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Article

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European Journal of Economics and Economic Policies: Intervention (EJEEP)

Provided in Cooperation with:

Edward Elgar Publishing

Suggested Citation: Caverzasi, Eugenio; Godin, Antoine (2015) : Financialisation and the sub-prime crisis: a stock-flow consistent model, European Journal of Economics and Economic Policies: Intervention (EJEEP), ISSN 2052-7772, Edward Elgar Publishing, Cheltenham, Vol. 12, Iss. 1, pp. 73-92,
<https://doi.org/10.4337/ejeep.2015.01.07>

This Version is available at:

<https://hdl.handle.net/10419/277320>

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Financialisation and the sub-prime crisis: a stock-flow consistent model

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Our opinion is that the so-called sub-prime mortgage crisis has been a structural crisis of the US's financial capitalism. In analysing the complex combination of factors that led to those events, we try not to focus on the most contingent aspects but to clarify the underlying structure that made the crisis endogenously emerge from the US's economic system. To reach this goal, we base our analysis on existing economic theories. In particular, the combination of the Financial Instability Hypothesis by Hyman Minsky, the theory of Capital Market Inflation by Jan Toporowski, and the post-Keynesian literature on financialisation represent the foundation of our analysis. The results of our analysis will then be reproduced through a simulated stock-flow consistent model to test their logical coherence.

Keywords: *Minsky, stock-flow consistent, financialisation, banks*

JEL codes: *E12, E37, G21*

1 THE CRISIS AS AN OUTCOME OF A SPECIFIC ECONOMIC SYSTEM

This paper aims to analyse the sub-prime mortgage crisis, in order to identify the complex combination of factors that led to those events. We argue that the crisis endogenously emerged in the US, because of the specific structure of that economic system. The goal of our paper is to elucidate the main features of that structure. In our investigation, we rely on two main tools. In Section 1 we present a brief theoretical analysis based on a combination of the Financial Instability Hypothesis by Hyman Minsky, the theory of Capital Market Inflation by Jan Toporowski and the post-Keynesian literature on the financialisation of the economy. We believe that these three streams of literature jointly provide for a thorough explanation of the main systemic fragility that led to the crisis.

In Section 2 we develop a post-Keynesian stock-flow consistent model (PK-SFC hereafter), which includes some aspects of novelty in the portfolio choice of firms and in the intra-sectoral dynamics. The rationale for using this class of model is twofold. On the one

* Corresponding author: eu.caver@gmail.com. We thank Alessandro Caiani, Stephen Kinsella, Apostolos Fasianos, Sean Ryan, Till van Treeck and one anonymous referee for their plentiful advice as well as the participants of the 6th Dijon Conference, 'Sovereign Debt, Economic Policies and Bank Reforms', for their valuable comments. We are grateful to Riccardo Bellofiore and Jan Toporowski for their precious and inspiring comments on a previous version of the paper. All remaining errors remain ours.

Received 18 February 2014, accepted 24 September 2014

hand, it allows for a consistency check of our analysis, as its logical and accounting implications are made explicit through the model. On the other hand, we believe that these types of models can represent an useful and structured locus where different theories – albeit in a simplified version – can be compared, offering ‘a potential . . . common ground for all heterodox schools’ (Lavoie 2008: 333).

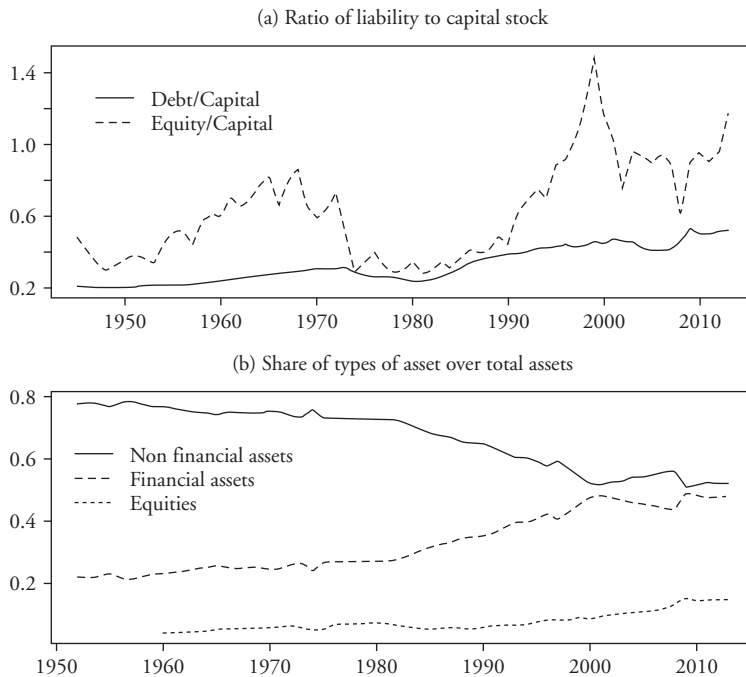
Section 3 presents the results of the simulations we ran to test the behaviour of our simplified economy. We conclude in Section 4, summarising the main findings of this article.

1.1 Financialisation: a portrayal

We believe that the longevity of capitalism is inherently linked with its ability to mutate. The understanding of existing institutions and contingencies is therefore quintessential in trying to explain any specific economic event, as it makes little sense to invoke a universal ‘capitalist economy’. In this section, we try – referring to existing economic theories – to underline the features of the US economic system, which, in our opinion, made the sub-prime crisis emerge endogenously. The starting point of the the identification of these pathogens is a stylised fact: the dramatic growth of the financial markets starting in the 1980s, allowed by their deregulation, which had major impacts on the economy at different levels. This complex phenomenon, usually defined as *financialisation*, structurally changed US capitalism. Figure 1(a) shows the evolution of debt to capital and equity to capital ratios in the US since 1945. The debt-to-capital ratio shows a steady increase, hampered only during the crises of the 1970s and mid 2000s when firms rebalanced their balance sheets. The equity-to-capital ratio (or *Tobin’s q*) shows more volatility but nonetheless presents a similar upward trend.

As described by the theory of Capital Markets Inflation (CMI from now on, see Toporowski 2000 for more details), the deregulation of financial markets caused the inflation of asset prices, which in turn had major impacts on the balance-sheet management of firms. Trying to summarise the theory in a nutshell, we could say that, as for any price, the price of equities grows with demand but, unlike the demand for goods or services, the demand for equities tends to increase together with price, because of the expectations of capital gains. This inflation, however, does not take place in the primary market where issuers collect funds, but in the secondary market where financial assets are exchanged among agents and institutions according to their portfolio choices. This dynamic had a perverse effect on firms’ financing decisions, as they issued further equities to take advantage of the increased prices and ended up being *overcapitalised* (ibid.: ch. 2), in practice having more funds than needed for entrepreneurial activities. This excess of funds was not used to increase real investment, but for financial activities (Toporowski 2009). The liquidity drawn allowed firms to launch portfolio restructuring, shifting their focus (hence liquidity preferences) in favour of financial assets.

This appears to be coherent with the analysis of several authors over the relations between the real and the financial sectors. Tobin (1965) already assumed a possible crowding-out effect of financial investment with respect to real capital accumulation. Stockhammer (2005) analysed a change in the governance of firms, defined as *shareholder value orientation*. According to his analysis, firms increasingly shortened their time horizon, because they started focusing on short-term remunerations of shareholders. This is hardly compatible with entrepreneurial activities, which require a longer time horizon. Hence corporations, looking for rapid returns, turned to the financial markets. The reason of the shift in liquidity preferences, in favour of cash, is analysed by Bates et al. (2009),



Source: Federal Reserve Bank of St. Louis – Economic Data, table B102; authors' calculations.

Figure 1 Ratio of liability to capital stock and share of types of asset over total assets, USA since 1945

showing that the holding of cash by US industrial firms more than doubled between 1980 and 2009. In practice, overcapitalisation, as described by Toporowski, was one of the first steps of financialisation and provided for the funds to be used for financial activities.¹

Figure 1(b) shows the situation in the US. It highlights how the share of firms' financial assets in total assets has increased in the last 60 years, attesting to the aforementioned crowding-out effect. Interestingly, the share seems to have stabilised since the turn of the century. Whereas the portion of equities in total assets was roughly constant until the 1990s, when it started to rise until the last financial crisis, when it stabilised again.

The empirical analysis of Orhangazi (2008) shows how this theorised preponderance of finance over enterprise finds correspondence in data. Among the results of these dynamics, two are particularly interesting for our analysis. First, on the corporate side, we witnessed a decrease in the rate of accumulation of real capital in favour of financial investment.

1. In this context, the activity of share repurchase, which, at first sight, might appear to be in contradiction with Toporowski's overcapitalisation, is just one of the different financial strategies (see Bhargava 2013) that firms might put into practice once they have become operational in the financial markets. The active decision (which differentiates *rentier* from *entrepreneurial* firms, see Toporowski 1993) to take part in this market requires liquidity. Therefore having liquid assets in excess of what is needed for entrepreneurial activity (that is, overcapitalisation) can be seen as a pre-condition for financialisation. Equity markets, as a large and affordable (see Toporowski 2000: first part) source of finance, represented a valid entry ticket for the financial(ised) market.

Second, on the banks side, there was a shift in banks' main business. Indeed, firms started financing through equity emissions and this – as described by Toporowski (2009) – led banks to focus on other activities such as securitisation and real estate.

Another feature of US capitalism in the last 30 years has been the rise of income inequality. The link between the evolution of income distribution and households' indebtedness has been at the core of the interpretation of the sub-prime crisis advanced by several scholars. This interpretation overcame the boundaries of the post-Keynesian school of thought (see Palley 2011; Zezza 2011; Cynamon/Fazzari 2014; among others), in which tradition the distribution of income has always played a key role, becoming popular also among authors belonging to more mainstream approaches (see Kumhof/Ranci re 2010; Rajan 2010). The core of the interpretation is the following: the reduction of the wage share led households to resort increasingly to speculation and debt as sources of income to sustain their consumption, implying growth in the level of indebtedness of the private sector with respect to income. Belabed et al. (2013) show how functional distribution and income distribution have different impacts on household debt and aggregate demand. Different authors have focused on different aspects of this dynamic, identifying different causal nexuses. As an exhaustive review of the literature is beyond the scope of this paper, we suggest Treeck/Sturm (2012) for a thorough analysis of existing works.

1.2 Financialisation elsewhere

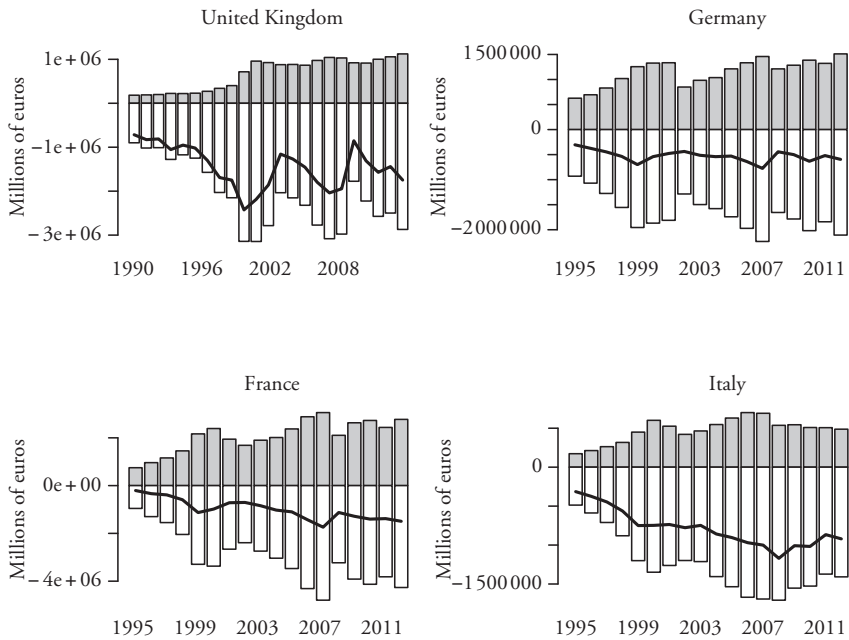
The situation in Europe is more contrasted. Figure 2 shows firms' equity position in four European economies. While the trend observed in the US seems reproduced in the UK (where firms appear to buy more equities than they emit), this is not true for Germany, France or Italy. Firms' gross equities position has increased in all countries, but while the growth was balanced in Germany, this was not the case in France and Italy, where firms' net position has worsened significantly in the last 15 years.

Figure 3 shows flows of investment going either to real capital (gross capital formation, dotted line) or to new equities holding (solid line) in the same four European countries. Again, the picture is more contrasted than in the US's case. Investment flows in equities have increased more than real investment flows in the UK, remained roughly constant in Germany and have not increased as much as real investment flows in France and Italy.

The analysis we develop here concentrates on the Anglo-Saxon case, where we observe that firms keep on relying on equities' emission to finance their investment decision but decide to invest more in financial assets, leading to a crowding-out effect of real investments. It is important to stress that while the net position in equities is roughly constant in the US or even slightly improving in the UK, this is not due to a reduction in their liability position but rather to an increase in their asset position. This shows the importance of explaining both sides of the balance-sheet decision of firms.

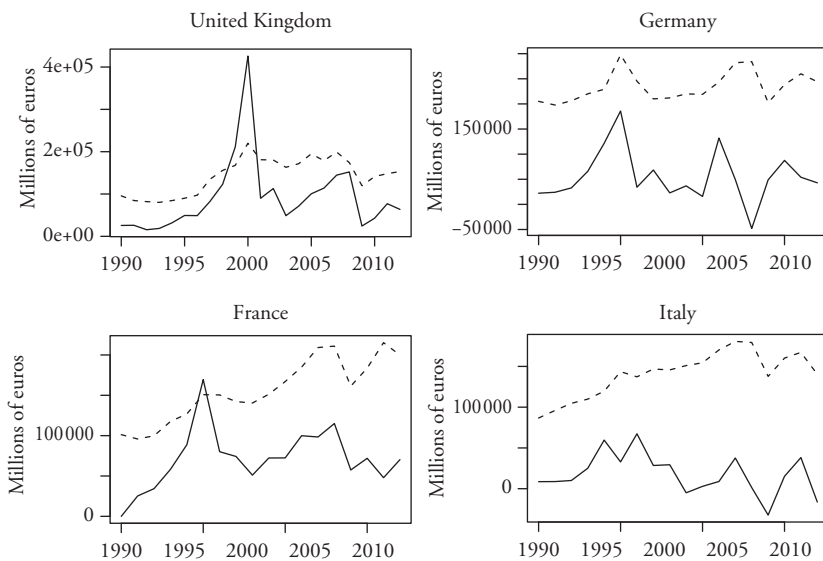
1.3 A Minskyan interpretation of the crisis

US capitalism has undoubtedly changed since Minsky first wrote the Financial Instability Hypothesis (FIH hereafter – see, for example, Minsky 1992). Reading the FIH from a 'banks perspective' and taking into account the aforementioned analyses of the financialised US economy, it is possible to provide a Minskyan interpretation of the sub-prime crisis. Heroically trying to summarise FIH in one sentence, we could say that banks increasingly finance a booming market, whose agents take increasingly risky positions,



Source: Eurostat, table nasa_f_b; authors' calculations.

Figure 2 Firms' equity positions in some European countries since 1990



Note: Dotted lines = investment in real capital; solid lines = new equities holding.

Source: Eurostat, table nasa_f_tr; authors' calculations.

Figure 3 Flows of investments in some European countries since 1990

up to the point at which the expansion become unsustainable and units start defaulting on their debts. This is exactly what happened in the sub-prime crisis.

However this metamorphosis – defined here as financialisation and which Minsky (1996) himself foresaw in its main aspects and defined as *Money Manager Capitalism* – was only partial. Banks succeeded in adapting to it. Hence, the destabilising pressures identified in the FIH were simply unburdened in a different business area.

As we have already said, the financialised US economy was characterised by the following sectorial dynamics: firms increasingly focusing on financial (speculative) rather than entrepreneurial activities and using financial markets rather than banks as their main source of finance; banks reverting to new businesses; workers with reduced wages reverting to financial markets to obtain money for consumption. The FIH took place during this stage. Banks focused their profit-seeking efforts in real estate and securitisation. The latter allowed the spread of the *lender's risk* of the growing credit granted to households which assumed increasingly financially fragile (speculative and Ponzi in the words of Minsky) positions.

The rise in the price of assets described by the CMI and in particular the housing bubble played a twofold role in this dynamic. On the one hand, it backed the dramatic growth in household debt, allowed also by the loose regulation on the credit market. On the other hand, it represented the expected capital gains which motivated households to ask for further credit (and which substitute the expected flow of profits of the original investment theory of Minsky). This self-enforcing dynamic continued up to the point at which it became unsustainable. Recalling Minsky, households moved from hedge to speculative and finally to a Ponzi position. People started defaulting on their mortgages, the bubble burst and the crisis spread all over the economy (and all over the world) because of the intercorrelation between balance sheets, which was particularly elevated due the securitisation of credit.

2 FROM THEORIES TO MATRICES AND EQUATIONS

This model aims to represent the aforementioned theoretical analysis, in order to obtain a neat understanding of the causal links involved, rather than to reproduce a specific economic event in detail. Therefore, we tried to eliminate all the elements not directly taking part in the dynamics depicted in Section 1. The major simplifying assumptions refer to the sectors and to the assets. First, we model a closed economy with no government sector nor central banks. Second, we assume a pure credit economy, where deposits are the most liquid assets. Third, the number of houses is taken as given (this choice is further explained in Section 2.2.5).

Exposing the model, we follow the functional ordering of its components. First, we introduce the matrices, representing the accounting framework of the economy. This, besides providing a rapid but clear overview of our hypothetical economy, allows us to highlight the main hypotheses of its structural composition. Second, we present the behavioural equations, which reproduce the main theoretical assumptions of the model.

Each of the two components contains aspects of novelty, which we believe represents an evolution, albeit a small one, for this class of model. These new features slightly increase the complexity of the model but are drawn upon the formalisation of the stylised facts described in Section 1. First, the matrices include an intra-sectoral dynamic in the firm sector. This is due to the assumption that firms, as an aggregated sector, purchase part of the equity they issue. Second, the Tobinesque portfolio approach, usually applied exclusively to the household sector (or sectors, if households are divided for example between workers and rentiers) is applied to the firms. This, as will be shown more in detail

in the presentation of the equations, led to the development of an original approach to the investment decisions of firms, which we believe is in line with the broad literature covering financialisation and in particular the analysis of Toporowski (as well as with an interpretation of Minsky, centred around ch. 17 of Keynes 1936).

2.1 Matrices

In order to be able to assess for the role of income distribution, households have been split between Workers and Rentiers, which together with Banks and Firms, form the four sectors of our economy. As shown in the *aggregate balance sheet* (Table 1), workers' wealth consists of houses and deposits minus the stock of debt they obtain to finance consumption. Rentiers can hold their wealth either in deposits, houses or equities. The firm sector includes an intra-sector dynamic, as already explained. This is represented in the equities row, which shows that the amount of equity, representing the liability of firms, is diminished by the value of the equities held within the sector. Loans to banks are the other liability of the sector, while deposits and real capital, together with equities, are the assets. The deposits and the loans of the first two sectors are, respectively, banks' liabilities and assets.

In Table 2, we can see the *transaction flow matrix* of the economy. Workers' income comprises wages and interest payments. The difference between these sources of income and the consumption decision gives the savings of the sector. Rentiers' income is composed of dividends, banks' profits and interest payments, and their expenditures consist of consumption. Firms produce consumption and investment goods, sold to households and firms respectively. Next to this entrepreneurial income, they receive interest on deposits and pay interest on loans. A fraction of profits is retained, while the rest is distributed either to households or within the firm sector. The result of this latter internal dynamic is more easily understandable considering the capital column of the sector. The outflow of money represented by firms' dividends is partially kept within the sector according to the proportion of equities held by firms. The latter, together with retained earnings, will represent the internal source of finance used for the portfolio choices, shown in Table 2. Finally, banks distribute all their profits to households.

The second part of Table 2 consists of the flow of funds. It is important to note that only the variation in the quantities of assets held is presented and not the variation in price of that asset (that is, $p_b \cdot \Delta H_b$ rather than $\Delta(p_b \cdot H_b)$). The effect on wealth due to a capital gain or loss is accounted for in the 'net worth' line, which is made explicit in the behavioural equation we present later on. Given the assumption that the number of houses is constant and not sold from one sector to the other, we see that all savings from households

Table 1 *Aggregate balance sheet*

	Workers	Rentiers	Firms	Banks	Σ
Deposits	$+D_b$	$+D_r$	$+D_f$	$-D$	0
Loans	$-L_b$		$-L_f$	$+L$	0
Capital			$+K$		$+K$
Houses	$+p_b \cdot H_b$	$+p_b \cdot H_r$			$+p_b \cdot H$
Equities		$+p_e \cdot E_r$	$-p_e \cdot E^s + (p_e \cdot E_f)$		0
Net worth	V_b	V_r	V_f	V_b	V

Table 2 Transaction flow matrix

	Workers	Rentiers	Firms		Banks	Σ
			Current	Capital		
Consumption	$-C_b$	$-C_r$	$+C$			0
Investment			$+I_K$	$-I_K$		0
Wages	$+W$		$-W$			0
Int. deposits	$+i_d \cdot D_{b,-1}$	$+i_d \cdot D_{r,-1}$	$+i_d \cdot D_{f,-1}$		$-i_d \cdot D_{-1}$	0
Int. loans	$-i_l \cdot L_{b,-1}$		$-i_l \cdot L_{f,-1}$		$+i_l \cdot L_{-1}$	0
Div. firms		$+Fd_b$	$-Fd$	$+Fd_f$		0
Div. banks		$+F_b$			$-F_b$	0
Ret. earnings			$-Fu$	$+Fu$		0
Σ	Sav_b	Sav_r	0	$-I + Fu + Fd_f$	0	0
Δ Deposits	$-\Delta D_b$	$-\Delta D_r$		$-\Delta D_f$	$+\Delta D$	0
Δ Loans	$+\Delta L_b$			$+\Delta L_f$	$-\Delta L$	0
Δ Capital				$-\Delta K$		$-\Delta K$
Δ Houses	$p_b \cdot \Delta H_b$	$p_b \cdot \Delta H_r$				0
Δ Equities		$-p_e \cdot \Delta E_r$		$+p_e \cdot (\Delta E - \Delta E_f)$		0
Total	0	0	0	0	0	0
Δ Net worth	ΔV_b	ΔV_r	0	ΔV_f	ΔV_b	0

end up in deposit accounts. The savings of rentiers are allocated between houses, equities and deposits. The flows of the firm sector are once again characterised by the aforementioned internal dynamics, as part of the newly issued equities are bought by firms. Firms can use their inflows, deriving from retained earnings, loans and newly issued equities, either for financial (deposits and equities) or real investment (capital stocks). The banks' flow of funds is straightforward: the increase in loans is balanced by the increase in deposits.

2.2 Behavioural equations

2.2.1 Firms

As mentioned before, firms produce consumption and capital goods. We assume firms produce goods on demand, allowing us to avoid the trouble of accounting for goods inventories. Equations (1) to (5) are rather standard. Total nominal output (Y) is given by consumption (C_b and C_r) and investment in real capital (I_K). Note that we assume the price of goods to be normalised to 1, so that all other prices are relative to the consumption good price. The profits net of interest payments (F_n) that firms make are either retained (F_u), or distributed (F_d), according to the exogenous parameter μ .

$$Y = C_b + C_r + I_K \quad (1)$$

$$F = Y - WB \quad (2)$$

$$F_n = F - i_l \cdot L_{f,-1} + i_d \cdot D_{f,-1} \quad (3)$$

$$F_d = \mu \cdot F_n \quad (4)$$

$$F_u = (1 - \mu) \cdot F_n \quad (5)$$

The main aspect of originality of our model lies in the way firms decide to grow. This process consists of three steps. First, firms choose by how much they desire their assets to grow (g_a , equation (6)), depending on the expected² rate of return³ of total assets (r_a^e). They then determine the corresponding amount of investment in all assets (I_A , which also depends of the depreciation of real capital D_K) and the expected level of total assets (A_f^e , equation (8)).

$$g_a = \gamma_0 + \gamma_1 \cdot r_a^e \quad (6)$$

$$I_A = A_{f,-1} \cdot g_a + D_K \quad (7)$$

$$A_f^e = A_{f,-1} \cdot (1 + g_a) \quad (8)$$

$$r_a = \frac{Fu + Fd_f + \chi \cdot CG_{f,e}}{A_{f,-1}} \quad (9)$$

$$CG_{f,e} = \Delta p_e \cdot E_{f,-1} \quad (10)$$

As, following Minsky, every investment decision implies a financing decision,⁴ or, as Minsky (1986: 192) puts it, ‘A decision to invest . . . is always a decision about a liability structure’, the second step of the firms’ growth decision is represented by the distinction of the source of finance. The value of planned total investment not covered by internal finance (F_I , composed of retained earnings and dividends distributed by firms to firms $F_{d,f}$), is covered in part by new loans and in part by the emission of new equities (respectively, ΔL_f and ΔE^s). The number of issued equities depends on the expected price of equity (p_e^e) and on a share ξ of the expected need of external finance ($I_A - F_I^e$). Loans are the buffer stock of liabilities and are determined by the realisation of expected values.⁵

$$F_I = F_u + F_{d,f} \quad (11)$$

$$\Delta E^s = \frac{\xi \cdot (I_A - F_I^e)}{p_e^e} \quad (12)$$

$$\Delta L_f = I_A - F_I - p_e \cdot \Delta E^s \quad (13)$$

2. The formation of expectations will be treated in detail in Section 2.2.

3. Capital gains are accounted for in the computation of the return rate but discounted by a factor $\chi < 1$.

4. This might appear obvious, however the identification and impact of the source of finance is usually overlooked by the models accepting the Modigliani–Miller Theorem.

5. Following Foley (1975) and many PK-SFC authors, the level of financial stocks held or owed might not be equal to their desired level, due to discrepancies between expectations and realisation. We thus need one asset that will absorb the difference between the aggregate level and the aggregate desired level.

The third step of the growth decision process represents a further contribution of our model. Firms use a Tobinesque portfolio choice (see Brainard/Tobin 1968) to distribute their expected level of assets (A_f^e) between real capital (K^d), equities ($p_e \cdot E_f^d$), and deposits (D_f^d), depending on the rate of returns⁶ of each asset.⁷ Deposits work as buffer stocks (equation (24)).

$$[D_f^d = (\gamma_{1,0} + \gamma_{1,1} \cdot i_d - \gamma_{1,2} \cdot r_e^e - \gamma_{1,3} r_k^e) \cdot A_f^e]$$

$$p_e \cdot E_f^d = (\gamma_{2,0} - \gamma_{2,1} \cdot i_d + \gamma_{2,2} \cdot r_e^e - \gamma_{2,3} r_k^e) \cdot A_f^e \quad (14)$$

$$K^d = (\gamma_{3,0} - \gamma_{3,1} \cdot i_d - \gamma_{3,2} \cdot r_e^e + \gamma_{3,3} r_k^e) \cdot A_f^e \quad (15)$$

$$A_f = A_{f,-1} + F_I + \Delta L_f + p_e \cdot \Delta E^s + CG_f - DK \quad (16)$$

$$D_f = A_f - K - p_e \cdot E_f \quad (17)$$

$$r_e = \frac{F_{d,f} + \chi \cdot CG_{f,e}}{E_{f,-1} p_{e,-1}} \quad (18)$$

$$r_k = \frac{F}{K_{-1}} \quad (19)$$

It is important to note that the demanded amount of each of the two assets does not necessarily correspond to the stocks held (K and $p_e \cdot E_f$), as firms have to respect two constraints. On the one hand, we assume that the level of real capital cannot diminish faster than its depreciation rate. This assumption is motivated by the structure of the economy, where all sales within the sector would not change the aggregate level. On the other hand, firms face a budget constraint, which ensures that the sum of the assets demanded does not surpass its financial wealth.

$$K = \max[(1 - \delta) \cdot K_{-1}, K^d] \quad (20)$$

$$p_e \cdot E_f = \min[A_f^e - K, p_e \cdot E_f^d] \quad (21)$$

$$I_K = K - K_{-1} + DK \quad (22)$$

$$A_f = A_{f,-1} + F_I + \Delta L_f + p_e \cdot \Delta E^s + CG_f - DK \quad (23)$$

$$D_f = A_f - K - p_e \cdot E_f - p_h \cdot H_u \quad (24)$$

We are aware that the application of the Tobinesque approach of portfolio choice to the investment decisions of firms is unusual and that several authors proposed valid

6. As the profit share is fixed, equation (19) can be seen as a proxy of capacity utilisation, which therefore becomes one of the determinants of investment decision. The endogenisation of the profit share is an interesting line of development of the model, but at the current stage it is beyond its scope.

7. The parameters $\gamma_{i,j}$ of the portfolio equation obey the required constraint: according to *adding up constraint* $\gamma_{1,0} + \gamma_{2,0} = 0$, while following the *symmetry constraint*, $\gamma_{1,2} = \gamma_{2,1}$.

investment functions to capture the spirit of the FIH (see, among others, Fazzari et al. 2001; Dos Santos 2005). However, our choice is grounded on the belief that this approach captures significant aspects of ch. 17 of Keynes (1936), in which Keynes presents his theory of asset value and asset choice, stressing the role of liquidity preference (see Macedo e Silva 2008). That chapter is central in the interpretation of Keynes developed by Minsky, as Minsky considered that in it were hidden some of the most powerful ideas of Keynes's *General Theory*.⁸ The competition between real and speculative investment in a portfolio choice is the cornerstone of Minsky's 'investment theory of business cycles and a financial theory of investment' (Friedman/Laibson 1989: 175). Indeed, in the *financial Keynesianism* of Minsky, portfolio choices have a direct effect on the determination of investment: 'The scale of investment will fluctuate for "reasons quite distinct" [which] revolve around portfolio preferences, financing conditions, and uncertainty' (Minsky 1975: 66, his quotation marks).

Furthermore, this Tobinesque approach allows us to embody a further element of Minsky's analysis linked to financing decisions, which is usually overlooked by the Formal Minskyian Literature,⁹ whereas it is central in the evolution of a 'Minskyan crisis', namely capital asset deflation: 'To finance investment in excess of I_I (internal [funds]) it is necessary either to run down holdings of financial assets that are superfluous to operations or to engage in external finance' (Minsky 1986: 213). This source of finance, which is at the core of the (Fisherian) capital assets deflation typical of a Minskyan crisis, is represented in our model by the possibility of allocating the (planned) financial wealth among assets, and to diminish the amount of a specific asset, held by firms (still respecting budget constraints).

However, there is still an apparent mismatch between our equation and Minsky's explanation of the business cycle. Indeed, in his analysis, the liquidity preferences of the banking sector played a key role (see Minsky 1980: 507) which is not accounted for in our model. Our choice finds explanation in the financialisation literature presented in Section 1. In particular, as shown by Toporowski's CMI, the inflation of the financial markets represents a source of finance for firms that do not need to revert to banks as a source of external finance. More generally, we believe that the broad literature on financialisation showed how the distinction between financial and non-financial firms is becoming increasingly ephemeral (at least for corporations). As shown by Orhangazi (2008), the percentage of financial assets over tangible assets in the balance sheets of the non-financial corporate sector rose from around 30 per cent in 1953 to around 110 per cent in 2003. It seems natural, therefore, to apply the portfolio approach to the decision process of firms.

2.2.2 Worker households

As we have assumed that the price of consumption and capital goods is normalised to one, we can define the wage bill as a function of the total output and the profit share (π). Workers consume a fixed share of their expected income (Y_b^e) and their consumption depends also positively on the net wealth of the previous period, on the expectation of increases in loans and on an imitation effect of rentiers' consumption.¹⁰

$$C_b = \alpha_{b,1} \cdot Y_b^e + \alpha_{b,2} \cdot NV_{b,-1} + \alpha_{b,3} \cdot \Delta L_b^e + \alpha_{b,4} \cdot C_{r,-1} \quad (25)$$

8. In the words of Minsky (1975: 76): 'In order to bring out the power of the ideas involved, we will undertake to adjust the argument of chapter 17'.

9. Definition taken from Dos Santos (2005).

10. For more details regarding these two last points, see Christen/Morgan (2005).

$$Y_b = WB + i_d \cdot D_{b,-1} - i_l \cdot L_{b,-1} \quad (26)$$

$$WB = Y \cdot (1 - \pi) \quad (27)$$

Households' flow of loans is assumed to be determined by the supply decision of banks. We are aware that this is a strong assumption. The idea we want to capture is that households' demand for loans is elastic and its realisation is ultimately determined by banks, which decide their level of exposure and thus determine the amount of credit they provide. This is meant to capture the banking *endogenous destabilising* behaviour, analysed in Section 1. No distinction is made between different kinds of loan, not only for the sake of clarity, but also considering the widespread habit in the US economy of refinancing mortgages for consumption purposes in the years before the crisis. The net worth in equation (31) gives us the difference between the stock of assets and liabilities held by the workers.

$$\text{Sav}_b = Y_b - C_b \quad (28)$$

$$D_b = D_{b,-1} + \text{Sav}_b + \Delta L_b \quad (29)$$

$$V_b = D_b + p_b \cdot H_b \quad (30)$$

$$NV_b = V_b - L_b \quad (31)$$

2.2.3 Rentier households

Rentier households follow the same behaviour as workers. Their income is composed of dividends distributed by firms ($F_{d,r}$), interest on deposits and banks' profits (F_b). They do not get indebted and their consumption depends on income and previous wealth ($V_{r,-1}$). As we have already said, households are assumed to allocate their expected financial wealth (V_r^e) among houses, equities and deposits (which once more are used as the buffer stock). The Tobinesque portfolio choice for the households is symmetric to the one of firms, except for the real assets (that is, real capital vs houses). Hence the constraints over the depreciation of real capital are absent.¹¹

$$C_r = \alpha_{r,1} \cdot Y_r^e + \alpha_{r,2} \cdot V_{r,-1} \quad (32)$$

$$[V_r = D_r + p_e \cdot E_r + p_h \cdot H_r]$$

$$V_r^e = V_{r,-1} + \text{Sav}_r^e + CG_{r,b}^e + CG_{r,e}^e \quad (33)$$

$$\text{Sav}_r^e = Y_r^e - C_r \quad (34)$$

$$[D_r^d = (\lambda_{1,0} + \lambda_{1,1} \cdot i_d - \lambda_{1,2} \cdot r_b^e - \lambda_{1,3} \cdot r_e^e) \cdot V_r^e]$$

11. It might be important to notice that equation (41) (just as equation (23) for firms) uses a different specification for total wealth than the one used in equation (30). The two specifications are equivalent, but we believe that the former is more intuitive if linked to the Tobinesque portfolio approach.

$$p_b \cdot H_r = (\lambda_{2,0} - \lambda_{2,1} \cdot i_d + \lambda_{2,2} \cdot r_b^e - \lambda_{2,3} \cdot r_e^e) \cdot V_r^e \quad (35)$$

$$p_e \cdot E_r = (\lambda_{3,0} - \lambda_{3,1} \cdot i_d - \lambda_{3,2} \cdot r_b^e + \lambda_{3,3} \cdot r_e^e) \cdot V_r^e \quad (36)$$

$$r_b = \frac{\chi \cdot C G_{r,b}}{p_{b,-1} \cdot H_{r,-1}} \quad (37)$$

$$Y_r = F_{d,r} + F_b + i_d \cdot D_{r,-1} \quad (38)$$

$$F_{d,r} = \frac{E_{r,-1}}{E_{-1}^s} \cdot F_d \quad (39)$$

$$\text{Sav}_r = Y_r - C_r \quad (40)$$

$$V_r = V_{r,-1} + \text{Sav}_r + C G_r \quad (41)$$

$$C G_r = C G_{r,b} + C G_{r,e} \quad (42)$$

$$C G_{r,b} = \Delta p_b \cdot H_{r,-1} \quad (43)$$

$$C G_{r,e} = \Delta p_e \cdot E_{r,-1} \quad (44)$$

$$D_r = V_r - p_b \cdot H_r - p_e \cdot E_r \quad (45)$$

2.2.4 Banks

Coherently with our theoretical analysis, banks play an active role in their relation with households. While granting the required credit to firms (L_f), they determine the level of loans to workers' households (L_b) according to two leverage ratios: lev_b – the leverage ratio of households – which is equal to workers' loans over the sum of deposits and the nominal value of houses owned by workers; and lev_t – the leverage ratio of the whole economy – which is equal to total loans (that is, the sum of firms' and workers' outstanding debt) over total assets (that is, the sum of all the assets owned by both types of households and firms). The interest rate on loans is determined as a mark-up on the interest rate paid on deposits.

$$\begin{aligned} \Delta L_b &= \tau_1 \cdot (\text{lev}_b^T - \text{lev}_{b,-1}) \cdot V_{b,-1} \dots \\ &\dots + \tau_2 \cdot (\text{lev}_t^T - \text{lev}_{t,-1}) \cdot (V_{b,-1} + V_{r,-1} + A_{f,-1}) \end{aligned} \quad (46)$$

$$\text{lev}_b = \frac{L_b}{V_b} \quad (47)$$

$$\text{lev}_t = \frac{L}{V_b + V_r + A_f} \quad (48)$$

$$i_l = i_d \cdot (1 + \sigma) \quad (49)$$

Ultimately, banks' profits (F_b) are determined by both the interest-rate differential (assumed as exogenous) and by the amount of loans and deposits. Banks expand their loans to households in order to reach their targeted leverage levels (lev_b^T and lev_t^T), which we assume to be constant. This formulation comprises two concepts. First, banks play an active role and target a sufficient level of profits. Thus any decrease (increase) in credit asked by firms might be compensated by an increase (decrease) in credit offered to households, leading to a stable aggregated level of loans. Second, by providing loans to workers when their assets gain in value, banks allow these workers to realise part of their capital gains. This is a further element of the model, representing the destabilising forces identified in the theoretical analysis of the paper.

$$D = D_b + D_r + D_f \quad (50)$$

$$L = L_f + L_b \quad (51)$$

$$F_b = i_l \cdot L_{-1} - i_d \cdot D_{-1} \quad (52)$$

2.2.5 Housing market

We assume a constant number of houses in each sector. The price of houses is determined by the portfolio equation of rentiers and is then reflected on the wealth of workers. This (strong) assumption allows us to avoid the complication of having a complete housing market as described in Zezza (2008). We do this for two reasons. First, we are interested in the wealth effect that households observe when the price of houses peaks due to speculative motives. It is true that this speculation on houses also had a role in the real economy by spurring house production. However, this process is only temporary, as houses are typical durable goods and thus there exists a threshold level of houses above which no one wants one more. The real effect of house speculation is thus limited in time and would thus not change our results significantly. Second, we are analysing the transition phase of the economy, responding to structural changes, and not the growth process of that economy. We have thus assumed population and productivity to be constant; the housing market described in Zezza (2008), on the other hand, is based on the assumption of a growing economy. Adapting this formulation to a stationary economy would add complexity to our model without bringing much to the results.

2.2.6 Expectations

Unless specified otherwise, expectations are built as the weighted sum of an average based on the previous four observations and of a correction mechanism linked to the gap between the expected and realised values of the previous period: $X^e = \bar{X} + v \cdot (X_{-1}^e - X_{-1})$.

3 RESULTS

To analyse the functioning of our models, we rely on simulations. The methodology we follow is in line with the PK-SFC literature. First, a stationary state is identified, then the system is 'shocked' through exogenous parametrical changes. The aim of the simulation is to assess the effects of the processes analysed in Section 1. To obtain a clearer depiction of

the causal links, we follow a gradual approach: the key variables of our analysis are left equal to zero or at their stationary state values and are then activated or shocked, at first one at the time and then jointly. This methodology allows us to highlight the causal nexus and the reciprocal interactions among variables.¹²

Three sets of variables are central in our analysis. First, $\gamma_{3,0}$ and $\gamma_{2,0}$ – respectively the preference for real and financial capital in the firms’ portfolio choice – which are left at their steady-state values. The increase of $\gamma_{2,0}$ with a corresponding decrease of $\gamma_{4,0}$ constitutes, in our model, the tendency of firms to invest increasingly in financial assets to the detriment of fixed capital, as described in Toporowski’s CMI. Second, τ_1 and τ_2 represent the active role of banks pursuing their leverage targets, leading the Minskian dynamic at the core of our interpretation of the crisis. Third, α_3 and α_4 , which in the workers’ class consumption equation represent respectively the propensity to consume out of the expected inflow of credit and the tendency to imitate the consumption behaviour of the rentiers. The simulations, performed on these variables, allow us to show the role played by each of the aforementioned phenomena (financialisation, indebted consumers and active banks) in driving the US economy towards an unsustainable path.

The financialisation process on its own (scenario *Financialisation*, shown in Figure 4) leads to a dynamic in which the financial and the real side of the economy interact significantly, alternating the leading role until the real side becomes completely subordinated to the financial sector. The starting point is the switch in firms’ portfolio preferences in favour of financial assets, which causes an inflation in the price of equities. This leads to a fall in the investment level, as we can see in Figure 4(a), whose negative effects on GDP are only slightly counterbalanced by the increase in consumption of rentiers, due to the wealth effect deriving from the capital gains from the price of equities. After the initial fall, real investment increases, owing to the increase in the wealth of firms allocated on different assets, through their portfolio choice. However, the weakening of the real sector determines a fall in the income level which, in the absence of consumption credit (as τ_1 and τ_2 are set to zero), leads to a plunge in the level of consumption and a resulting contraction of real investment. GDP therefore plunges. On the financial side, the firms sector sees its position becoming more solid due to the inflation of its financial assets, while households, albeit not increasing their stock of debt, experience a rise in their leverage (see Figure 4(b)), owing to a depreciation of their real assets. Indeed the price of houses falls, after an initial rise determined by the wealth effect on rentiers’ stock of equities.

We run two scenarios adding to the baseline the ‘active banks’ parameters (τ_1 and τ_2). However, the results do not change significantly from the previous simulation (except for a steeper increase in the leverage of households) owing to the absence of a channel of transmission between the increase in credit to households and the real economy. We thus do not show any of these results.

As becomes clear from looking at the results of simulation *Keeping Up Consumption*¹³ (Figure 4(c)), the transmission channel is represented by the increase in household consumption determined by variables α_3 and α_4 . Indeed, when activating these parameters, the dynamics change dramatically, even without the banks side of our story. As we can see from the Figure 4(c), the outcome in this case is a bubble. In the first stages, the dynamic

12. Only the most interesting results are reported in this paper. For the complete simulation results and the source code, contact the authors.

13. The name of this scenario is inspired by the idiomatic expression ‘Keeping up with the Joneses’ used by Christen/Morgan (2005).

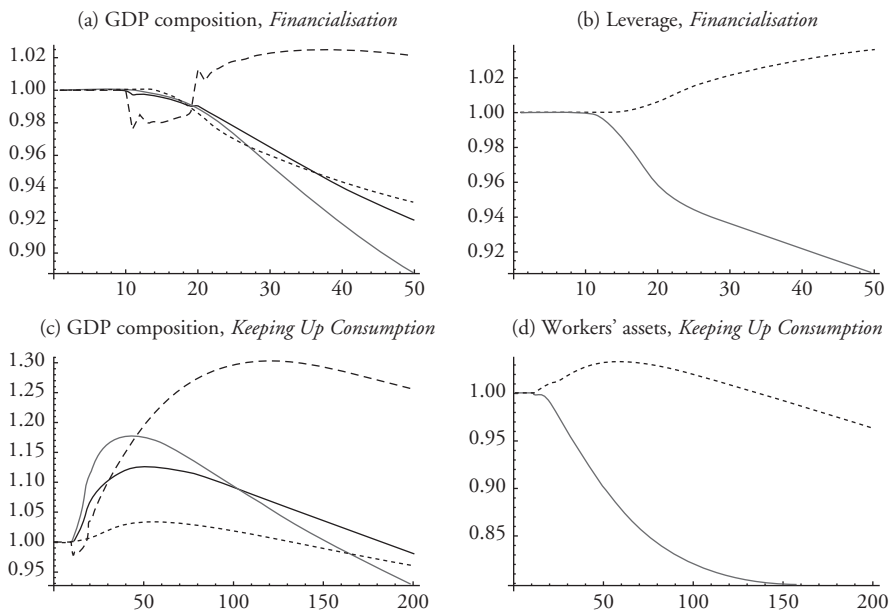


Figure 4 GDP composition: GDP (black solid), investments (black dashed), workers' consumption (grey solid), and rentiers' consumption (grey dashed). Leverage: firms (solid), households (dashed). Workers' assets: deposits (solid), houses (dashed)

is similar to the previous ones, but accentuated. Once again, the shift in preferences determines a fall in investment while rentiers' consumption increases owing to the wealth effects determined by stock market inflation. However, this time, due to the imitating behaviour of the workers (determined by α_4), the increase in consumption offsets more than the initial fall in investment, leading to a rise in GDP. This leads firms to increase real investment, which starts increasing steeply.

The boom in the real side of the economy determines a rise of income, which in turn nourishes the asset bubble, causing generalised asset inflation and an initial decrease of leverage. While for firms the improvement in financial stability is lasting, this is not the case for households, which, by consuming more than they can afford, see their deposits decreasing (Figure 4(d)), determining a steep increase in their leverage and a deterioration of their net wealth. This is the turning point in this scenario, because when the fall in net wealth (owing to the fall of deposits) drags down consumption, the boom comes to an end and the debt burden becomes unsustainable. Income falls, and so does the price of houses, further squeezing consumption. As consumption is the main component of GDP, it falls dramatically, leading the economy into recession. Investment takes longer to fall since consumption is still higher than at the steady state, but it eventually starts decreasing following the economic downturn.

The dynamics, both in its booming and bust phases, becomes steeper when banks pursue a target leverage with respect to households and to the whole economy (that is, the activation of τ_1 and τ_2). The results in this case are almost identical to those obtained in the previous simulation. The increased credit to households fuels the dynamic, causing an anticipated bursting of a bigger bubble.

The most intriguing results are probably obtained when banks focus their profit-seeking efforts exclusively onto the household sector (which in our model is represented by a positive τ_1 and a τ_2 equal to zero, scenario *Active Banking Consumed*, Figure 5). Once again, the shock on firms' portfolio preferences is followed by a fall in real investment, which is more than offset by the consumption boom determined by the wealth effect (as in scenario *Keeping Up Consumption*) and by the skyrocketing loans to households. On the real side of the economy, the rise in credit nourishes the consumption boom which drives the growth of investment, hence also of GDP (see Figure 5(a)) and consequently income. An interesting outcome of this scenario is the rise in rentiers' consumption, which in relative terms experiences the higher and steeper growth among the components of GDP. This is mainly driven by the dividends they receive from firms and banks, once again determined by the dramatic increase in working households' indebtedness for consumption. Investment also takes part in these dynamics as firms experience high returns on the real assets.

On the financial side, we observe a generalised asset inflation (in line with the analysis of Toporowski), which allows firms to decrease their leverage and their recourse to external funding (see Figure 5(b)). The boom continues until the credit by banks stabilises. As in a Ponzi scheme, when the inflow of money ceases, the burden of debt becomes unsustainable and the bubble bursts. Workers' consumption falls, owing to an increasing debt burden, dragging down income and thus activating a downward spiral. The recession spreads to all sectors of the economy, pulling down first rentiers' consumption, then house prices and, once again in a later stage, investment. It is important to note that due to the inflation in the price of equity, the financial stability of the firms' sector is practically untouched by the crisis.

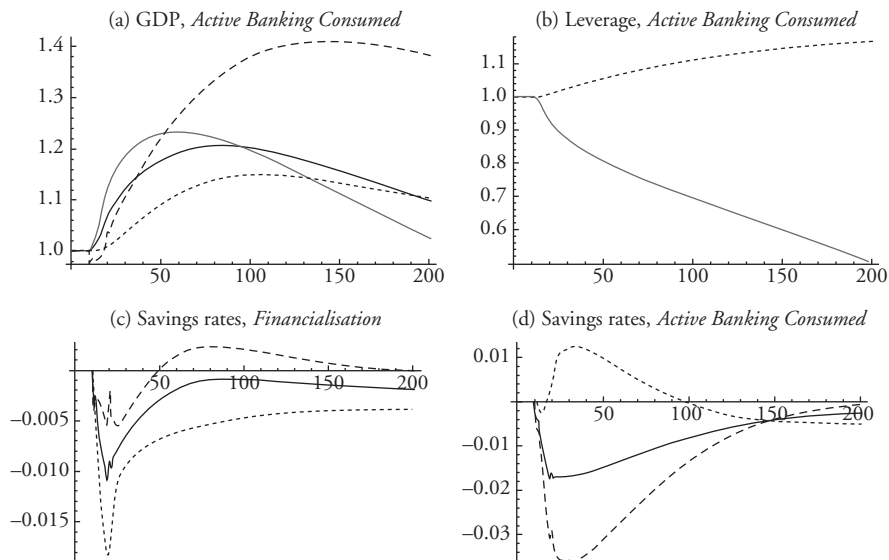


Figure 5 GDP composition: GDP (black solid), investments (black dashed), workers' consumption (grey solid), and rentiers' consumption (grey dashed). Leverage: firms (solid), workers (dashed). Saving rates: Aggregate (solid), workers (dashed), rentiers (dotted)

A different way to analyse the various scenarios is to look at the evolution of the saving rates of the different households groups. The initial shock hits investment, and, depending on how consumption evolves, the economy might fall directly into recession or only after a first bubble. In the *Financialisation* scenario, the increase in wealth due to the increase in equity price induces the rentier to spend more and thus implies a reduction in their saving rate (see Figure 5(c)). The same wealth effect through the housing market impacts workers' but in a much smaller way. Owing to the relative size of each household group, the impact on the aggregate is also relatively mild. On the other hand, in the *Active Banking Consumed* scenario, there are three effects impacting the consumption (and thus the saving decisions) of workers: the aforementioned wealth effect, the emulation effect and the increase-in-credit effect. This leads to a drastic reduction in workers' saving rate (see Figure 5(d)). By contrast, the saving rate of the rentier actually increases after a first decline. This is due to the increase in rentiers' income via dividends and the implicit transfer from workers to rentiers due to credit. The reduction of savings from workers more than compensates the increase in savings from rentiers and leads to an important reduction of the aggregate saving rate at first.

To sum up, the simulations highlight interesting dynamics emerging in the model by the interaction between the financial and the real market. Financialisation appears to weaken the economy. However, when coupled with a channel of transmission from the financial to the real side of the economy (that is, consumption credit), it can lead to an initial phase of boom. The growth fuelled by debt is unsustainable and soon the bubble bursts. This highlights the notion that credit is good for the economy but debt is bad. Indeed, while growth is fuelled by credit, the stock of debt accumulates, leading to an increase of what Palley (2008) calls the debt footprint.

4 CONCLUSION

The ultimate goal of this paper was to develop a structural explanation for the 2007 sub-prime mortgage crisis. In order to do so, we developed a theoretical analysis based on the work of Hyman P. Minsky and Jan Toporowski. The paper enters the debate about the coherence between the analysis of Minsky and the recent crisis. Our idea is that the endogenous forces leading the economy from stability to instability – as described by Minsky – can also be identified in the sub-prime crisis, if the attention is shifted from the role of firms to that of banks, which we consider as 'the endogenous destabilizer' of the FIH. This idea finds its roots in the analysis of Toporowski, who underlines how the new peculiarities of the financial system led banks to shift their core business away from investment financing.

Our theoretical analysis was then reproduced through a post-Keynesian stock-flow consistent model, which embodies important aspects of novelty. First, an intra-sectoral dynamic in the firms sector was made explicit. Firms are indeed at the same time the issuer and one of the purchasers of equities. Second, the Tobinesque portfolio choice approach was applied also to the firms sector, allowing us to capture important elements of our theoretical analysis, as well as of the broad financialisation literature.

Finally, we ran several simulations to investigate the behaviour of the model. The simulations allowed us to analyse further the role of the three dynamics, which according to our analysis were at the core of the crisis, namely financialisation, income distribution and indebted consumers, and active banks. What emerged from our model was that financialisation plays a depressive role on the economy which can be counterbalanced if there is a channel to realise capital gains. However, if the channel is households' debt not associated with an increase in their income (as it was in the US), the dynamic is unsustainable. Further interesting results

are obtained with regard to the interaction between the real and the financial side of the economy, as it leads in most cases to self-reinforcing (but unsustainable) dynamics.

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