reasonable to argue that the higher is the fragility of banks, the higher is the amount of new loans that are credit rationed, since banks perceive their illiquidity and insolvency risk to increase.[13] Of particular importance for our analysis is parameter b_2, which represents the responsiveness of credit rationing procedure to the fragility of banks. The higher is this parameter the more banks take into account their own liquidity and solvency position and thereby the more the fragility of banks affects the amount of loans that are credit rationed.

The fourth term in function (13) reflects the impact of the output on banks' credit rationing. We argue that as, the firms become more optimistic within periods of tranquility, it is also banks that become more optimistic when output increases. This behavior of banks is based on two aspects. On the one hand, there is the Minskyan

[11] This idea rests on what Dymski (2005, p.440) refers as 'financial exclusion', which refers to the failure of the formal banks to offer credit and depository services.

[12] For a similar definition of fragility of banks see Dos Santos and Macedo e Silva (2009). See also Forman *et al.* (1984) and Cozzi and Toporowski (2006) whereby the ratio of loans to deposits is used in order to capture the liquidity pressure of the banking sector. Also other economists have recognized that banks are interested in keeping specific ratios of its assets to liabilities. In most of these models the authors focus on the liquidity of banks in order to measure the lending capacity of the whole sector and their performance towards fundamental uncertainty and not especially for banks' fragility. Dymski (1988) proposed that banks hold a specific asset to deposit ratio while Alves *et al.* (2008) used the ratio of reserves to deposits and the leverage ratio in order to examine banks' liquidity and credit risk. Another example is the stock-flow model in Godley (1999) who has figured out banks with a specific norm for the ratio of bills to liabilities. Lavoie and Godley (2006) and Godley and Lavoie (2007, ch. 10) have complemented the previous analysis by formalizing banks to take into account a specific bills to deposits ratio.

[13] For similar arguments see Wolfson (1990, p. 349; 1995, p. 353), Paula and Alves (2006) and Eatwell *et al.* (2008).

analysis. Minsky (1986, p.132),[14] Paula and Alves (2006), Grabel (1995, p.136), Palley (1994) 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 favorable views about the future 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 banks (Basu, 2003, p.238; Dymski and Pollin, 1992, p.45; Grabel, 1995, p.142; Paula and Alves, 2006). It is suggested that high competition, seen through increasing prosperity and high output, compels banks relax their credit behavior and engage in risky activities in order to cement their institutional position. This 'asymmetric reward structure', as Crotty (1996) names it, rewards more and punish less the aggressive banks.

3. 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 firms along with the fragility of banks. 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 firms.[15] Following Lima and Meirelles (2006, 2007), the classification of firms as hedge or speculative depends on whether their gross profits are sufficient or not to cover their investment expenditures plus the interest payments. In particular, if the gross profits are higher than investment

[14] "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).

[15] See section 1 for some alternative definitions of firms' fragility within the Minskyan framework. It should be noted that our analysis does not consider the possibility of ponzi firms, since it is deemed that at the macro-level the net profits are difficult to be negative, at least in the context of a closed economy.

expenditures plus the interest payments, the firms are deemed as hedge. This implies that at the aggregate level the new amount of loans is negative.[16] On the other hand, if the sum of effective investment plus the interest payments is higher than the gross profits, firms are classified as speculative. Therefore, a Minskyan taxonomy can be derived as follows:

Hedge firms: $(1-\Omega)Y \geq I + i_L \cdot L$ or $\dot{L} \leq 0$ **(15)**

Speculative firms: $(1-\Omega)Y < I + i_L \cdot L$ or $\dot{L} > 0$ **(16)**

We use equation (9) along with equations (1) to (3) and (12) to (14) and substitute it in the previous equations in order to consider the hedge and speculative firms in connection with the fragility of banks. After some manipulations we finally obtain:[17]

Hedge firms:

$$F^B\Big|_H^F \geq -\frac{a_0 - b_0}{i_L - a_1 i_L - b_1 i_L - b_2} - \frac{1-(a_1+b_1)(1-\Omega) - a_2 - b_3}{i_L - a_1 i_L - b_1 i_L - b_2} \cdot Y \qquad \textbf{(17)}$$

Speculative firms:

$$F^B\Big|_S^F < -\frac{a_0 - b_0}{i_L - a_1 i_L - b_1 i_L - b_2} - \frac{1-(a_1+b_1)(1-\Omega) - a_2 - b_3}{i_L - a_1 i_L - b_1 i_L - b_2} \cdot Y \qquad \textbf{(18)}$$

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

[16] This does not exclude the possibility that at the micro level there exist firms that get a positive amount of new loans. However, the amount of loans that is repaid from the other firms is higher resulting in a negative loan expansion at the aggregate level.

[17] In our analysis we have adopted the simplifying assumptions that $c_2 = a_1 + b_1 = 1$ and $i_{DB} = i_L$. In other words we assume that the income from the deposits is entirely consumed. This has permitted us to derive a two-dimensional system instead of a three-dimensional one which would significantly complicate our analysis. Also, these assumptions permit us to have a diagrammatical representation of the dynamic system and the firms' fragility demarcation line (see section 4). We contend that these assumptions do not change the essence of our arguments.

$$F^B\big|^F_{H-S} = -\frac{a_0 - b_0}{i_L - a_1 i_L - b_1 i_L - b_2} - \frac{1-(a_1+b_1)(1-\Omega) - a_2 - b_3}{i_L - a_1 i_L - b_1 i_L - b_2} \cdot Y \qquad \textbf{(19)}$$

where $F^B|^F_{H-S}$ is the level of banks' fragility corresponding to the regime transition from hedge to speculative firms, as shown in figure 1. It should be pointed out that in figure 1 we have depicted the case in which the slope of the demarcation line is positive. This corresponds to regime I that will be developed in section 4. In the subsequent section we will also consider the case of a negative-sloped demarcation line.

It is worth pinpointing that the positive slope of firms' demarcation line indicates that, as the level of output increases, the fragility of banks needs to become higher in order to firms remain hedge. The rationale is that a higher level of output puts upward pressure on firms' loans and effective investment, under regime I, which have to be counterbalanced by a higher level of bank's fragility that has an opposite effect on new loans.[18]

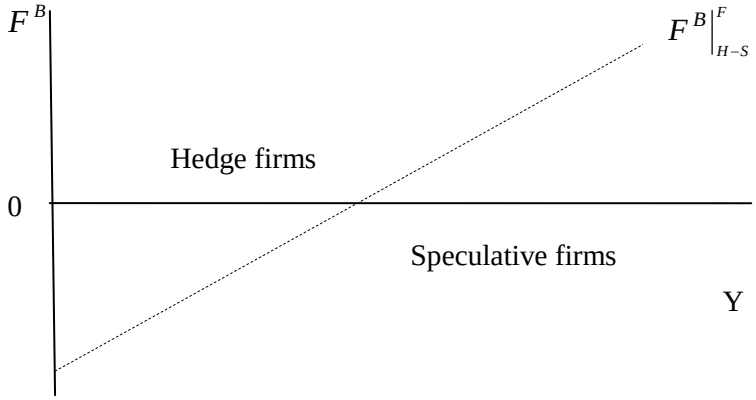

Fig. 1. The classification of firms

Regarding the fragility of banks we follow Dos Santos and Macedo e Silva (2009) and distinguish between hedge and speculative banks. If banks hold enough deposits in

[18] Under regime I we assume that $\Omega < a_2 + b_3$ in order to take a positive slope for the firms' demarcation line. Under regime II, the opposite condition holds implying a negative slope of the firms' demarcation line. The rationale is that an increase in output rises loans and effective investment but this is overcompensated by the increase in the gross profits of firms. Consequently, hedge firms can have a large amount of output with a smaller amount of banks' fragility.

order to cover the amount of loans on their balance sheet they are defined as hedge. In the opposite case, they are classified as speculative. More specifically, we have that:

Hedge banks: $L \leq DB$ **(20)**

Speculative banks: $L > DB$ **(21)**

If we substitute equation (14) into the previous equations after some manipulations we obtain:

Hedge banks: $F^B|_H^B \leq 0$ **(22)**

Speculative banks: $F^B|_S^B > 0$ **(23)**

In the case that banks' fragility is smaller or equal to zero then banks can be characterized as hedge. On the contrary, speculative banks are characterized by a banks' fragility greater than zero. This is the case in which the deposits in the balance sheet of banks are lower than their loans, implying that liquidity problems are more likely to emerge.

Let us also derive the corresponding demarcation line this time for banks in the (Y, F^B) space:

$F^B|_{H-S}^B = 0$ **(24)**

where $F^B|_{H-S}^B$ is the level of banks' fragility corresponding to the regime transition from hedge banks to speculative banks which is tantamount to the output axis, as shown in figure 2.

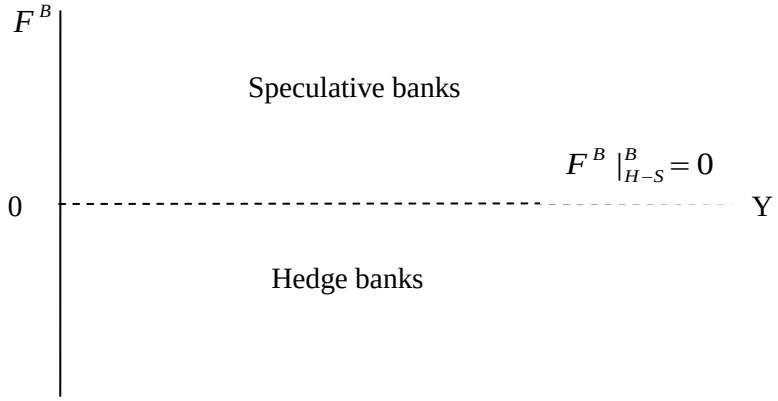

Fig. 2. The classification of banks.

We now turn to put together figures 1 and 2 in order to depict the overall picture for the financial fragility of the economy. There are four different situations that may emerge. There is first the possibility of an *'ultra hedge'* economy characterized by hedge banks and hedge firms; both output and banks' fragility are low. This situation corresponds to the area on the left of the demarcation line of the firms and below the demarcation line of banks. Both sectors are deemed to have a low illiquidity risk. The *'semi speculative type I'* economy is the case where the firms are characterized as speculative and banks are conceived as hedge; banks' fragility is low and output is high. This situation is depicted by the area on the right of the demarcation line of firms and underneath the demarcation line of banks. The financial fragility of the economy is higher relative to the aforementioned situation since there is a higher possibility for firms to face liquidity problems.

The third possibility is that of a *'semi speculative type II'* economy where banks are speculative and firms are hedge, while the economy exhibits low output and high banks' fragility. This case is captured by the zone on the left of the demarcation line of the firms and above the demarcation line of banks. In this situation banks' deposits are lower than their loans and thereby their loan position has to be funded by further resources. This makes banks more fragile. Our last case is the *'ultra speculative'* economy where both sectors are characterized by speculative finance; both output and banks' fragility are high. It is located to the right of the demarcation line of firms and over the demarcation line of banks. This is the case where the financial fragility of the

economy is the largest compared to all the previous ones. There is excessive financial fragility in the economy since both sectors are susceptible to liquidity problems.

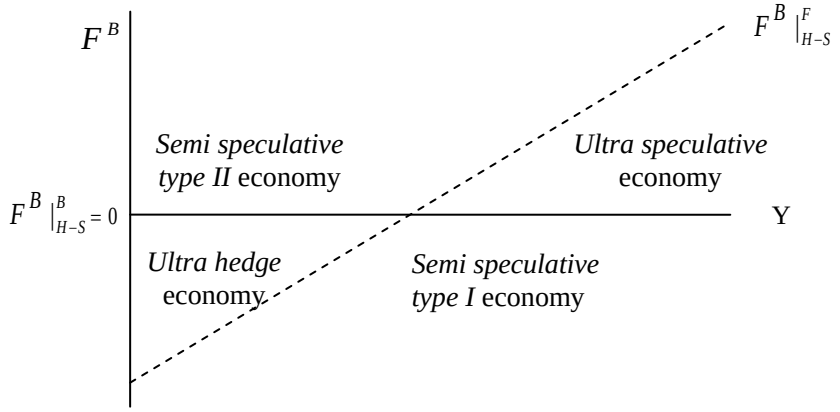

Fig. 3. The overall classification of the economy.

4. The dynamic behaviour of the model and the emergence of financial fragility

This section deals with the dynamic interaction between banks' fragility and the output of the economy. We derive a two dimensional system and set out the equations that will be the basis of our analysis for the emergence of financial fragility.

The change in output is captured by the following equation (see also Asada, 2004):

$$\dot{Y} = e(C + I - Y) \qquad \textbf{(25)}$$

where $0 < e < 1$ is a positive parameter. Replacing C from equation (7), I from equation (9) and making use of equations (1) to (3), and (10) to (14) we find the mechanism for the motion of output. The next step consists in substituting the fragility of banks for loans and the amount of deposits from equation (14). After some manipulations we ultimately obtain:

$$\dot{Y} = e\{a_0 - b_0 - (1 - c_1\Omega - (a_1 + b_1)(1 - \Omega) - a_2 - b_3) \cdot Y - (b_2 + a_1 i_L + b_1 i_L) \cdot F^B\} \qquad \textbf{(26)}$$

Having presented the mechanism of output we now turn to the way that the real economy affects the change in the fragility of banks. Differentiating F^B from equation (14) with respect to time we get:

$$\dot{F}^B = \dot{L} - D\dot{B} \quad \textbf{(27)}$$

We introduce equations (10) and (8) into the previous equation and by combining equations (1) to (3), (7) and (11) to (14) we end up with:

$$\dot{F}^B = a_0 - b_0 - (1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3) \cdot Y + (i_L - a_1 i_L - b_1 i_L - b_2) \cdot F^B \quad \textbf{(28)}$$

Equations (26) and (28) constitute an autonomous two-dimensional system of differential equations, in which the derivatives of Y and F^B depend on the levels of Y and F^B as well as on the parameters of the system. We can therefore analyze the interaction of the economy with banks' fragility 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:

$$\Im_{11} = \partial \dot{F}^B / \partial F^B = i_L - a_1 i_L - b_1 i_L - b_2 < 0 \quad \textbf{(29)}$$

$$\Im_{12} = \partial \dot{F}^B / \partial Y = -(1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3) \quad \textbf{(30)}$$

$$\Im_{21} = \partial \dot{Y} / \partial F^B = -e(a_1 i_L + b_1 i_L + b_2) < 0 \quad \textbf{(31)}$$

$$\Im_{22} = \partial \dot{Y} / \partial Y = -e(1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3) \quad \textbf{(32)}$$

Not all of the above partial derivatives can be unambiguously signed. In particular, the sign of $\Im_{11}$, $\Im_{21}$ is negative but the sign of $\Im_{12}$ and $\Im_{22}$ depends on the sign of $1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3$. The negative sign of expression (29) implies that

the change in the fragility of banks is negatively affected by the level of banks' fragility. On the one hand, an increase in the fragility of banks makes the loans that are credit rationed higher; it also decreases the desired amount of new loans since it leads to lower net profits and thereby to lower desired investment. On the other hand, a higher fragility of banks exerts an upward pressure on the new amount of loans that are demanded due to the higher interest payments of firms. Overall, under the assumptions of the model the former effects counterbalance the latter one. Equation (31) implies a negative effect of banks' fragility on the output change. An increase in the fragility of banks makes higher the amount of new loans that are credit rationed with negative feedback effects on economic activity. Further, an increase in the fragility of banks decreases the desired investment since it increases the interest obligations of firms.

We now proceed to construct the standard phase diagrams. The first step consists in finding the shape of isoclines $\dot{Y}$ and $\dot{F}^B$ from equations (26) and (28). As far as the former isocline is concerned, we get:

$$F^B\Big|_{\dot{Y}=0} = \frac{a_0 - b_0}{a_1 i_L + b_1 i_L + b_2} - \frac{1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3}{a_1 i_L + b_1 i_L + b_2} \cdot Y \qquad \textbf{(33)}$$

$$\frac{\partial F^B\Big|_{\dot{Y}=0}}{\partial Y} = -\frac{1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3}{a_1 i_L + b_1 i_L + b_2} \qquad \textbf{(34)}$$

We can see that $\dot{Y} = 0$ is a straight line with positive or negative slope depending on the sign of $1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3$.

For the banks' fragility isocline we obtain:

$$F^B\Big|_{\dot{F}^B=0} = -\frac{a_0 - b_0}{i_L - a_1 i_L - b_1 i_L - b_2} + \frac{1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3}{i_L - a_1 i_L - b_1 i_L - b_2} \cdot Y \qquad \textbf{(35)}$$

$$\frac{\partial F^B\big|_{\dot{F}^B=0}}{\partial Y} = \frac{1-c_1\Omega-(a_1+b_1)(1-\Omega)-a_2-b_3}{i_L-a_1 i_L-b_1 i_L-b_2}. \qquad \textbf{(36)}$$

The results for the shape of the $\dot{F}^B = 0$ line indicate that it is a straight line with a positive or negative slope depending on the sign of $1-c_1\Omega-(a_1+b_1)(1-\Omega)-a_2-b_3$. At this point of the analysis we introduce two possible regimes the economy can rest upon (see table 1). *Regime I* is the case where the economy is characterized by a large propensity to consume out of wage income and a high elasticity of investment and credit rationing with respect to the expectations that are formed as a result of upswings and downturns. Under *Regime II* there is a low propensity to consume out of wage income and a small elasticity of investment and credit rationing with respect to the expectations that are formed as a result of changes in the level of output.

	Regime I	**Regime II**
a_2, b_3	high	low
c_1	high	low
$1-c_1\Omega-(a_1+b_1)(1-\Omega)-a_2-b_3$	-	+
J_{11}	-	-
J_{12}	+	-
J_{21}	-	-
J_{22}	+	-
Det(J)	+	-
Tr(J)	-	
Equilibrium point	stable	saddle
Figure	4	5

Table 1. The two regimes.

We first focus attention on regime I. Under this regime expression (30) is positive. More specifically, an increase in output increases firms' creditworthiness and banks' expectations and therefore it decreases the new amount of loans that are credit rationed. Furthermore, an increase in output increases the net profits of firms as well as their expectations, placing upward pressures on the desired investment and in turn on the desired amount of new loans. Hence, according to these forces the banks' fragility tends to increase. However, this positive impact may be overwhelmed by

forces which tend to decrease banks' fragility. More specifically, the increase in output increases the internal finance of firms and thereby decreases the amount of new loans that firms desire to take; further, it increases the amount of new deposits. In regime I the positive impact overcompensates the negative impact one. This implies that an increase in output exerts an upward pressure on the change in the fragility of banks.

As far as the sign of equation (32) is concerned, this is positive under regime I and implies that, when output becomes higher, the change in output goes up. The increase in output increases firms' creditworthiness and banks' expectations; therefore the amount of loans that are credit rationed decreases. There is also an increase in net profits and firms' expectations that brings about a rise in the desired investment. Both outcomes make effective investment increase. Moreover, a rise in output increases wage income and thereby consumption expenditures. Under regime I, the condition for equilibrium in the output market does not hold and hence an increase in the level of output leads to an increase in the change of output.

In regime I $\Im_{12}$ and $\Im_{21}$ are positive and thus $Det(\Im)$ is positive and $Tr(\Im)$ turns negative.[19] This implies a stable point as figure 4 indicates. Overall, under the assumptions of regime I expressions (34) and (35) are positive, which leads us to draw the phase diagram portrayed in figure 4.[20] Figure 4 also shows the position of the demarcation line of the firms' fragility. The area above the firms' fragility demarcation line characterizes the firms as hedge while in the opposite case they are characterized as speculative. We can see that in the intersection of the isoclines firms are always characterized as hedge.[21]

[19] Under the assumption that $b_2 > -e(1-c_1\Omega-(a_1+b_1)(1-\Omega)-a_2-b_3)$.

[20] Under regime I the slope of the output isocline is smaller than the slope of the banks' fragility isocline since the denominator of the former is larger than that of the latter and under the assumption of regime I that $1-c_1\Omega-(a_1+b_1)(1-\Omega)-a_2-b_3<0$. Further, in order to attain a positive equilibrium output under regime I it is assumed that $a_0-b_0<0$.

[21] The banks' fragility isocline has a larger slope than the firms' fragility demarcation line since $(1-c_1)\Omega<\Omega$. To the extent that these isoclines have the same intercept, the equilibrium point will be characterized by hedge firms under regime I and II.

Figure 4 indicates the possibility of cycles. Assume that the economy is initially at the 'ultra hedge' situation (hedge firms, hedge banks) where both output and banks' fragility are low. Because of the low level of debt, firms' desired investment is increasing; simultaneously, low banks' fragility leads them to decrease the credit rationed loans contributing to the expansion of the economy, since the new amount of effective loans is increasing. At some point the amount of gross profits does not cover investment expenditures and interest payments; thus, the economy slides into the 'semi speculative type I' situation (speculative firms, hedge banks).

The expansion of the economy continues and is reinforced by the euphoric expectations of both firms and banks. At some point banks' fragility starts to increase, whereas the amount of effective loans becomes larger than the amount of the households' deposits turning the economy to the 'ultra speculative' situation where both firms and banks are speculative. This is the occasion that the economy is found with the largest degree of financial fragility. Gradually, the high level of banks' fragility starts having negative feedback effects on the output of the economy, since effective investment decreases as a result of higher credit rationing and lower internal funds. The decrease in output leads the economy to the 'speculative type II' situation (speculative banks, hedge firms). Furthermore, the fragility of banks starts decreasing again as a result of credit restriction. Eventually, the decreasing fragility of banks leads the economy to the 'ultra hedge' situation; then, the stage is set for a new cycle until the equilibrium point *E* is reached.

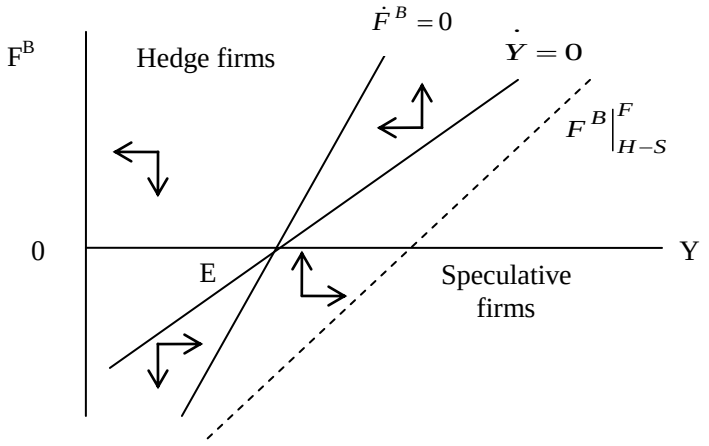

Fig. 4. Phase diagram for *Y* and F^B under regime I.

Under regime II equation (30) is negative; the positive effect of higher output on the internal funds of firms and on the new deposits more than offsets the negative impact that higher output has on the fragility of firms, as a result of the increase that it triggers on the desired investment and the amount of loans that are not credit rationed.

The sign of equation (32) is also negative since under regime II the equilibrium condition for the product market is satisfied. It follows that $Det(\Im)$ is negative and hence the equilibrium is an unstable saddle point irrespective of the sign of $Tr(\Im)$. Figure 5 depicts the dynamics of regime II. Also, we introduce in the figure the firms' fragility demarcation line. It is worthwhile to pinpoint that above this line hedge firms are depicted while below it they are situated speculative firms.[22]

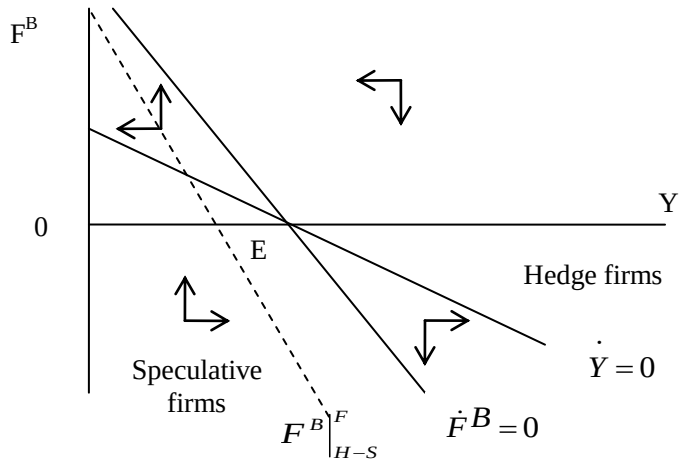

Fig. 5. Phase diagram for Y and F^B under regime II.

What counts are the initial conditions. In the occasion the economy is within the area on the right of the demarcation line characterizing the fragility of firms and below the demarcation line of the fragility of banks the most possible scenario is for both firms and banks to remain hedge with low banks' fragility and high output. This is similar to the result of Lima and Meirelles (2007) where, if the equilibrium is located into the firms' hedge area, along with a procyclical banking mark-up and a growth rate larger

[22] Under regime II the slope of the output isocline is larger than the slope of the banks' fragility isocline since the denominator of the former is larger than that of the latter and under the assumption of the regime that $1-c_1\Omega-(a_1+b_1)(1-\Omega)-a_2-b_3>0$. Moreover, in order to have a positive equilibrium output under regime II we assume that $a_0-b_0>0$.

than the interest rate, the firms will remain hedge. If the economy is within the zone of speculative banks and firms the high level of fragility has an unfavourable impact on the level of output while the low level of output further exerts upward pressures on the fragility of banks. Thus, the economy can be trapped into the 'ultra-speculative' area. Finally, if the economy is initially within a 'semi-speculative' zone there are almost equal possibilities the economy to slide into the 'ultra-hedge' or 'ultra-speculative' zone.

A further step in our analysis is to examine the impact of an increase in parameter b_2. Recall that this parameter captures the responsiveness of credit rationing to the fragility of banks. Such an increase may be caused for instance by a change in the institutional structure of banking sector or by an exogenous decrease in the confidence of banks with respect to their liquidity problems.

The analysis is confined to regime I which is closer to Minsky' conceptualization for the behaviour of the economy and the emergence of financial fragility. We get:

$$\left.\frac{\partial F^B}{\partial b_2}\right|_{\dot{Y}=0} = -\frac{a_0 - b_0 - (1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3)\cdot Y}{(a_1 i_L + b_1 i_L + b_2)^2} < 0 \qquad \textbf{(37)}$$

$$\left.\frac{\partial F^B}{\partial b_2}\right|_{\dot{F}^B=0} = -\frac{a_0 - b_0 - (1 - c_1\Omega - (a_1 + b_1)(1-\Omega) - a_2 - b_3)\cdot Y}{(i_L - a_1 i_L - b_1 i_L - b_2)^2} < 0 \qquad \textbf{(38)}$$

$$\left.\frac{\partial F^B}{\partial b_2}\right|^{F}_{H-S} = -\frac{a_0 - b_0 - (1 - (a_1 + b_1)(1-\Omega) - a_2 - b_3)\cdot Y}{(i_L - a_1 i_L - b_1 i_L - b_2)^2} < 0 \qquad \textbf{(39)}$$

We immediately see that an exogenous rise in the credit rationing responsiveness to banks' fragility, obtains the result of a downward shift and a smaller slope for both of $\dot{Y} = 0$ and $\dot{F}^B = 0$ isoclines (see equations (37) and (38) respectively). As far as the former isocline is concerned this is because banks' fragility has a more negative impact on effective investment and thereby in output; hence the accumulated amount of loans of firms has to decrease in order for output to remain at the same level. Furthermore, an increase in the credit rationing responsiveness to banks' fragility

shifts the isocline $\dot{F}^B = 0$ downwards according to equation (38). This is because the higher banks' fragility increases the amount of loans that are credit rationed and hence decreases the effective amount of new loans. As a result, at the same level of output, banks' fragility shifts down. We can see the new equilibrium point E_1 in figure 6. In the new equilibrium point the banks' fragility is lower, while output is larger. Hence, it follows that an increase in the parameter under investigation makes the economy centre around an equilibrium point that exhibits lower banks' fragility and higher output.

It is also essential to note that the increase in the credit rationing responsiveness to banks' fragility has an important impact on the intercept and the slope of the demarcation line of firms' fragility as equation (39) pinpoints. This captures the fragility firms in figures 1 and 3. In particular, this line shifts downwards, which implies that the area that corresponds to speculative firms becomes smaller. It is therefore clear that a more conservative banking stance drives down banks' fragility and also increases the area of hedge firms.

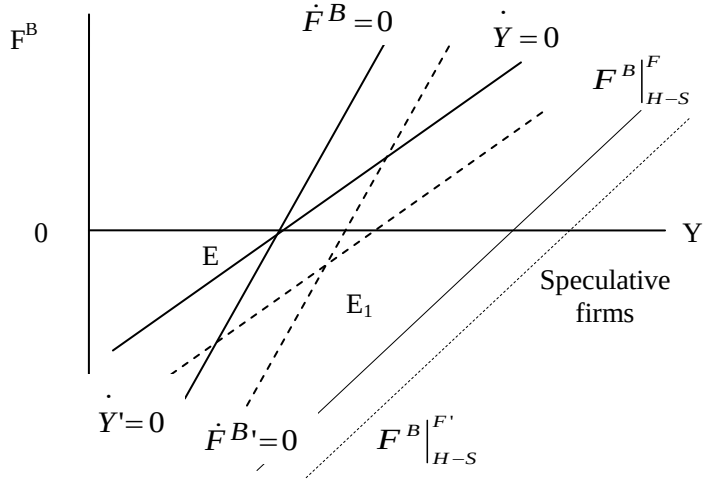

Fig. 6. An increase in the credit rationing responsiveness to banks' fragility under regime I.

5. Conclusion

This paper attempted to contribute to the Post Keynesian literature on financial fragility by putting forward a macroeconomic model with Minskyan insights that

places emphasis on the interaction between banks and the real economy, as well as on the financial structures that are likely to emerge as a result of this interaction. In our analysis we made a distinction among four different financial structures for the economy, based on both the fragility of firms and the fragility of banks.

In the dynamic analysis we distinguished between two different regimes. Under the first regime there is a high propensity of households to consume out of wage income; further, the responsiveness of firms' desired investment and banks' credit rationing to output changes is high. It turns out that the increase in output overshoots the fragility of banks since the increase that it brings about in the amount of new loans overcompensates the rise in deposits. Furthermore, the product market is characterized by a disequilibrium condition. We showed that under this regime the economy is likely to follow a cyclical pattern where banks follow the euphoric expectations of firms contributing to the emergence of financial fragility. These euphoric expectations are reflected on the credit rationing behaviour that permits loan expansion in the upswing and restricts credit availability in the downturn.

Under regime II, there is a low propensity of households to consume out of wage income and the same holds for the responsiveness of firms' desired investment and banks' credit rationing to output changes. A higher level of output slows down the fragility of banks; further, there is an equilibrium adjustment mechanism in the product market. In this case, the economy can eventually reach a situation characterized either by hedge firms and hedge banks or by speculative firms and speculative banks. This depends crucially on the initial conditions.

Our analysis can lead us to argue that the interaction between banks and the real economy is likely to lead to financial structures that are susceptible to instability. However, it was also illustrated that the fragility of the economy can substantially decline if banks take more into consideration their liquidity risk in the credit rationing procedures. This can be for instance attained if adequate institutional reforms are to be implemented, which can lead banks to take more into account their liquidity when they provide credit to borrowers.

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