Securitization, Household Debt and Financial Instability in a Stock-Flow Consistent Model

Maria Nikolaidi

Abstract: This paper develops a stock-flow consistent model that encompasses a three-sector financial system and explicitly integrates the process of securitization into the workings of the macroeconomy. An endogenously determined rate of default on loans is introduced and the implications of securitization for the credit availability to households are explicitly analyzed. The model pays particular attention to the dynamic interplay between the housing market and the financial sector in order to illuminate, among others, the interconnection between household lending and the developments in the securities market. With the aid of simulations it explores the channels through which exogenous institutional changes within the financial system are likely to generate financial fragility and to eventually bring about instability in the economy.

JEL-Classification: E12, E44, E51, G21

Keywords: financial instability, securitization, SPVs, household debt, Minskyan macroeconomic analysis

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1. Introduction

The subprime mortgage crisis that started in August 2007 has, among others, brought to the surface the potential destabilizing forces of euphoric expectations and financial innovations. It has also revealed the growing financial fragility and low margins of safety of economic units, which were at the root of the recent financial disarray. In this context, Minsky’s analysis for the financial instability of capitalist economies has received growing attention by economists and the media.

Minsky (1982, 1986a) has put forward a theory of financial fragility in order to explain how an environment of stability along with euphoric expectations is likely to transform economic units from hedge to speculative and ultimately to ponzi ones, with destabilizing feedback effects on the macroeconomy. He has also put emphasis on how the behavior of profit-seeking businessmen along with changes in the regulatory framework are likely to lead to financial innovations that eventually generate instability in the financial system (see e.g. Minsky, 1986b, 1987, 1991).

However, Minsky’s analysis has to a great extent focused attention on the external finance of firms’ investment expenditures. Lower attention has been paid by him to the workings of the housing and financial sector and to how these workings are likely to contribute to the financial fragility of the economic system. This issue is of particular importance if someone is to understand the functioning of modern money manager capitalism.

This paper seeks to contribute towards this direction. We develop a stock-flow consistent model that focuses on the workings of the housing market and the dynamic interaction that the latter has with the financial sector. In this model securitization is

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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).

2 It is important, however, to note that Minsky (1982, pp. 52-53) has suggested a classification of households into hedge, speculative and ponzi using as a basis the debt payment commitments relative to their expected wage income.
explicitly integrated, as the prevailing financial innovation of the recent decades. In order to analyze its repercussions we split the financial sector into the commercial banking sector, the investment banking sector and the Special Purpose Vehicles (SPVs). The model is then used to indicate how institutional changes that lead to higher securitization and higher allocation of banks’ assets towards securities are likely to push up, via the interaction of the housing and the financial sector, the financial fragility in both of these sectors, and to eventually bring about financial instability.

In so doing, the paper aims to extend the current literature on stock-flow consistent modelling, in which not a great deal of attention has so far been paid to the formalization of the securitization process and of the interplay between the housing market and the financial sector. Indeed, most of the stock-flow consistent models have incorporated simplified banking sectors without off-balance sheet operations (see e.g. Zezza and Dos Santos, 2006); more advanced formalizations have introduced the role of the liquidity preference of banks (Le Heron and Mouakil, 2008), the effects of non performing loans (Godley and Lavoie, 2007, ch. 11; Tymoigne, 2009) and the impact of capital adequacy ratios on interest rate determination (Godley and Lavoie, 2007, ch. 11).

Two recent contributions by Zezza (2008) and Eatwell et al. (2008) are, however, close to our analysis. Zezza (2008) has constructed a model in which households take on loans from commercial banks in order to invest in the housing market. He has explored the channels through which a rise in the expected price of houses is likely to lead to a bubble in the housing market. Eatwell et al. (2008) have put forward a model that introduces SPVs in the social accounting matrix and takes explicitly into account the securitization of mortgages, which are granted to households in order to purchase houses.

Compared to the above-mentioned works, this paper has four distinct features. First, it pays explicit attention to the interconnection between credit rationing and the securitization process. Second, it introduces an endogenously determined rate of default on loans and points out its implications for the interaction between the housing market and the financial sector. Third, by inserting the investment banking sector in
the model, it considers a three-sector financial system, instead of a two-sector one, as in Eatwell et al. (2008) and Taylor (2008). Fourth, it relies on various indices in order to capture financial fragility and instability in the system and carries out simulations in order to investigate how these indices are likely to be affected by institutional modifications.

The rest of the paper is organized as follows. Section 2 presents the structure of our model and describes the behavioural equations. Section 3 conducts simulation experiments in order to explore the effects of an exogenous rise in the proportion of securitized loans and in the desire of the investment banking sector to hold securities. Particular attention is paid to the channels through which these changes can lead to financial fragility and instability. Section 4 summarizes and concludes.

2. The structure of the model

Eight sectors comprise our macroeconomy: worker households, investor households, commercial banking sector, investment banking sector, SPVs, central bank, government and firms. Worker households earn their income by participating in the production process and take on loans from the commercial banking sector in order to finance their housing investment. Investor households earn capital income and allocate their wealth to deposits of both the commercial and investment banking sector as well as to treasury bills and cash. The commercial banking sector lends to worker households following a credit rationing procedure. A part of the loans granted to worker households is securitized and becomes a component of the asset side of the balance sheet of SPVs. The later transform these loans into Mortgage Backes Securities (MBSs), which are acquired by the investment banking sector, using as main source of fund the long term deposits of investor households. In order to concentrate on the dynamics of the housing market and the financial sector, the modeling of the rest of the economy is kept at a simple level. In particular, we hypothesize that firms do not use external finance in order to undertake investment, no taxes are imposed by the government and commodity inflation is assumed away.

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3 This extension relies on a suggestion made by Lavoie (2008).
4 See Zezza (2008) and van Treeck (2009) for a similar split of the household sector.
<table>
<thead>
<tr>
<th></th>
<th>Worker Households</th>
<th>Investor Households</th>
<th>Commercial Bank. Sector</th>
<th>Investment Bank. Sect.</th>
<th>SPVs</th>
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Table 1. Balance sheet matrix.
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<th>Commercial Banking Sector</th>
<th>Investment Bank. Sector</th>
<th>SPVs</th>
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**Table 2. Transactions matrix.**
SFC modelling is based on the balance sheet matrix (stocks) and the transactions matrix (flows). In table 1 the balance sheet matrix of our model is portrayed. Symbols with plus signs depict assets and negative signs specify liabilities. The sum of every row is zero except in the case of accumulated capital in the firm sector and housing investment in worker households. The last row presents the net wealth of each sector. Table 2 depicts the transactions matrix which describes monetary flows between the eight sectors of the economy. Every row represents a monetary transaction, and every column corresponds to a sector account. The latter is fragmented into a current and a capital account, except in cases of worker households, investor households, central bank and the government. Sources of funds appear with plus signs and uses of funds are indicated by negative signs. Every row and every column must sum to zero.

### 2.1 Worker Households

**Income, wealth and consumption**

\[
YD_w = W - i_{L-1} (L_{-1} - NPL) \tag{1}
\]

\[
V_w = V_{w-1} + YD_w - C_w + CG_H + NPL \tag{2}
\]

\[
C_w = c_{w1} YD_w + c_{w2} V_{w-1} \tag{3}
\]

\[
CG_H = \Delta P_H \cdot H_{D-1} \tag{4}
\]

\[
CG^e_H = CG_{H-1} + \mu_H \cdot (CG_{H-1} - CG^e_{H-1}) \tag{5}
\]

Equation (1) defines the disposable income of worker households \((YD_w)\), which is equal to the wage income minus the interest payments on loans; \(W\) denotes the wage income of worker households, \(i_L\) is the interest rate on loans and \(L\) is the amount of loans that worker households take on in order to invest in the housing market. Our analysis introduces the possibility of default on the part of worker households. Hence, the interest paid reduces by the interest that corresponds to the non performing loans \((NPL)\)\(^5\).

\(^5\) See also Godley and Lavoie (2007, pp. 390-391).
Equation (2) shows that the amount of wealth of worker households \((V_w)\) is equal to their lagged wealth plus their saving - given by the difference between the disposable income and consumption \((C_w)\) - and the capital gains due to changes in the price of houses \((CG_H)\) (see e.g. Zezza, 2008 for a similar specification). Additionally, in our pattern the non performing loans exert a positive impact on the amount of wealth of worker households. Worker households’ consumption, as shown by equation (3), depends positively on their disposable income and past wealth\(^6\). Equation (4) describes the capital gains on houses, while equation (5) depicts the expected capital gains on houses, following an adaptive expectations error correction formula. Note that \(H_p\) is the demand for houses, \(P_p\) is the price of houses and \(\mu_H\) is the speed of the adjustment of expectations.

\[\text{Demand for loans, financial fragility and non performing loans}\]

\[\begin{align*}
NL_D &= (H_{ND} - H_{D-1}) \cdot P_{H-1} + rep \cdot L_{-1} + C_w - YD_w \quad (6) \\
L &= L_{-1} + NL - repL_{-1} \quad (7) \\
NPL &= np \cdot L_{-1} \quad (8) \\
np &= np_0 + np_1 \cdot Liq_{-1} \quad (9) \\
Liq_H &= \frac{(i_{L-1} + rep)L_{-1}}{YD_w + NL} \quad (10) \\
F_H &= \frac{(i_{L-1} + rep)L_{-1}}{YD_w} \quad (11) \\
Lev_H &= \frac{L}{P_H H_D} \quad (12)
\end{align*}\]

Equation (6) shows the desired amount of new loans of worker households \((NL_D)\). Worker households demand credit in order to invest in the housing market and potentially repay their debt obligations; \(rep\) denotes the repayment ratio. In order to

decide for the amount of money that they wish to invest in houses, they take into account their notional demand for houses, $H_{ND}$ (defined below), and use as a reference the prices of houses in the previous period\(^7\). Equation (6) implies that the amount of new loans demanded is diminished as the savings of worker households increase. See also Zezza (2008) and Eatwell et al. (2008) for similar specifications\(^8\).

Equation (7) gives the outstanding amount of loans, while equation (8) shows the amount of non-performing loans ($NPL$). The rate of default is captured by $np$, which is positively affected by the lagged degree of liquidity pressure ($Liq_{H}$) of worker households. The degree of liquidity pressure is defined as the ratio of the debt commitments of worker households of the previous period to their disposable income plus the new loans ($NL$) (defined in equation 37). We make the assumption that, when the degree of liquidity pressure in the sector increases, it is more likely that more worker households (at the unit level) will face liquidity problems. Thus, at the aggregate level, a higher degree of liquidity pressure translates into a higher rate of default\(^9\).

At this point, the distinction between the degree of liquidity pressure and our worker households financial fragility index ($F_{H}$), defined in expression (12), should be highlighted\(^10\). The financial fragility index differs from the liquidity pressure in that it does not take into account the new loans granted from banks. Thus, the financial fragility index indicates the need of worker households for borrowing from the

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\(^7\) As it will become clear below, the equilibrium condition in the housing market safeguards that $H_{H}$ corresponds to the houses actually purchased.

\(^8\) Eatwell et al. (2008) assume that the whole amount of demanded loans is used by households in order to invest in the housing market.

\(^9\) In Godley and Lavoie (2007, ch.11) the rate of default is deemed exogenous. Tymoigne (2009) underpins that the amount of debt that is written off as well as the amount of principal serviced is crucial for the definition of the net change in the amount of debt. Charpe et al. (2009) assume that default is a proportion of actual real loans.

\(^10\) In the literature, various ways can be found through which the financial fragility of households has been captured. Drawing on Minsky (1982, p.30), most of the approaches have focused on the relationship between interest debt obligations and the disposable income, using the debt service ratio (see Zezza, 2008; Cynamon and Fazzari, 2008 and Keen, 2009) or the financial obligation ratio (e.g. Tymoigne, 2007, 2010b and Brown, 2007). Other researchers have utilized the household debt to GDP ratio (Pollin, 1988; Brown, 1997; Guttmann and Plihon, 2010; Leclaire, 2010). In similar lines, Pollin (1990) and Brown (2007) have incorporated into their analysis the income quantile along with the debt to income ratio. Setterfield (2004) has used the difference between the level of debt and accumulated savings and Eatwell et al. (2008) have focused attention on the leverage of households.
commercial banking sector in order to be liquid, whereas the degree of liquidity pressure captures the actual liquidity position. In this context, it is likely that in an environment where there is high availability of credit from banks, financial fragility rises, while the degree of liquidity pressure remains stable or even decreases. However, if for some reason the provision of loans goes down, the liquidity pressure will rise, leading to more non performing loans. As it will become clearer below, this relation between the two indices is important in order to depict how financial fragility can be translated into instability. In equation (12) we also define the leverage of worker households, expressed as the ratio of loans to the value of houses \((\text{Lev}_H)\). This variable will be argued to play a crucial role in the credit availability from the commercial banking sector.

**Housing market**

\[
\frac{\Delta H_{ND}}{H_{ND-1}} = h_{10} - h_{11} \cdot P_{H-1} + h_{12} \cdot \frac{CG^e_H}{P_{H-1} \cdot H_{D-1}} - h_{13} \cdot F_{H-1} \tag{13}
\]

\[
\Delta H_D \cdot P_H = YD_w + NPL + \Delta L - C_W \tag{14}
\]

\[
\frac{\Delta H_S}{H_{S-1}} = h_{20} + h_{21} \cdot \frac{P_{H-1}}{c_H} \tag{15}
\]

\[
H_D = H_S \tag{16}
\]

Expression (13) shows the growth rate of the notional demand for houses. Following Eatwell *et al.* (2008), we assume that this is a negative function of the price level and a positive function of the expected rate of return, \( (CG^e_H / P_{H-1} \cdot H_{D-1}) \). Moreover, worker households’ financial fragility affects negatively the willingness of worker households to invest in houses (see also Zezza, 2008 and Esteban and Altuzarra, 2008). Equation (14) illustrates the actual change in the value of houses, after considering the effect of credit rationing in the new loans that are provided.

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\(^{11}\) Zezza (2008) and Esteban and Altuzarra (2008) specify that the demand for houses is negatively affected by the change in the ratio of interest rate to disposable income (debt service burden). Zezza (2008) incorporates in the nominator the mortgage repayment households, which can be viewed as an indicator of borrower’s risk.
The growth rate of the supply of houses \( (H_s) \) is given by expression (15) and indicates that it is positively affected by an increase in the price of houses (see Eatwell et al., 2008 and Mooslechner and Wagner, 2010). In order to restore equilibrium in the housing market, we assume that the demand for houses is equal to the supply of houses (equation 16). The equilibrium mechanism in the housing market follows the mechanism for the equity market in Godley and Lavoie (2007, ch. 11).

### 2.2 Investor Households

**Income, wealth and consumption**

\[
YD_I = i_{TB} TB_{I,1} + i_{DBC} D_{BC,1} + i_{DBL} D_{BL,1} + PF_D
\]  
(17)

\[
YD'_I = YD_{I,1}
\]  
(18)

\[
V_I = V_{I,1} + YD_I - C_I
\]  
(19)

\[
V'_I = V_{I,1} + YD'_I - C_I
\]  
(20)

\[
V_{II} = V_I - HPM_I
\]  
(21)

\[
V'_{II} = V'_I - HPM_I
\]  
(22)

\[
HPM_I = h_I C_I
\]  
(23)

\[
C_I = c_{I1} YD'_I + c_{I2} V_{I,-1}
\]  
(24)

The disposable income of investor households \( (YD_I) \) is equal to the sum of the interest received on treasury bills, short term deposits, long term deposits and firms’ distributed profits \( (PF_D) \) (equation 17). Note that \( i_{TB} \) is the interest on treasury bills \( (TB_I) \), \( i_{DBC} \) is the interest on short term deposits \( (D_{BC}) \) and \( i_{DBL} \) is the interest on long term deposits \( (D_{BL}) \). As for the expected disposable income \( (YD'_I) \), we assume adaptive expectations (equation 18). The change in wealth of investor households \( (V_I) \) is equal to the difference between disposable income minus their consumption \( (C_I) \) (equation 19); the expected wealth of investor households \( (V'_I) \) is given by the sum of lagged wealth and the expected disposable income minus their consumption (equation 20). The wealth net of cash flow \( (V_{II}) \) is equal to the wealth of investor households minus the cash flow.
households minus the high-powered money \((HPM_i)\) they hold (equation 21). Equation (22) says that the expected wealth net of cash flow \((V_{ih}^e)\) is made up by the expected wealth minus the high-powered money. The latter is a proportion of their consumption (equation 23)\(^{12}\). Equation (24) gives the consumption of investor households, which depends on their expected disposable income and past wealth.

*Portfolio choice*

\[
\frac{D_{BC}}{V_{ih}^e} = \lambda_{i0} + \lambda_{i1}i_{DBC} + \lambda_{i2}i_{TB} + \lambda_{i3}i_{DBI} + \lambda_{i4} \frac{YD_i^e}{V_{ih}^e}
\]  \hspace{1cm} (25)

\[
\frac{TB_{IN}}{V_{ih}^e} = \lambda_{20} + \lambda_{21}i_{DBC} + \lambda_{22}i_{TB} + \lambda_{23}i_{DBI} + \lambda_{24} \frac{YD_i^e}{V_{ih}^e}
\]  \hspace{1cm} (26)

\[
\frac{D_{BIN}}{V_{ih}^e} = \lambda_{30} + \lambda_{31}i_{DBC} + \lambda_{32}i_{TB} + \lambda_{33}i_{DBI} + \lambda_{34} \frac{YD_i^e}{V_{ih}^e}
\]  \hspace{1cm} (27a)

\[D_{BIN} = V_{ih} - D_{BC} - TB_{IN}\]  \hspace{1cm} (27)

\[D_{Bi} = z_1 \cdot D_{BIN}\]  \hspace{1cm} (28)

\[z_1 = 1 \text{ iff } D_{BIN} \geq 0; \text{ otherwise } z_1 = 0\]  \hspace{1cm} (29)

\[TB_i = z_1 \cdot TB_{IN} + z_2(V_{ih} - D_{BC})\]  \hspace{1cm} (30)

\[z_2 = 1 \text{ iff } D_{BIN} < 0; \text{ otherwise } z_2 = 0\]  \hspace{1cm} (31)

Investor households allocate their expected wealth net of high-powered money between short term deposits, treasury bills and long term deposits. Following the Tobinsque principles, investor households are assumed to hold a certain proportion \(\lambda_{i0}\) of their expected net wealth in the form of one asset, with this proportion modifying according to the interest rate of the assets and the expected disposable income (equations 25-27a). Note that equation (27a) is replaced, in the computer model, by equation (27), with long term deposits acting as a buffer. Equations (28)-(31) ensure that the long term deposits and treasury bills are positive.

**2.3 Commercial banking sector**

\(^{12}\) See e.g. Zezza (2008) for such a specification.
In our model the proportion of securitized loans \(a\) by the commercial banking sector is exogenously determined by the institutional structure and the regulation with regard to the financial activities. Equation (32) gives the securitized amount of loans that are transferred to the balance sheet of SPVs \(L_{SPV}\); expression (33) shows the non securitized amount of loans that are retained in the balance sheet of the commercial banking sector \(L_{BC}\).

The profits of the commercial banking sector \(PB_{BC}\) are equal to the sum of the interest on non securitized loans, the interest on treasury bills \(TB_{BC}\) and the fees \(Fee\) obtained from the securitization process, minus the interest on short term deposits, the interest on advances from the central bank and the interest on non performing loans (equation 34). According to equation (35) the capital of the commercial banking sector \(K_{BC}\) is equal to the sum of their capital of the previous period and their profits minus the amount of non performing loans, which eventually erodes the capital of the next period (see Godley and Lavoie, 2007, ch.11). The amount of non performing loans of the commercial banking sector is a proportion \(np\) out of the amount of \(L_{BC}\) of the previous period (equation 36). \(A_{CB}\) is the advances the commercial banking sector takes from the central bank and \(i_A\) is the interest paid to the central bank.

**Asset choice and credit rationing**

\[ NL = k \cdot NL_0 \]  

(37)
\[ k = k_0 - k_1 \cdot \text{Lev}_{H-1} + k_2 \cdot (\text{CAR}_{-1} - \text{NCAR}) \]  \hfill (38)

\[ \text{CAR} = \frac{K_{BC}}{L_{BC}} \]  \hfill (39)

\[ HPM_{BC} = h_{BC} \cdot D_{BC} \]  \hfill (40)

\[ TB_{BCN} = K_{BC} + D_{BC} - L_{BC} - HPM_{BC} \]  \hfill (41)

\[ A_{CBN} = L_{BC} + HPM_{BC} - K_{BC} - D_{BC} \]  \hfill (42)

\[ A_{CB} = z_3 \cdot A_{CBN} \]  \hfill (43)

\[ z_3 = 1 \text{ iff } A_{CBN} \geq 0; \text{ otherwise } z_3 = 0 \]  \hfill (44)

\[ TB_{BC} = z_4 \cdot TB_{BCN} \]  \hfill (45)

\[ z_4 = 1 \text{ iff } TB_{BCN} \geq 0; \text{ otherwise } z_4 = 0 \]  \hfill (46)

As already mentioned, the commercial banking sector applies credit rationing when it grants loans to worker households. In order to capture this in our model, we make a distinction between the desired amount of new loans demanded by worker households and the effective amount of new loans; the latter represents the amount of new loans that are ultimately provided after imposing the credit rationing procedure. Expression (37) gives the effective amount of new loans as a proportion of the desired amount of new loans. The parameter \( k \) in equation (38) captures the degree of credit availability \((0 \leq k \leq 1)\) and is assumed to depend on two factors. The first is the leverage of worker households. The higher is this leverage the lower is the degree of credit availability. The second is the difference between the capital adequacy ratio (\( \text{CAR} \)) of the commercial banking sector, defined in equation (39). Note that the normal capital adequacy ratio (\( \text{NCAR} \)) is set in our simulations equal to 10%, which is above the required by authorities capital adequacy ratio (which is equal to 8%). The higher is the capital adequacy ratio relative to the normal one the more the commercial banking sector is willing to provide credit to worker households.

The commercial banking sector holds a proportion of deposits in the form of cash (\( HPM_{BC} \)), based on the reserve requirement ratio (\( h_{BC} \)) determined by the central bank (equation 40). The investment in treasury bills occurs only when there exist sources of funds that have not been used for the provision of loans and for the holding
of the adequate reserve requirements. Otherwise, the commercial banking sector takes advances from the central bank. This is captured by expressions (41)-(46).

### 2.4 Investment banking sector

**Profit, capital and capital gains on MBSs**

\[
P_{Bl} = i_M M_{D-1} + i_{TB-1} TB_{Bl-1} - i_{DBl-1} D_{Bl-1} \quad (47)
\]

\[
K_{Bl} = K_{Bl-1} + PB_{Bl} + CG_M \quad (48)
\]

\[
CG_M = \Delta P_M \cdot M_{D-1} \quad (49)
\]

\[
CG^e_M = CG_{M-1} + \mu_M \cdot (CG_{M-1} - CG^e_{M-1}) \quad (50)
\]

The investment banking sector gets revenues from the holding of MBSs and treasury bills and pays out interest on long term deposits. Hence, its profits are given by equation (47); \(i_M\) is the interest rate on MBSs, \(M_D\) is the demand for MBSs that the investment banking sector decides to buy from the SPVs, \(TB_{Bl}\) denotes the treasury bills of the investment banking sector and \(PB_{Bl}\) is the profit of the investment banking sector. The change in the capital of the investment banking sector \((K_{Bl})\) is equal to its profits plus the capital gains obtained from holding MBSs (equation 48). The capital gains on MBSs \((CG_M)\) are described in equation (49). The expected capital gains on MBSs \((CG^e_M)\) are given in equation (50), adopting an adaptive expectations error correction formula where \(\mu_M\) is the speed of adjustment of the expectations.

**Portfolio choice**

\[
P_M M_D = (\gamma_{01} + \gamma_{11} \cdot r^e_M + \gamma_{21} \cdot i_{TB}) \cdot (K_{Bl-1} + D_{Bl-1}) \quad (51)
\]

\[
TB_{Bl} = (\gamma_{02} + \gamma_{12} \cdot r^e_M + \gamma_{22} \cdot i_{TB}) \cdot (K_{Bl-1} + D_{Bl-1}) \quad (52a)
\]

\[
TB_{Bl} = K_{Bl} + D_{Bl} - M_D \cdot P_M \quad (52)
\]

\[
r^e_M = i_M + \frac{CG^e_M}{P_{M-1} \cdot M_{D-1}} \quad (53)
\]
The portfolio choice of the investment banking sector relies on the Tobinsque principles and is captured by equations (51) and (52a). The demand for MBSs and treasury bills of the investment banking sector is a proportion of the sum of the capital of the investment banking sector of the previous period and long term deposits of the previous period. This proportion changes according to the expected rate of yield on MBSs (see equation 53) and the interest rate on treasury bills. The expected rate of yield on MBSs ($r_{M}^{e}$) is equal to the interest rate on MBSs and the expected rate of return on MBSs. The demand for treasury bills is ultimately given by equation (52).

2.5 SPVs

SPVs facilitate the securitization process and offload the liquidity and default risk out of the commercial banking sector.

\[
PS = i_{L-1}(L_{SPV-1} - NPL_{SPV}) - i_{M-1}M_{S-1} - Fee
\]  
(54)

\[
K_{SPV} = K_{SPV-1} + PS - NPL_{SPV} - CG_{M}
\]  
(55)

\[
NPL_{SPV} = np \cdot L_{SPV-1}
\]  
(56)

\[
Fee = f \cdot a \cdot NL
\]  
(57)

\[
\Delta M_{S} \cdot P_{M} = \Delta L_{SPV} + NPL_{SPV} - PS
\]  
(58)

\[
M_{D} = M_{S}
\]  
(59)

The profits of the SPVs ($PS$) are given by the interest on loans (after subtracting the non performing loans ($NPL_{SPV}$)) minus the interest on MBSs and the fees paid to the investment and commercial banking sector respectively (equation 54); $M_{S}$ is the supply of MBSs. The capital of the SPVs ($K_{SPV}$) is equal to the capital of the previous period plus their profits, minus their non performing loans and the capital.

---

13 See e.g. Le Heron and Mouakil (2008).
14 In our specification SPVs hold profits in order to finance the supply of MBSs. But, to the extent to the SPVs are passive intermediaries, in other words they can not finance their position in the occasion they have negative cash flows, the commercial banking sector must intervene (Wray, 2007, p.26; Dymski, 2010, p.252). More specifically, at the subprime crisis the commercial banking sector had to issue new commercial paper in order to finance the negative cash flow position of the SPV’s (Kregel, 2007, p.23; Wray, 2008, p.25). This is not taken into account in our model.
losses on MBSs (equation 55). The amount of the non performing loans of the SPVs is equal to a proportion $np$ out of the amount of loans that was securitized in the previous period (equation 56). The amount of fees the SPVs gives to the commercial banking sector in exchange to the interest on $L_{SPV}$ is a proportion $f$ of the effective amount of new loans that is securitized; note that for this reason this amount is also a proportion $a$ out of the effective amount of new loans (equation 57). The supply value of MBSs is equal to the change in SPVs loans plus the non performing loans in the balance sheet of SPVs, minus the profits of the SPVs. We assume that there is equilibrium in the MBSs market, following the mechanism suggested by Dos Santos and Zezza (2004) with respect to the equilibrium in the equity market.

2.6 The determination of interest rates

\begin{align*}
i_L &= i_{TB} + x_1 \\ i_{DBC} &= i_{TB} - x_2 \\ i_{DBI} &= i_{TB} - x_3 \\ i_M &= k_M + f_M \cdot \frac{PS - PS_{-1}}{PS_{-1}}
\end{align*}

Equations (60-62) describe interest rates on loans, on short term deposits and on long term deposits respectively. We assume through equation (63) that the interest rate on MBSs is a proportion of the growth rate of the SPVs profits. Note that $x_1, x_2, x_3, k_M$ are constants. The structure of interest rates has as follows:

$i_L > i_{DBI} > i_{DBC}, i_L > i_M$

2.7 Firms

\begin{align*}
Y &= C_W + C_I + I + G + \Delta H_s \cdot P_H \\
I &= PF_U \\
PF_U &= (1 - s) \cdot PF_{-1} \\
PF &= Y - W
\end{align*}
\[ PF_D = PF - PF_U \] (68)
\[ W = \Omega \cdot PF_{-1} \] (69)

The output of the economy is determined in equation (64); \( I \) is the investment in physical capital stock and \( G \) denotes the government expenditures. The investment is equal to the undistributed profits \((PF_U)\) (equation 65). The undistributed profits depend on the total profits \((PF)\) of the previous period (equation 66); \( s \) is the amount of total profits that are distributed to investor households. Total profits are equal to output minus the wage income, as it is indicated by equation (67). The distributed profits are equal to the total profits minus the undistributed profits (equation 68) and wages are a proportion \((\Omega)\) of the lagged profits (equation 69).

2.8 Central bank

\[ PB_{CB} = i_{TB_{-1}}TB_{CB_{-1}} + i_{A_{-1}}A_{CB_{-1}} \] (70)
\[ HPM = HPM_{+} + HPM_{BC} \] (71)
\[ TB_{CB} = HPM - A_{CB} \] (72)
\[ TB_{CBred} = TB - TB_{i} - TB_{BC} - TB_{Bl} \] (73)
\[ i_{A} = i_{TB} \] (74)

The central bank holds treasury bills \((TB_{CB})\) and advances in the asset side of its balance sheet; high powered money \((HPM)\) is its only liability. Therefore, the profits of the central bank \((PB_{CB})\), which are described in equation (70), are equal to the interest payments they receive on treasury bills and advances\(^{15}\). The central bank provides the high powered money that investor households and the commercial banking sector demand (equation 71). The amount of treasury bills the central bank holds is equal to the difference between high powered money of the central bank and advances (equation 72). Our redundant equation indicates that the central bank holds the treasury bills the other sectors do not hold (see equation 73). \( TB \) is the treasury bills of the government. It is assumed in equation (74) that the interest rate on

\(^{15}\) See e.g. Zezza and Dos Santos (2004, 2006) and Zezza (2008).
advances is set as a constant equal to the interest on treasury bills set by the
government (following Godley and Lavoie, 2007, ch 10).

2.9 Government

\[
TB = TB_{-1} + G + iTB_{-1}TB_{-1} - PB_{CB} \tag{75}
\]

\[
G = G_{-1} \cdot (1 + g) \tag{76}
\]

\[
i_{TB} = i_{TB} \tag{77}
\]

According to equation (75), the change in treasury bills the government provides is
equal to the sum of government expenditures \((G)\) and interest payments on treasury
bills minus the profits of the central bank\(^{16}\). The government expenditures are
increasing with a constant rate \(g\) (see equation 76); the interest rate on treasury bills is
set exogenously (equation 77).

3. Simulation experiments

Given the complexity of our model, we proceeded to solve it numerically utilizing a
plausible set of parameters. Then, a steady-state solution was found, which served as a
basis for our simulation experiments, the aim of which was to investigate the dynamic
process through which financial innovation is likely to lead to financial fragility in the
housing market and the financial sector, and to eventually bring about financial
instability in the macroeconomy\(^{17}\).

In particular, we considered two exogenous developments, which are linked to the
institutional structure in the financial sector. The first is a change in the regulatory
framework regarding the capacity to securitize. This is deemed to lead to a rise in the
proportion of loans that are securitized by the commercial banking sector. The second
is the institutionalization of credit rating agencies as the formal evaluators of the
quality of MBSs. This institutionalization is considered to lead to a change in the

\(^{16}\) See also Zezza and Dos Santos (2006), Zezza, (2008) and Le Heron and Mouakil (2008).

\(^{17}\) The simulation experiments are conducted with Eviews 5. In figures 1-9, we homogenize the values
to one in order to compare them with the steady state solution.
liquidity preference of the investment banking sector, which now allocate a higher proportion of their funds towards MBSs\textsuperscript{18}. In our model these developments are captured by an exogenous rise in parameters $a$ and $\gamma_{01}$, respectively.

The rise in securitized loans produces an increase in the capital adequacy ratio of commercial banking sector (figure 1). The reason is the decline in the amount of loans in the asset side of the balance sheet of the commercial banking sector. Due to the link that we have postulated between the capital adequacy ratio and the credit rationing procedure, the aforementioned development leads to a higher degree of credit availability (figure 2).

Higher credit availability contributes to the initial rise in the effective amount of new loans, which is depicted in figure 3. As the access to credit becomes higher for worker households, their investment in housing market increases, which in turn sets the stage for a rapid rise in the price of houses (figure 4). Note that there is also an increase in the notional demand for houses, the underlying reason of which is the rise in the expected rate of return from housing investment.

The above developments, which take place in the initial periods after the shocks, have significant implications for the leverage ratio, the financial fragility index and the degree of liquidity pressure of worker households. To start with, there are two opposite pressures on the leverage ratio. On the one hand, there is a rise in the outstanding loans of worker households (see figure 3), which exerts a positive impact on the leverage ratio. On the other hand, the value of houses rises with downward pressures on the leverage ratio. With our choice of parameters, the second effect overwhelms the first one causing a decline in the leverage ratio.

\textsuperscript{18} The destabilizing role of credit rating agencies has been pointed out by e.g. Minsky (1987), Wray (2007) and Kregel (2008b).
As far as the financial fragility index is concerned, this increases vigorously reflecting the rise in the debt obligations of worker households, relative to their disposable income (figure 5). On the contrary, the degree of liquidity pressure decreases. Recall that the latter differs from the former in that it includes in the denominator the new amount of loans. This downward shift in the degree of liquidity pressure causes a
decline in the rate of default on loans (see figure 7). Consequently, higher financial fragility coexists with a higher rate of default in the initial periods after the shocks.

Another important development triggered by the rise in the securitized loans is the stimulus in the growth rate of the economy, as a result of the higher economic activity in the housing market (figure 6). It can therefore be argued that in the first periods after the shock the economy seems to experience a boom.

However, the rise in the financial fragility index has as a result the notional demand for houses gradually to decrease (figure 4). This in turn makes lower the desired amount of new loans as well as the outstanding amount of loans (see figure 3). As a consequence, the price and the amount of houses drop (figure 4). Moreover, the growth rate of the economy decreases, relative to the baseline solution (figure 6), and there is also an increase in the degree of liquidity pressure, which in turn shifts up the rate of default on loans (figure 7). These developments reveal the temporary character of the above-mentioned initial beneficial effects.

![Figure 3. Effects on the effective and desired amount of new loans and on the outstanding loans.](image)

It should be noted that in his simulation experiments, Zezza (2008) derives some similar results when he imposes an exogenous rise in the expected price of houses.
Figure 4. Effects on the notional demand for houses, the amount of houses and the price of houses.

Figure 5. Effects on worker households’ financial fragility index and degree of liquidity pressure.
Overall, it can be argued that the rise in the proportion of securitized loans causes a turbulence in the housing market and the macroeconomy. In particular, we can observe instability in the housing market, which is captured by the decline in the prices of houses, as well as in the real economy, which is proxied by the declining
growth rate of output, the increasing degree of liquidity pressure and the higher rate of default on loans\textsuperscript{20}.

Let us now turn attention to the developments in the security market and the other sectors of the financial system. The exogenous rise in the desired proportion of MBSs in the total assets of the investment banking sector stimulates the demand for these securities and gives thereby rise to their prices. It should be noted that this increase in the price of MBSs is also reinforced by the higher expected rate of yield, which is associated with the rise in the proportion of securitized loans. The linkage has as follows: the existence of more securitized loans stimulates the profits of SPVs, this brings about a rise in the interest rate on MBSs and this in turn pushes up their expected rate of yield.

The change in the liquidity preference of the investment banking sector overall increases the financial fragility of this sector, as this can be captured by liquidity and solvency indices. In particular, we follow Godley (1999) and Godley and Lavoie (ch. 10, 11) and use the treasury bills to long term deposits ratio to indicate the liquidity pressure in the investment banking sector. As figure 9 portrays, this ratio drops, following the developments in securities market. Furthermore, the potential insolvency problems are captured by the ratio of MBSs to the capital of the investment banking sector, which turns out to increase vigorously, at least in the first periods after the shocks\textsuperscript{21}. Therefore, our investment banking sector seems to have a higher exposure to illiquidity and insolvency risks.

Moreover, despite the initial euphoria in the securities market, figure 8 shows that the rise in the price of MBSs is of temporary nature. A few periods after the initial shocks, the price of MBSs falls and eventually tends to a level that is lower than the baseline solution, causing instability in the market. The underlying mechanism is linked with what is going on in the housing market. More precisely, we pointed out before that, some periods after the initial shocks, there is a decline in the amount of loans granted as a whole to worker households (see figure 3). As a result, the profits of the SPVs go down and this causes a fall in the interest that they pay on MBSs. This

\textsuperscript{20} Tyampoigne (2010b) has recently linked financial instability with non performing loans.
\textsuperscript{21} See also Alves et al. (2008) for a similar index.
feeds into the expected rate of yield with negative effects on the demand for these securities.

Figure 8. Effects on the amount of MBSs, the price of MBSs and the value of MBSs.

Figure 9. Effects on the ratios of treasury bills to deposits and on the value of MBSs to capital in the investment banking sector.
Taking the financial sector as a whole, the preceding analysis has an interesting implication as regards the capacity of capital adequacy ratios to capture financial fragility issues. Figure 1 depicts that the capital adequacy ratio in the commercial banking sector increases as a consequence of the institutional changes imposed in our system. Observing this, one could potentially argue that the financial sector is not financial fragile and not vulnerable to instability. However, this appears not to be the case if someone draws attention to the indices that capture the developments in the investment banking sector and SPVs, whereby the financial fragility turns out to go up. This result seems to be in line with the arguments recently put forth by Kregel (2007, p.18) and Wray (2007, p.8; 2009, p.815), according to which securitization gives the capacity to the commercial banking sector to escape reserve and capital requirements.

4. Conclusion

This paper put forward a stock-flow consistent model that integrates a three-sector banking system and explicitly introduces the dynamic interplay between the housing market and the financial sector. The model was deployed in order to explore how exogenous institutional changes in the financial sector are likely to generate financial fragility and make the economic system prone to financial instability.

The results so far suggest that a more intensive securitization process and a higher preference of the investment banking sector for MBSs are likely to give a positive upshot both in the real and the financial side of an economy. However, this upshot is combined with financial fragility, which in our model is basically captured by the rise in the debt obligations of worker households, relative to their income, as well as by the lower amount of safe assets held by the investment banking sector. The presence of financial fragility turns out to lead the system to financial instability, the latter captured by a decreasing growth rate of output, falling prices in the housing and securities markets as well as a higher rate of default on loans.

An implication of our analysis is that the traditional array of instruments that has been utilized for the supervision of the banking sector, such as the capital adequacy ratio, may not be effective to prevent financial fragility and instability, under the era of
securitization. Additional indices are arguably necessary, which will more closely be linked to the workings of the other segments of the financial sector. However, further research is essential to shed light on this issue.
References


