Securitization, housing market and banking sector behavior in a Stock-Flow Consistent model

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Abstract

This paper focuses on the different balance sheet management behavior of private banks and worker households, when assets are market-based. We take into consideration the securitization process, through which mortgage lending of households are converted into tradable securities that are demanded by investment banks in order to make profits. The demand of deposits by speculative households and realized capital gains on selling of mortgage-backed securities in the secondary market produce an inflation balloon in security markets, although we apply Basel III agreements on private banking behavior. We find that banks have active management of their balance sheets, this gives rise to a pro-cyclical leverage ratio, which is coherent with empirical evidence from the private banking sector. The model behaves well also with respect to the behavior of indebted households, that is the leverage of workers is countercyclical, as in Adrian and Shin (2010). These results are coherent with the recent financial crisis in U.S., as the evidence suggests that it has been a finance-led crisis and not a households-led crisis (Eatwell et al., 2008).

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1 An active banking sector

Post Keynesian theory states that Central Banks can only set an exogenous key interest rate, but cannot control the quantity of money put in the system since it comes from various sectors on the demand side (Kaldor, 1982). However, even if the endogeneity of money has been recognized also by New Consensus Model (Setterfield, 2004), there is very little investigation in Stock-Flow Consistent (SFC) literature about the working of private banks (Le Heron and Mouakil, 2008)[1]. The aim of this work is to fill the black box containing private banking, providing an active role for investment banks, which enter the capital market and respond to changes in asset prices. In fact, the evidence suggests that financial intermediaries tend to keep their net worth intact and adjust the size of total assets, blowing their balance sheets in order to generate profits (Shin, 2009). Securitization process makes this increase possible.

The paper is organized as follow. We first start to review the relevant literature about securitization and sketch briefly the model at hand. In section 2, we provide a description of the structure of the model, through the aim of social accounting matrixes, and its main characteristics. Then, in section 3, the equations of the model are provided by sectors. The model properties of the model are then investigated in section 4, as we proceed with two shock simulations to observe the reaction of agents whenever expected asset prices changes. Conclusions are finally drawn in section 5.

1.1 Securitization

Minsky (1975), in addition to the financial instability hypothesis, wrote on the theory of securitization, describing various steps of the process. The first stage is represented by "the debtor: the fundamental paper emitter and source of cash flow income that validate the securities". In fact, the initial creation of paper is based on cash flow from income-creating activities. The second is the "paper creator", the person who structures the credit and accepts the promise of the debtor to repay. The two first steps define the conventional bank-customers relation, after which the paper can be negotiated. The third player is the "investment banker", which "finds and negotiate with the paper creator and buys the paper". The paper become

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[1] Le Heron and Mouakil recognize that Kaldorian Post-Keynesians consider private banking behavior similar to those of central banks, as they set the interest rate on loans, applying a mark up on the key rate, and provide all loans required by creditworthy borrowers at this rate. However, they reckon that within the horizontalist view (Moore, 1988), the way private banks behave "remain a black box... So in order to open this black box, some Post Keynesian more inspired by H. Minsky (1975) than N. Kaldor, propose to generalize the Keynes theory of liquidity preference to private banks" (Le Heron and Mouakil, 2008, p. 406).

the corpus trust. On the basis of the assets in trust, the investment bankers creates securities. In this phase, credit rating agencies collaborate with the paper creator to design packages of securities that will deserve high ratings. Then Minsky introduces "the trustee", the "servicing organization" and the "maker of a secondary market", which is the investment bank. Finally, there are the "funders", that is households and intermediaries between banks and ultimate households.

Opinions about securitization process may be summarized by two broad views. One, which dates before the crisis 2007/2008, is based on the "originate and distribute" model of banking management. It emphasizes the positive role played by securitization in dispersing credit risk: "because a substantial part of the risk will be borne by other financial institutions, banks essentially faced only the 'pipeline' risk of holding a loan for some month until the risk were passed on so they had little incentive to take particular care in approving loan applications and monitoring loans" (Brunnermeier, 2009, p. 82). On the other side, after the explosion of the crisis, a new wisdom recognizes the distorted incentives of securitization process where new sources of funding where available for new creditors in a supply-chain of securities which rises the problem of a multi-layered agency problem, where several players act and important frictions exist between them (Ashcraft and Schuermann, 2008). In conventional economic theory, the agency problem has been also important in the formulation of the relationship between firms and financial markets, where the only purpose of corporations is to get the firm's managers to maximize profits on behalf of shareholders, which take greater control over management. This has served to create perverse incentives through giant bonuses paid to top managers. Of course, profits and bonuses are maximized in the boom by maximizing leverage which in turn maximizes risks. This mechanism creates excessive risk, as it is rational for top executives to take massive risk in the bubble even if they understand that their decision are likely to cause a crash (Crotty, 2009).

Shin has called the negative view of securitization the 'hot potato' hypothesis, where "there is always a greater fool in the chain who will buy the bad loan" (Shin, 2009, p. 312). The 'fool' he refers to are sophisticated financial intermediaries which end up keeping subprime securities. The reason why they hold such securities in their balance sheet responds to their need to maximize their return on equity through leverage in the attempt to maintain the highest level of leverage consistent with limits set by creditors or regulations. Shin also observes the relation between leverage and balance sheet size whenever changes in assets price occur. In the case of households the evidence is in favor of a strong inverse relation, since "when the price of my house goes up, my net worth increases and so my leverage goes down" (Adrian and Shin, 2010, p. 5). On the contrary, in the case of financial sector, an increase (or a decrease) in assets price would cause an active management of balance sheet, which entails a pro-cyclical leverage. In fact,

an increase in the price of houses determines an increase in the price of securities held by the banking sector as assets, thus increasing net worth and reducing leverage. However, financial intermediaries "attempt to maintain the highest level of leverage consistent with limits set by creditors... the evidence suggest that they tend to keep equity intact and adjust the size of total assets" (Shin, 2009, p. 310). The initial decreasing of leverage stimulates a demand for extra assets, this is possible if additional debt is given by an external creditor and then is used to buy securities, whose price is proportional to the price of the residential property used (the collateral), thus feeding an "inflation balloon which fills up with new assets. As the balloon expands the banks search for new assets to fill the balloon. They look for borrowers that they can lend to" (Shin, 2009, p. 331).

1.2 The model in a blink of an eye

This paper describes a theoretical model which tries to investigate the relationships among housing sector, securitization process and banking behavior, putting emphasis on the leading role plaid by the private banking sector. The methodology used here refers to the Post Keynesian SFC approach which strictly follows an accounting framework to design models (Godley and Cripps, 1983; Godley and Lavoie, 2007; Taylor, 2004).

Figure 1 represents the flow diagram of the model. The diagram represents schematically all flows as connectors between sectors, symbolized by square boxes. The diagram shows that there are six sectors: two household sectors - workers and capitalists-, one productive sector -firms-, and three banking sectors -commercial banks and investment banks 1 and 2-. Furthermore, the model contains one commodity, two physical assets -capital and houses-, and eight financial assets -houses, three sorts of deposits, mortgages, mortgage-backed securities, equities and interbank credit-. The framework is quite complete and is designed to shed light on the interplay between the financial market and the real economy.

In general, the starting point of SFC model are the aggregate Balance Sheet (BS) and the Transaction Flow Matrix (TFM) (table 1 and 3, in Appendix B). A deeper analysis of each of these tables allows for a better understanding of the model. Indeed, the BS depicts the stock situation of each sector at the beginning of the period and the TFM shows the inter-sector payments occurring during the period[2]. Each table may be read by column, that is concentrate on each sector transactions, or by row and analyze the source and destination of each transac-

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[2] Following Godley and Lavoie (2007) the TFM is a specification of all the potential real and financial flow in the model economy. This is essentially an abstract representation of the accounts as they are published in the "flow of funds" table provided for many countries. Here, the exclusion of public sector in favor of a more detailed private banking sector is a choice at the discretion of the author.
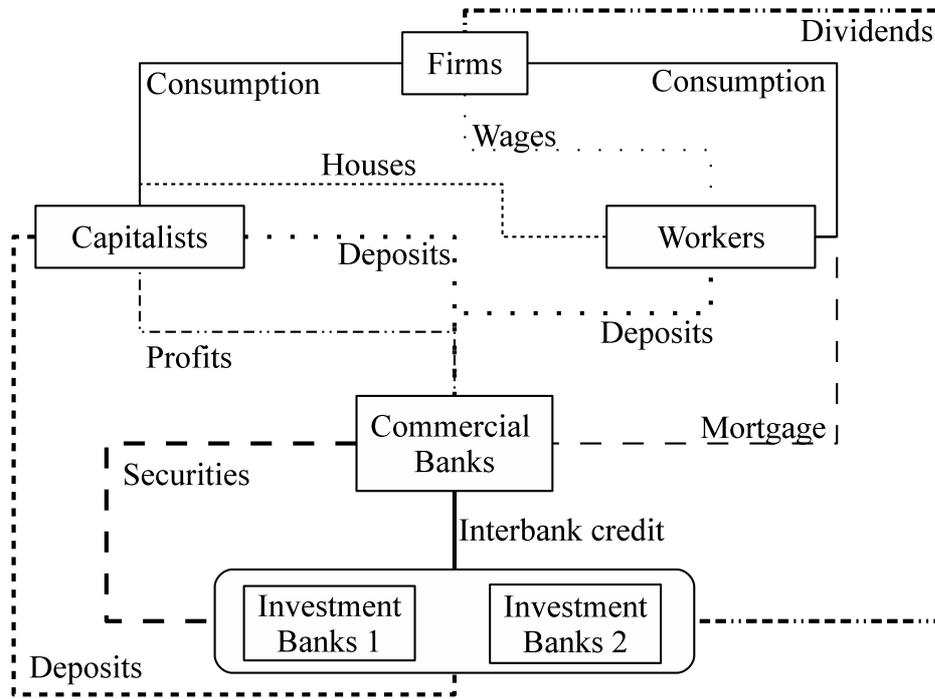
Figure 1: Flow diagram of the model

tion. Take, for example, the column *(i)* of the TFM. The column represents the current account of workers. We can see that source of income for workers is composed of their wage bill $(+WB)$ and that their spending are composed of consumption goods $(-C_w)$, rents on houses $(-rent_{H,-1})$ and interests on mortgages $(-i_{M,-1}M_{-1})$. The difference between income and spending is equal to their savings SAV_w, leading to equation (i).

$$SAV_w = WB - C_w - rent_{H,-1} - i_{M,-1}M_{-1} \qquad \text{(i)}$$

On the other hand, we could focus on the *Consumption* row of the TFM, which states that Firms income out of consumption (C) is composed of consumption from workers (C_w) and from capitalists (C_c), leading to equation (Consumption).

$$C = C_w + C_c \qquad \text{(Consumption)}$$

With the help of the flow diagram and both the TFM and the BS, we can have a broad overview of the main mechanisms at work in our model. Houses are purchased by both households, where for workers it is a real assets and for capitalists it is a financial assets. Workers demand mortgages to commercial banks in order to buy a house whenever savings is not enough. Such mortgages are then supplied on demand. Capitalists accumulate a set of financial assets that are deposits (of

both commercial and investment banks) and houses. The source of funding for investment banks is given by deposits of capitalists and, whenever deposits are not enough, by interbank credit they may ask to commercial banks, which accommodate any quantity, like a central bank would do. They use such funds to invest in equities and securities, with a portfolio choice behavior, and make profits that are ultimately distributed to capitalists. Firms finance their investment through retained profits, issuing of equities and loans that commercial banks grants on demand.

2 General features of the model

The choice of the SFC methodology to analyze banking behaviors is evident, as it is typically designed to shed light on the interplay between financial market and real economy. In fact, a SFC model provides a complete framework where decomposition of aggregate demand, transfers among sectors and financial flows linked to corresponding stock accumulation are encompassed.

The SFC macroeconomic modeling originates from the work of a group of economists that during seventies and eighties conceived a new family of models. In his seminal works, James Tobin (Tobin, 1969; Brainard and Tobin, 1968) has presented a different approach to Monetarism, where the two sides of the economy -real and financial- must be mutually consistent. The main features of this approach are "(i) precision regarding time [...], (ii) tracking of stocks, (iii) several assets and rate of returns [...], (iv) modeling of financial and monetary policy operation [...]; (v) Walras's Law and adding-up constraints" (Tobin, 1982, pp. 172-173). Similarly, Wynne Godley has developed a remarkable monetary theory which brings together stocks and flows, and shows the stock implications of flow decisions in a process of accumulation and growth (Godley and Cripps, 1983). The temporal and causal scheme in the dynamic of a SFC model matches current flows with current stocks, which, in turns, influence future flows, giving origin to an "intrinsic dynamics"of the system (Turnovsky, 1977). Origins and destinations of all flows must be registered into matrices and there cannot be "black holes"(Godley, 1996, p. 7). Accounts must be comprehensive in the sense that everything comes from somewhere and everything goes somewhere (Backus et al., 1980). In order to trace all transactions among sectors, SFC modeling is based on the Social Accounting Matrix (SAM) framework, where the Transaction Flow Matrix depicts flows occurring during the period and the Balance Sheet matrix provides stock accounts at the beginning of the period.

The artificial economy that is described here refers to a closed economy where three macro-institutional sectors are present. First, households, which are then divided into two groups, worker households and capitalist households, according

to their different behavior on the housing and financial markets[3]. Second, non financial firms, that represent the real productive sector of the model. Third, the banking system -the main object of analysis of this paper- which contains three separate sectors: commercial banks and investments banks that are ultimately divided into two groups (1 and 2) that behave in a similar way[4]. Although a typical SFC model is always completed with a public sector, namely government and central bank, we do not include it here in order to keep the model very close to the focus of investigation and to limit the number of equations. We are limiting our study to the functioning of assets markets and their effects on the balance sheets of owner sectors.

As already said, there are two real assets: houses and real capital. However, houses have a different nature according to the households holding them. If for workers a home is a tangible asset, which gives a direct utility to the user, capitalists demand houses for speculative purposes. Real capital is used by firms to produce consumption goods and capital goods.

We assume adaptive expectations, meaning that the expected future values of a variable is determined by its past value plus an adjustment process. The adaptive expectations hypothesis is formalized by the following equation:

$$p_{t,t+1}^{e} = p_{t-1,t}^{e} + \lambda \left(p_t - p_{t-1,t} \right)$$

where $p_{t,t+1}^{e}$ is the expectations of p_{t+1} at time t, and λ is the partial adjustment term of the forecasting error, i.e. the difference between p_t and $p_{t-1,t}$.

The model encompasses capital gains that are important source of income and wealth for agents. Capital gains (or losses) arise for assets whenever their value increase (or decrease) while they are being held[5]. In this model, capital gains refer to market-valued assets, that is equities, securities and houses.

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[3] The "capitalists" category partly corresponds to the coalition identified by Bresser-Pereira (2010) between capitalists-rentiers, and financists. In fact, here, only capitalist-rentiers are taken into account.

[4] The reason for this sub-division will become clearer when describing the treatment of capital gains assumed here.

[5] When modeling a sector holding financial assets, it is important to account for capital gains and add (or remove in the case of a loss) them from the desired variation in quantities held of that asset, otherwise the variation in stock is not explained by the flows and the model is no more consistent (Godley and Lavoie, 2007, p. 135).

$$\Delta\left(p_{BL}BL\right) = p_{BL}BL - p_{BL,-1}BL_{-1} = \left(\Delta BL\right)p_{BL} + \left(\Delta p_{BL}\right)BL_{-1} \qquad \text{(CapitalGain)}$$

In (CapitaGain), $\left(\Delta BL\right)p_{BL}$ is equal to the new investment in that asset, that is the increase in quantity held times its price. However, because the price has changed, the nominal variation in asset held is equal to the new investment plus capital gains. We thus have in general that the wealth of a sector in period t is equal to the wealth of that sector in period $t-1$ plus savings plus capital

2.1 Variables and accounting identities

We follow the methodology developed by Mouakil (2006), as we find it the clearest way of exposition when dealing with cumbersome SFC models.

First, the model must contain the 50 variables of the TFM (Table 3, in appendix B), each of them is associated with the behavior of the corresponding sector. The BS (Table 1, in Appendix B) ensures that the level of stocks and their distribution among the different sector remain consistent through time.

- Worker households: C_w, SAV_w, $D_{w,b}$, M, H_w, $rent_H$

- Capitalist households: C_c, SAV_c, $D_{c,b}$, D_{i1}, D_{i2}, H_c, p_H

- Firms: I, WB, FU, FD_Q, Q_f, L, p_Q

- Commercial banks: F_b, D_b, S_b, C_b, i_L, i_M, i_C, p_s

- Investment banks 1: $FD_{Q,i1}$, $FD_{S,i1}$, F_{i1}, Q_{i1}, S_{i1}, C_{i1}

- Investment banks 2: $FD_{Q,i2}$, $FD_{S,i2}$, F_{i2}, Q_{i2}, S_{i2}, C_{i2}

Second, we write down the Transaction Flow matrix accounting identities resulting from each column (i-xii), where elements on the left side refer to "uses of funds", while those on the right hand side to "sources of funds".

$$C_w + rent_{H,-1} + i_{M,-1}M_{-1} + SAV_w \equiv WB \tag{i}$$

$$p_H\Delta H + \Delta D_{w,b} \equiv SAV_W + \Delta M + CG_w \tag{ii}$$

$$C_c + SAV_c \equiv F_b + F_{i1} + F_{i2} + rent_{H,-1} \tag{iii}$$

$$\Delta D_{c,b} + \Delta D_{i1} + \Delta D_{i2} + p_H\Delta H_c \equiv SAV_c + CG_c \tag{iv}$$

$$WB + FU + FD_Q + i_{L,-1}L_{-1} \equiv C + I \tag{v}$$

$$I \equiv FU + p_Q\Delta Q_f + \Delta L \tag{vi}$$

$$i_{S,-1}S_{b,-1} + F_b \equiv i_{M,-1}M_{-1} + i_{L,-1}L_{-1} + i_{C,-1}C_{b,-1} \tag{vii}$$

$$\Delta M + \Delta L + \Delta C_b \equiv \Delta D_b + p_s\Delta S_b + CG_b \tag{viii}$$

$$i_{C,-1}C_{i1,-1} + F_{i1} \equiv FD_{Q,i1} + FD_{s,i1} \tag{ix}$$

$$p_Q\Delta Q_{i1} + p_s\Delta S_{i1} \equiv \Delta D_{i1} + \Delta C_{i1} + CG_{i1} \tag{x}$$

$$i_{C,-1}C_{i2,-1} + F_{i2} \equiv FD_{Q,i2} + FD_{s,i2} \tag{xi}$$

$$p_Q\Delta Q_{i2} + p_s\Delta S_{i2} \equiv \Delta D_{i2} + \Delta C_{i2} + CG_{i2} \tag{xii}$$

gains, see equation (NetWealth).

$$V_t = V_{t-1} + sav_t + CG_t \tag{NetWealth}$$

Third, we must define each variable of the six sectors of the economy using an accounting identity or a behavioral equation. When additional unknowns are introduced in behavioral equations they are immediately defined, thus having the same number of equations as unknown. The system is then determined.

3 Modeling behaviors

The following subsections described the different behaviors modeled in this paper. To ease the reading of these descriptions, we did not include any equations, these can be found in Appendix A.

3.1 Worker households

Disposable income of worker households is given by wage income, minus interest payments on mortgages and the rent paid to capitalists for the houses that are rented[6]. The consumption function of workers depends on several factors. In a very standard way, it is determined by expected disposable income and past net worth. In addition, it is also affected first by an emulation effect, given by the income distribution inequality between workers and capitalists. When this ratio grows, workers decide to consume more in order to "keep up with the Joneses" (Christen and Morgan, 2005). Second, workers' consumption is affected by a habit effect expressing the fact that households oppose retrenchment in their acquired standard of consumption, as Barba and Pivetti (2009) suggest in their "class determined consumption function". There are also positive effects on consumption coming from expected capital gains, that follow an adaptive expectation process, and from the flow of mortgages that have been asked in the previous period, this to reflect what has been observed in the sub-prime crisis. Indeed, U.S. households used mortgages to buy cars or to pay for their children studies. All these factors have different respective impacts on the level of consumption.

The amount of workers' net worth is equal to its past value plus their saving -given by the difference between disposable income and consumption- and by capital gains arising from the change in the price of houses. Capital gains are calculated on the stock of houses held. The demand of mortgages arises in order to buy a house and follows an adjustment process towards a target level of leverage[7]. The leverage ratio for workers households is given by the proportion of their liabilities (mortgages) over their total assets, that is their deposits in commercial banks. We assumed, without loss of generality that deposits carry no interest rate.

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[6] We assume the rent to be an fixed exogenous value.

[7] The target level of leverage can be interpreted as a sort of credit constraint on borrower households.

Deposits are determined as the residual variable of the sector, given the net worth, demand of mortgages and nominal value of houses held.

3.2 Housing market

The actors of the housing market are workers and capitalists on the demand side and firms on the supply side. The demand of houses (in growth rates) of workers households depends (a) negatively on the expected variation of houses price and (b) negatively on the expected variation in the debt service ratio. As Eatwell et al. (2008) observe, (a) and (b) correspond to the relationship suggested by economic theory without considering restrictions facing the borrowers in the housing market. If no restrictions occur on the credit market (no leverage is taken into consideration in the equation of Mortgage demand), an increase of price has an unambiguous negative effect on the demand for houses, through (a), which, in turns, reduces the demand of mortgages. On the contrary, with binding quantitative restriction on borrowers, the impact of house prices is less clear-cut, since another indirect effect, in the opposite direction, through the leverage ratio enters the equation of demand of mortgage. Thus, an increase in the house prices reduces leverage and increases mortgages

The supply of new homes relies on a buffer mechanism based on unsold houses available on the market, in a very similar treatment than in Zezza (2008). The stock of unsold houses increases when the number of houses supplied exceeds the demand from both households. The supply of new houses increases whenever expected demand of both households increases and there is a positive expected variation of house prices. The market price of houses is a negative function of number of unsold houses.

3.3 Capitalist households

The disposable income of capitalist households is equal to the sum of profits of commercial banks, investment banks of both groups, dividends received on their share of equities and of securities, rent paid by worker households for the capitalists' houses they are renting.

Consumption of capitalists depends on a share of expected disposable income -equal to its past value- and on a share of past net worth. The amount of net worth of worker households is equal to its past value plus their saving and capital gains on price of houses.

from commercial banks and Tobin's q ratio. The utilization rate is determined as a ratio between output level and full-capacity output, that is set as a fixed proportion of past capital stock.

3.6 Commercial banks

Commercial banks in this model without a public sector play the role of a central bank, namely it sets a key interest rate and accommodate demand of money. Since there are no central bank, the economy described is thus a *pure credit money* system (Graziani, 2003). In more details mortgages, loans and interbank credit are granted on demand by households, firms and investment banks with no restriction. However, as already explained in section 3.1, the targeted leverage level might be seen as a form of rationing. Indeed, as the realized leverage level fluctuates around its targeted value, households reacts in order to obtain the target.

One important aspect of the model in investigating the functioning of private banking refers to the commercial banks behavior. Once commercial banks have granted mortgages to households, they use such idle assets in the securitization process, assuming that the whole stock of mortgages is securitized. In practice, each "unit" of stock of securities issued is backed by a "unit" of mortgages. The nominal value of securities is then determined according to the price of securities that is formed on the market as a market-clearing price from the matching between supply and demand. On the supply side, we have commercial banks, which "issue" securities pledged to the quantity of mortgages, while on the demand side there are capitalist households and investment banks of both groups that compete in the securities market.

Interest rate on loans, mortgages and securities are set adding a constant mark-up on the key interest rate on credit, set at discretion of commercial banks sector. The structure of interest rate is such that the interest rate on loans is larger than the interest rate on mortgages, which is larger than the interest rate on securities, which is larger than the interbank credit. We assume, with no loss of generality, that the key interest rate on credit is the interbank credit rate and is constant.

Profits of commercial banks are the sum of interest rate payments they receive on past loans, interbank credits and mortgages, minus interests commercial banks pay on stock of securities. Such profits are ultimately distributed to capitalists.

3.7 Investment banks

Although investment banks sector is disaggregated into two subsectors (1 and 2), we assume the two groups behave similarly in their active management of balance sheet and portfolio choice behavior. However, we assign different values to parameters in their respective asset demands as well as to starting values.

Investment banks profits are determined by dividends on equities, plus dividends on securities, minus interest payments on past credits demanded. Dividends on equities depend on the basis of the share of equities they hold with respect to the total equities issued. Dividends on securities depend on the stock of securities bought in the previous period and interest rate applied, in previous period, to securities.

Investment banks decide how to allocate their financial wealth between equities and securities following a portfolio choice which relies on Tobinesque principles, as for capitalists. The demand of securities and equities is a proportion of a ratio between expected deposits and the leverage target to which investment banks are subjected. The proportion then changes according to expected rate of return of assets.

Investment banks decide how much to invest on the basis of deposits they expect to receive from capitalists. Expected deposits depend on past deposits, on the variation occurred during the previous period and a share of past growth rate in profits that investment banks have realized in previous period and ultimately distributed to capitalists. In practice, the higher profits investment banks make, the higher deposits they expect to receive from capitalists and thus the higher liabilities they have at disposal to invest in the capital market, without running into external debt. In the case of excess leverage according to Basel III regulation -either because investment banks did not collect as much deposits as expected or because of unexpected capital gains-, invetsment banks need more reserve, which is furnished by Comercial Banks at a price equal to the interbank interest rate.

The expected rate of return on securities held by investment banks depends on the expected real interest rate on securities and on a share of expected capital gains on prices of securities, following an adaptive error correction formula, according to how much they invest in securities in the previous period. The expected rate of return on equities for investment banks depends, similarly to capitalists, on expected dividends and a share of expected capital gains on prices of equities according to how much they invest in equities in the previous period.

4   Experiments

Below, we discuss the effects of an increase in the expected price of securities and of an increase in the expected price of houses. After finding a stable baseline steady state for our model using a set of reasonable parameter values (reported in appendix C) and initial values for stocks and lagged endogenous variables, we

shock the relevant parameter (one at a time) and follow the reaction of some important variables relative to their baseline values[9].

4.1 Effect of a shock on expected price of securities

The first experiment we did was to shock the expected price of securities through an exogenous positive increase in expectations. The immediate effect is an increase in the expected rate of return on securities for both investment banks groups. After few periods, however, the positive effect on the rate of return due to rising expected capital gains is overcome by the decrease in the real interest rate of securities (Figure 2.a)

The stocks of securities held by investments banks change in a different way: for investment banks 1 they increase, while for investment banks 2 they fall (Figure 2.b). This is due to investment banks' portfolio choice structure, which is very sensible to variations of expected rate of returns on their assets. Indeed, while for investment bank 2, the expected increase in securities' price leads to a proportional decrease of the stock held, because they favor more equities than securities, the effect is opposite for investment bank 1.

Higher quantity of securities held by investment banks 1 determines higher dividends for investment banks. This results in a rising of profits for investment banks 1, while a decreasing for investment banks 2. As a result, since profits are ultimately distributed to capitalist households, the net effect on their disposable income is positive (Figure 2.c).

Now capitalists perceive a higher expected rate of return on their deposits by investment banks 1 (Figure 2.d) since their profits have actually increased and thus their expectations on future profits are revised. The opportunity to get more yield on deposits will revert their demand towards more deposits, given their portfolio choice. In fact, actual deposits by investment banks generally increase (Figure 2.e). In a very similar way, since actual deposits increase as well as profits, deposits that investment banks expect to receive from capitalists are higher (Figure 2.f).

The result of an increase in expected securities price is produced by the mechanism on asset prices described by Toporowski and Michell (2011):

> there are two reasons why the price of equities would change in the
> absence of any new issuance of shares. The first is the appearance of
> new piece of information on the prospective returns from real invest-
> ment. If there is a rise in the expected level of dividend payments,

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[9] The simulation experiments are conducted with Eviews 7. In figures 2-3, we homogenize the values to one in order to compare them with the steady state solution. The timescale is arbitrary and only gives an idea of the time-span. Note that these exercises are no predictions.

money flow will arise as a result of fund being reallocated between banks depositis and securities in the portfolios of households. A rise in the retained profits, in the form of firms bank deposits would reinforce the expectations of a higher dividend and increase the potential value of equities. The second possibility arises from the fact that, once the rise in the price of shares has taken place, the expectation of further rises in share prices will and thus the prospects of capital gains for the owners of equity may cause further inflows into these assets. In turn, this inflow of funds causes prices to rise, validating the judgment of those astute enough to have seen them coming.

In this model, the interaction is between deposits by investment banks and portfolio choice of capitalists. A rise in the expected level of distributed profits to capitalists would generate a reallocation of wealth toward deposits and this reinforces the expectations of investment banks of higher deposits and thus higher liabilities to rely on in order to invest and make profits in the securities market.

4.2 Effect of a shock on expected price of houses

The next simulation experiment focuses on the price of the asset held by indebted households, that is houses. We positively shock the expected price of houses. At first, the increase in the price of houses make the leverage of workers households decrease, since the value of the houses held is higher (Figure 3.a).

However, after some periods, a leverage ratio below the target level, stimulates households to demand more mortgage to buy more houses. This will make the leverage increase again. However, in the long run, even if the mortgage stabilizes at a higher level than before the shock, the leverage will tend towards a lower level, suggesting that workers facing higher prices of houses, decide to take on more prudential behavior through a reduction in their leverage (Figure 3.b).

The result of the simulation agrees with the consideration of Eatwell et al. (2008) about the plausible causes of financial crisis. They investigate two scenarios: a bank-led financial crisis and a household-led one. They found that when the impact of leverage on workers demand of houses is set relatively high, this would make the "perverse" positive effect of house price on demand higher than the negative effect. However, as they report, this hypothesis is not empirically observed, since higher level of net worth of households, due to higher price of houses, does not correspond to a higher level of leverage (Figure 3.c). In our model the leverage of workers is countercyclical, as in Adrian and Shin (2010), since an increase in the price of houses produces a lower leverage of workers households.

(a) Expected rate of return on securities

(b) Securities held by Investment Banks

(c) Profits of Investments Banks

(d) Expected rate of return on deposits

(e) Investment Banks' deposits

(f) Investment Banks' expected deposits

Figure 2: Effect of a shock on expected price of securities

(a) Demand of houses

(b) House price effect on mortgages

(c) Leverage and price of houses

Figure 3: Effect of a shock on expected price of houses

5 Conclusion

This paper tries to investigate how worker households and private investment banks act in facing variations in the prices of their assets. The housing sector is explicitly modeled as in the work of Zezza (2008), to which securitization process has been added, in order to show the links between housing market and financial sector.

The model describes an economy without public sector, in order to limit the number of equations and the difficulties in searching for a steady state solution. The missing role of central bank is assumed here to be played by commercial banks that act as a lender of last resort to economic agents according to their financial needs, especially to investment banks in the securitization process.

Focusing on the role played by investment banks in responding to changes in security prices, we find an active management of their balance sheets. This gives rise to a pro-cyclical leverage ratio, which is coherent with empirical evidence from the private banking sector.

The model behaves well also with respect to the behavior of indebted households. In fact, in our model the leverage of workers is countercyclical, as in Adrian and Shin (2010), since an increase in the price of houses produces a lowe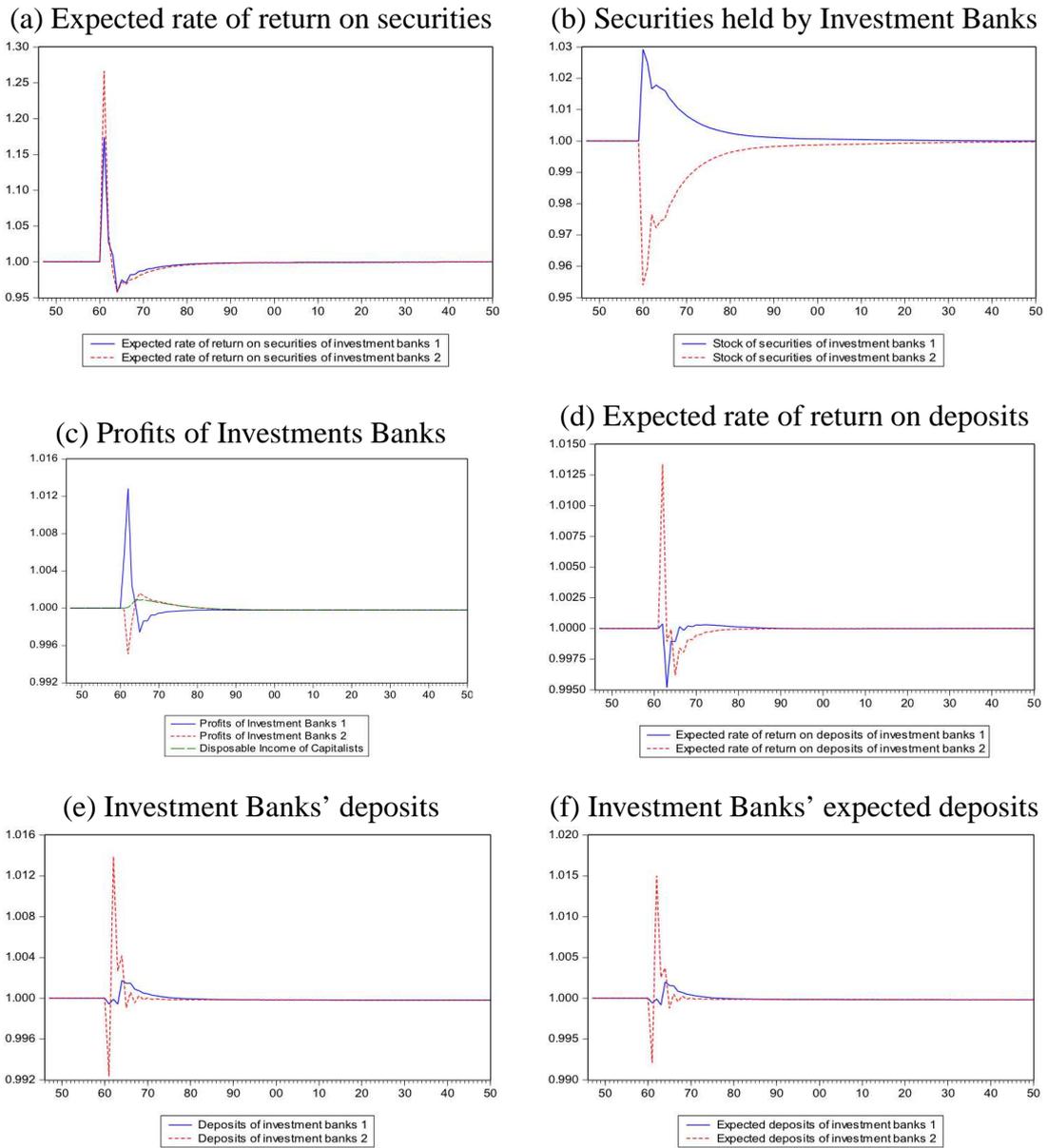r leverage of workers households. These results are coherent with the recent financial crisis in U.S., as the evidence suggests that it has been a finance-led crisis and not a households-led crisis (Eatwell et al., 2008).

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A Model Equations

A.1 Worker households

$$YD_w = WB - i_{M,-1}M_{-1} - rent_{H,-1} \tag{1}$$

$$rent_{H,-1} = rentrate H_{c,-1} \tag{2}$$

$$C_w = \alpha_{1w}YD_w^e + \alpha_{2w}NW_{w,-1} + \alpha_{3w}\frac{YD_c}{YD_w} + \alpha_{4w}\frac{YD_{w,-1}}{YD_w} + \dots$$

$$\dots + \alpha_{5w}CG_{Hw}^e + \alpha_{6w}\Delta M_{w,-1} \tag{3}$$

$$YD_w^e = YD_{w,-1} + \mu\left(YD_{w,-1}^e - YD_{w,-1}\right) \tag{4}$$

$$CG_w^e = CG_{w,-1} + \mu\left(CG_{w,-1}^e - CG_{w,-1}\right) \tag{5}$$

$$SAV_w = YD_w - C_w \tag{6}$$

$$NW_w = NW_{w,-1} + SAV_w + CG_w \tag{7}$$

$$CG_w = \Delta p_H H_{w,-1} \tag{8}$$

$$\Delta M_w = \tau_1\left(p_H \Delta H_w\right) + \tau_2(lev_w^T - lev_{w,-1}) \tag{9}$$

$$lev_w = \frac{M_w}{p_H H_w + D_{w,b}} \tag{10}$$

$$D_{w,b} = NW_w + M_w - p_H H_w \tag{11}$$

A.2 Housing market

$$\frac{\Delta H_w^d}{H_{w,-1}^d} = -\beta_1 \frac{p_H^e - p_{H,-1}}{p_{H,-1}} - \beta_2 \frac{dsr^e - dsr_{-1}}{dsr_{-1}} \tag{12}$$

$$p_H^e = p_{H,-1} + \mu\left(p_{H,-1}^e - p_{H,-1}\right) \tag{13}$$

$$dsr = \frac{i_{M,-1}M_{-1}}{YD_w} \tag{14}$$

$$dsr^e = dsr_{-1} + \mu\left(dsr_{-1}^e - dsr_{-1}\right) \tag{15}$$

$$\Delta H_u = H_n - \Delta H_c - \Delta H_w \tag{16}$$

$$H_n = \chi_1\left(\Delta H_c^e + \Delta H_w^e\right) + \chi_2 \Delta^e p_H \tag{17}$$

$$H = H_{-1} + H_n \tag{18}$$

$$\Delta H_c^e = \Delta H_{c,-1} + \mu\left(\Delta H_{c,-1}^e - \Delta H_{c,-1}\right) \tag{19}$$

$$\Delta H_w^e = \Delta H_{w,-1} + \mu\left(\Delta H_{w,-1}^e - \Delta H_{w,-1}\right) \tag{20}$$

$$\Delta^e p_H = \Delta p_{H,-1} \tag{21}$$

$$\frac{\Delta p_H}{p_{H,-1}} = -\chi_3 \Delta H_u \tag{22}$$

A.3 Capitalists households

$$YD_c = F_b + F_{i1} + F_{i2} + rent_{H,-1} \tag{23}$$

$$C_c = \alpha_{1c} YD_c^e + \alpha_{2c} NW_{c,-1} + \alpha_{3c} CG_{H,c}^e \tag{24}$$

$$YD_c^e = YD_{c,-1} + \mu \left(YD_{c,-1}^e - YD_{c,-1} \right) \tag{25}$$

$$CG_{Hc}^e = CG_{Hc,-1} + \mu \left(CG_{Hc,-1}^e - CG_{Hc,-1} \right) \tag{26}$$

$$NW_c = NW_{c,-1} + SAV_c + CG_{Hc} \tag{27}$$

$$SAV_c = YD_c - C_c \tag{28}$$

$$CG_{Hc} = \Delta p_H H_{c,-1} \tag{29}$$

A.4 Portfolio choice of capitalist households

$$\frac{D_{i1}}{NW_c^e} = \lambda_{10} + \lambda_{11} r_{i1}^e - \lambda_{12} r_{i2}^e - \lambda_{13} r_H^e - \lambda_{14} \frac{YD_c^e}{NW_c^e} \tag{30}$$

$$\frac{D_{i2}}{NW_c^e} = \lambda_{20} - \lambda_{21} r_{i1}^e + \lambda_{22} r_{i2}^e - \lambda_{23} r_H^e - \lambda_{24} \frac{YD_c^e}{NW_c^e} \tag{31}$$

$$\frac{p_H H_c}{NW_c^e} = \lambda_{30} - \lambda_{31} r_{i1}^e - \lambda_{32} r_{i2}^e + \lambda_{33} r_H^e - \lambda_{34} \frac{YD_c^e}{NW_c^e} \tag{32}$$

$$\frac{D_{c,b}}{NW_c^e} = \lambda_{40} - \lambda_{41} r_{i1}^e - \lambda_{42} r_{i2}^e - \lambda_{43} r_H^e + \lambda_{44} \frac{YD_c^e}{NW_c^e} \tag{33}$$

$$NW_c^e = NW_{c,-1} + YD_c^e - C_c \tag{34}$$

$$r_{i1}^e = \frac{F_{i1}^e}{D_{i1,-1}} \tag{35}$$

$$r_{i2}^e = \frac{F_{i2}^e}{D_{i2,-1}} \tag{36}$$

$$F_{i1}^e = F_{i1,-1} + \mu \left(F_{i1,-1}^e - F_{i1,-1} \right) \tag{37}$$

$$F_{i2}^e = F_{i2,-1} + \mu \left(F_{i2,-1}^e - F_{i2,-1} \right) \tag{38}$$

$$r_H^e = \frac{rent_{H,-1} + v(CG_{H,c}^e)}{p_{H,-1} H_{c,-1}} \tag{39}$$

$$D_{c,b} = NW_c - D_{i1} - D_{i2} - p_H H_c \tag{40}$$

A.5 Firms

$$Y = C_w + C_c + I + H_n p_H = WB + F_T \tag{41}$$

$$y = C_w + C_c + I + H_n \tag{42}$$

$$WB = wN \tag{43}$$

$$N = \frac{y}{pr_N} \tag{44}$$

$$w = \frac{pr_N}{1+\rho} \tag{45}$$

$$F_T = Y - WB \tag{46}$$

$$FU = F_T - FD_Q - i_{L,-1}L_{-1} \tag{47}$$

$$FD_Q = (1 - s_f)\left[FT_{-1} - i_{L,-1}L_{-1}\right] \tag{48}$$

$$I_F = I - FU \tag{49}$$

$$p_Q\Delta Q_f = \phi I_{F,-1} \tag{50}$$

$$K = K_{,-1} + I - \delta K_{-1} \tag{51}$$

$$I = gr_K K_{,-1} + \delta K_{-1} \tag{52}$$

$$gr_k = \gamma_0 + \gamma_1 u_{-1} - \gamma_2 i_{L,-1}\frac{L_{-1}}{K_{-1}} + \gamma_3\frac{p_{Q,-1}Q_{-1}}{K_{-1}} \tag{53}$$

$$u = \frac{y}{y^{fc}} \tag{54}$$

$$y^{fc} = \sigma K_{-1} \tag{55}$$

$$L = L_{-1} + I - FU - p_Q\Delta Q_f \tag{56}$$

A.6 Commercial banks

$$D_b = D_{w,b} + D_{c,b} \tag{57}$$

$$S_b = M \tag{58}$$

$$C_b = C_{i1} + C_{i2} \tag{59}$$

$$NW_b = D_b + p_S S_b - L - M - C_b \tag{60}$$

$$i_L = (1 + \eta_L)i_C \tag{61}$$

$$i_M = (1 + \eta_M)i_C \tag{62}$$

$$i_S = (1 + \eta_S)i_C \tag{63}$$

$$F_b = i_{L,-1}L_{,-1} + i_{C,-1}C_{b,-1} + i_{M,-1}M_{,-1} - i_{S,-1}S_{b,-1} \tag{64}$$

A.7 Investment banks

$$F_{ii} = FD_{Q,ii} + FD_{S,ii} - i_{C,-1}C_{ii,-1} \tag{65}$$

$$FD_{Q,ii} = FD\frac{Q_{ii}}{Q_f} \tag{66}$$

$$FD_{S,ii} = i_M S_{ii,-1} \tag{67}$$

$$CG_{S,ii} = \Delta p_S S_{ii,-1} \tag{68}$$

$$CG_{Q,ii} = \Delta p_Q Q_{ii,-1} \tag{69}$$

$$p_S S_{ii} = \left[\theta_{10i} + \theta_{11i} r^e_{S,ii} - \theta_{12i} r^e_{Q,ii} \right] \frac{D^e_{ii}}{lev^T_i} \tag{70}$$

$$p_Q Q_{ii} = \left[(1 - \theta_{10i}) - \theta_{11i} r^e_{S,ii} + \theta_{12i} r^e_{Q,ii} \right] \frac{D^e_{ii}}{lev^T_i} \tag{71}$$

$$D^e_{ii} = D_{iI,-1} + \Delta D_{ii,-1} \left(1 + \psi \frac{\Delta F_{ii,-1}}{F_{ii(-2)}} \right) \tag{72}$$

$$C_{ii} = (p_S S_{ii} + p_Q Q_{ii}) \, lev^T - D_{ii} \tag{73}$$

$$r^e_{S,ii} = v_i \frac{i_S}{p^e_S} + v_S \frac{CG^e_{S,ii}}{p_{S,-1} S_{ii,-1}} \tag{74}$$

$$p^e_s = p_{s,-1} + \mu(p^e_{s,-1} - p_{s,-1}) \tag{75}$$

$$CG^e_{S,ii} = CG_{S,ii,-1} + \mu \left(CG^e_{S,ii,-1} - CG_{S,ii,-1} \right) \tag{76}$$

$$r^e_{Q,ii} = \frac{FD^e_{Q,ii} + v_Q(CG^e_{Q,ii})}{p_{Q,-1} Q_{ii,-1}} \tag{77}$$

$$FD^e_{Q,ii} = FD_{Q,ii,-1} + \mu \left(FD^e_{Q,ii,-1} - FD_{Q,ii,-1} \right) \tag{78}$$

$$CG^e_{Q,ii} = CG_{Q,ii,-1} + \mu \left(CG^e_{Q,ii,-1} - CG_{Q,ii,-1} \right) \tag{79}$$

A.8 System wide implications

$$Q_f = Q_{i1} + Q_{i2} \tag{80}$$

$$S_b = S_{i1} + S_{i2} \tag{81}$$

B Balance Sheet and Transaction Flow Matrix

	Workers (1)	Capitalists (2)	Firms (3)	Commercial Banks (4)	Investment Banks 1 (5)	Investment Banks 2 (6)	Real Assets	Σ
Capital			$+K$				$-K$	0
Real Estate	$+p_H H_w$	$+p_H H_c$					$-p_H H$	0
Commercial Banks Deposits	$+D_{w,b}$	$+D_{c,b}$		$-D_b$				0
Investment Banks Deposits		$+D_{i1}$			$-D_{i1}$			0
		$+D_{i2}$				$-D_{i2}$		0
Loans			$-L$	$+L$				0
Equities			$-p_q Q_f$		$+p_q Q_{i1}$	$+p_q Q_{i2}$		0
Interbank credit				$+C_b$	$-C_{i1}$	$-C_{i2}$		0
Mortgages	$-M$			$+M$				0
Securities				$-p_s S_b$	$+p_s S_{i1}$	$+p_s S_{i2}$		0
Net Worth	$-NW_w$	$-NW_c$	$-NW_f$	$-NW_b$	$-NW_{i1}$	$-NW_{i2}$	$+p_H H + K$	0

Table 1: Balance Sheet

C Parameters

Deposits investment banks 1	Deposits investment banks 2	Houses	Deposits commercial banks
$\lambda_{10} : -0.209$	$\lambda_{20} : 0.186$	$\lambda_{30} : 0.2$	$\lambda_{40} : 0.823$
$\lambda_{11} : 0.6$	$\lambda_{21} : 0.2$	$\lambda_{31} : 0.2$	$\lambda_{41} : 0.2$
$\lambda_{12} : 0.2$	$\lambda_{22} : 0.4$	$\lambda_{32} : 0.2$	$\lambda_{42} : 1.2 * 10^{-10}$
$\lambda_{13} : 0.2$	$\lambda_{23} : 0.2$	$\lambda_{33} : 0.4$	$\lambda_{43} : 1 * 10^{-25}$
$\lambda_{14} : 0.2$	$\lambda_{24} : 1.2 * 10^{-10}$	$\lambda_{34} : 1 * 10^{-25}$	$\lambda_{44} : 0.2$

Table 2: Portfolio choice parameters for capitalists

	Workers		Capitalists		Firms		Commercial Banks		Investment Banks 1		Investment Banks 2		Σ
	Current (i)	Capital (ii)	Current (iii)	Capital (iv)	Current (v)	Capital (vi)	Current (vii)	Capital (viii)	Current (ix)	Capital (x)	Current (xi)	Capital (xii)	
Consumption	$-C_w$		$-C_c$		C								0
Investment					$+I$	$-I$							0
Wages	$+WB$				$-WB$								0
Rent	$-rent_{H,-1}$		$+rent_{H,-1}$										0
Interests on Loans					$-i_{L,-1}L_{-1}$		$+i_{L,-1}L_{-1}$						0
Interests on Mortgages	$-i_{M,-1}M_{-1}$						$+i_{M,-1}M_{-1}$						0
Interests on Interbank Profits							$+i_{C,-1}C_{b,-1}$		$-i_{C,-1}C_{i1,-1}$		$-i_{C,-1}C_{i2,-1}$		0
Dividends on Equities					$-FD_Q$				$+FD_{Q,i1}$		$+FD_{Q,i2}$		0
Dividends on Securities							$-i_{s,-1}S_{b,-1}$		$+FD_{S,i1}$		$+FD_{S,i2}$		0
Banks Profits			$+F_b+F_{i1}+F_{i2}$				$-F_b$		$-F_{i1}$		$-F_{i2}$		0
Retained earnings					$-FU$	$+FU$							0
Savings	$-SAV_w$	$+SAV_w$	$-SAV_c$	$+SAV_c$									0
Capital Gains		$+CG_w$		$+CG_c$		$+CG_f$		$+CG_b$		$+CG_{i1}$		$+CG_{i2}$	0
Δ Housing		$-p_H\Delta H_w$		$-p_H\Delta H_c$	$+p_H\Delta H$	$-p_H\Delta H_u$							0
Δ Deposits Commercial		$-\Delta D_{w,b}$		$-\Delta D_{c,b}$				$+\Delta D_b$					0
Δ Deposits Investment 1				$-\Delta D_{i1}$						$+\Delta D_{i1}$			0
Δ Deposits Investment 2				$-\Delta D_{i2}$								$+\Delta D_{i2}$	0
Δ Loans						$+\Delta L$		$-\Delta L$					0
Δ Equities				$-p_Q\Delta Q_c$		$+p_Q\Delta Q_f$				$-p_Q\Delta Q_{i1}$		$-p_Q\Delta Q_{i2}$	0
Δ Interbank Credit								$-\Delta C_b$		$+\Delta C_{i1}$		$+\Delta C_{i2}$	0
Δ Securities				$-p_S\Delta S_c$				$+p_S\Delta S_b$		$-p_S\Delta S_{i1}$		$-p_S\Delta S_{i2}$	0
Δ Mortgage		$+\Delta M$						$-\Delta M$					0
Σ	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: Transaction Flow Matrix

Firms	
Symbol	Value
prN	2.52
ρ	0.68
s_f	0.212
ϕ	0.2
δ	0.1
γ_0	-1.417015
γ_1	0.1
γ_2	0.1
γ_3	0.1
σ	1.5
μ	0.5

Housing market	
Symbol	Value
χ_1	0.05
χ_2	0.04
χ_3	0.1

Capitalists households	
Symbol	Value
$\alpha_{1,c}$	0.7
$\alpha_{2,c}$	0.025
$\alpha_{3,c}$	0.01
$rent\,rate$	0.1
γ	0.02
v	0.05

Investment Banks	
Symbol	Value
Ψ	0.1
lev_i^T	0.1
v_i	1
v_Q	0.05
v_S	0.05

Workers households	
Symbol	Value
$\alpha_{1,w}$	0.7
$\alpha_{2,w}$	0.025
$\alpha_{3,w}$	0.01
$\alpha_{4,w}$	0.01
$\alpha_{5,w}$	0.01
$\alpha_{6,w}$	0.01
β_1	0.03
β_2	0.05
τ_1	0.01
τ_2	0.02

Commercial Banks	
Symbol	Value
i_C	0.02
η_L	0.375
η_M	0.25
η_S	0.125

Table 4: Parameters

Investment banks 1	Investment banks 2
$\theta_{10} : 0.96$	$\theta_{10} : 0.05$
$\theta_{11} : 0.4$	$\theta_{11} : 0.2$
$\theta_{12} : 0.1$	$\theta_{12} : 0.7$

Table 5: Portfolio choice parameters for Investment banks 1 and 2