National and Kapodistrian University of Athens

Essays on Financial Fragility, Instability and the Macroeconomy

Maria Nikolaidi

Ph.D. thesis

May 2014

European Union
European Social Fund

OPERATIONAL PROGRAMME
EDUCATION AND LIFELONG LEARNING
investing in knowledge society
MINISTRY OF EDUCATION & RELIGIOUS AFFAIRS, CULTURE & SPORTS
MANAGING AUTHORITY

NSRF 2007-2013
programme for development
EUROPEAN SOCIAL FUND

Co- financed by Greece and the European Union

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This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

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Acknowledgements

I would like to thank my doctoral supervisor Georgios Argitis for his generous support to my research and his highly valuable guidance and recommendations. I am also very grateful to Dimitri Papadimitriou and Stavros Thomadakis for their constructive comments and suggestions that have substantially improved this thesis. The dissertation has also benefited from discussions and comments by Yannis Dafermos, Reiner Franke, Dimitris Moschos, Soon Ryoo, Engelbert Stockhammer, Eric Tymoigne and the participants of the various conferences at which parts of the thesis have been presented. The responsibility for any remaining errors rests entirely with me. This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program 'Education and Lifelong Learning' of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund. The partial financial support from the Antonios Papadakis Endowment is also gratefully acknowledged.

Abstract

The aim of this thesis is to shed some new theoretical and empirical light on the issues of financial fragility and instability of the macroeconomic systems. The thesis consists of four independent essays. The first essay develops a macrodynamic model in which firms' and banks' desired margins of safety play a central role in macroeconomic performance. Mathematical analysis and numerical simulations illustrate that the endogeneity of the desired margins of safety during the investment cycles is conducive to instability. Moreover, it is indicated that fiscal policy can reduce the destabilising forces in the macroeconomic system. The second essay explores, via a stock-flow consistent model, the macroeconomic channels through which securitisation and wage stagnation can jointly affect financial fragility. The results from simulation experiments provide support to the view that the combination of risky financial practices and higher inequality can substantially increase the likelihood of financial instability in the macro system. The third essay proposes a new bank liquidity ratio that explicitly considers the time-varying nature of liquidity by assigning weights on banks' balance sheet items that depend on financial risks and perceptions. This ratio is estimated and assessed for the EMU-12 countries. Furthermore, the essay investigates the link between macroeconomic fragility and bank liquidity for the EMU. The empirical results suggest that banks in the EMU do not self-impose higher liquidity requirements when macroeconomic fragility increases. The fourth essay puts forward a liquidity index that extends Minsky's well-known financial taxonomy of economic units to the government sector. The index is estimated for Greece over the period 2001-2009. The data analysis supports the view that the financial fragility of the Greek government sector increased significantly before the sovereign debt crisis.

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1. Introduction

1.1 Financial fragility, instability and the macroeconomy: The relevance of Minsky's analytical framework

The financial crisis that hit the world economy in 2007-8 has brought to the fore the relevance of Minsky's (1975, 1982, 2008) concepts of financial fragility and instability in the examination of macroeconomic systems. In Minsky's theoretical analysis the complex financial arrangements in modern capitalist economies render them inherently unstable. Periods of prolonged prosperity and tranquillity increase the euphoria of economic units and can lead to growing financial fragility. This increasing financial fragility can set the stage for instability, recessions and crises.

Minsky's innovative thinking on the financial roots of crises has induced various analysts to label the recent financial distress a 'Minsky moment' (see e.g. Whalen, 2008). Although some of the causes of the 2007-8 financial crisis were not at the core of the basic theoretical exposition of Minsky (e.g. household debt, global imbalances or increasing inequality[1]), it is undoubtful that Minsky's overall conceptualisation of the interrelationship between the financial and the macroeconomic systems provides a coherent basis for the understanding of the crisis events. Furthermore, Minsky's dynamic and institutionally-specific perspective of the capitalist economies has been proved valuable for the macroeconomic analysis both in periods of prosperity and in periods of turbulence.

The economic literature that has explored and extended the Minskyan analysis is extensive. So far, attention has been paid to the more detailed development of Minsky's theoretical arguments, the modelling of certain aspects of Minsky's theoretical insights and the use of Minsky's conceptual framework in the empirical investigation of fragility and instability in modern economies. The recent crisis has enhanced the interest in Minsky's 'financial macroeconomics' and has posed new challenges to the analysis of financial fragility and instability.

[1] See, for instance, Davidson (2008A), Dymski (2010) and Palley (2010).

This thesis aims to contribute to this theoretical and empirical research. We use macroeconomic modelling to investigate, in an innovative way, the endogenous nature of firms' and banks' desired margins of safety during the investment cycle, the implications of firms' and banks' financial behaviour for macroeconomic stability, the stabilising role of fiscal policy, as well as the impact of securitisation and wage stagnation on financial fragility. Furthermore, we propose a new bank liquidity ratio that explicitly considers the time-varying nature of liquidity. We estimate this ratio for the EMU-12 countries and we investigate econometrically the link between bank liquidity and macroeconomic fragility. Lastly, we develop a liquidity index that extends Minsky's financial taxonomy of economic units to the government sector. This index is estimated for the Greek government sector.

1.2 The structure of the thesis

The thesis is structured as follows. Chapter 2 provides a literature review of the theoretical and empirical developments on financial fragility, instability and the macroeconomy. The literature covers both the Post Keynesian/Minskyan approaches and the mainstream ones.

In chapter 3 we develop a stock-flow consistent macrodynamic model in which firms' and banks' desired margins of safety play a central role in macroeconomic performance. The model incorporates an active banking sector and pays particular attention to the leverage of both firms and banks. It is shown that the endogenous change in the desired margins of safety of firms and banks is likely to transform an otherwise stable debt-burdened economy into an unstable one. The endogeneity of the margins of safety can also produce, under certain conditions, investment and leverage cycles during which investment and leverage move both in the same and in the opposite direction. The chapter also investigates the potential stabilising role of fiscal policy. It is indicated that fiscal policy can reduce the destabilising forces in the macroeconomic system when government expenditures adjust adequately to variations in the divergence between the actual and the desired margins of safety.

In chapter 4 we put forward a stock-flow consistent model that allows the investigation of the macroeconomic channels through which securitisation and income inequality can jointly affect financial fragility. Particular attention is paid to their role in supporting a borrowing-induced expansion, a housing boom and an appreciation in MBSs prices that are of temporary nature. The results from simulation experiments provide support to the view that the combination of risky financial practices and higher inequality can substantially increase the likelihood of financial instability in a macro system.

In chapter 5 we investigate two issues that have not been addressed in Basel III and which are of particular importance for the attainment of a more effective liquidity regulation. The first is the need for a dynamic definition of liquidity that takes into account the time-varying liquidity and stability of banks' balance sheet items. The essay develops a new liquidity ratio that explicitly considers this changing nature of liquidity, by assigning weights that depend on financial risks and perceptions. The ratio is estimated and assessed for the EMU-12 countries. The second issue is the need for macro fragility-related liquidity requirements. We provide empirical evidence which suggests that the banking sector does not self-impose such requirements. Based on this evidence, it is argued that the regulatory agents should introduce a positive link between bank liquidity and macroeconomic fragility.

In chapter 6 we develop a liquidity index that extends Minsky's well-known financial taxonomy to the government sector. This index is applied to Greece for the period 2001-2009. It is shown that the Greek government sector was Ponzi in the years 2001-2002 and ultra-Ponzi thereafter. Moreover, the data indicate that the proposed index deteriorated substantially since 2006 revealing the growing fragility of the public sector in the years before the onset of the sovereign debt crisis. It is argued that this deterioration of the index is among the factors that contributed to the financial instability that the Greek economy has been experiencing over the last years.

In chapter 7 we present the key findings of our thesis. In addition, we outline some directions for future research.

2. Financial fragility, instability and the macroeconomy: A review of the literature

2.1 Introduction

The notions of financial fragility and instability have been at the core of Post Keynesian macroeconomics since the 1980s when Minsky's 'financial instability hypothesis' began to gain popularity among the scholars of this school of macroeconomic thought. Since then, many theoretical and empirical developments within the Post Keynesian framework have enhanced our understating of the complex links between the financial and the real spheres of the economy and the conditions under which financial fragility and instability are likely to emerge. Contrariwise, in the mainstream macroeconomic literature the notions of financial fragility and instability had received only limited attention till the emergence of the recent financial crisis. This is not accidental. In the dominant macroeconomic paradigm the financial factors play no significant role in the determination of macroeconomic performance (especially in the long run); hence, the financial structures of economic units are not important for the basic macroeconomic analysis. Moreover, in this paradigm the dominant view is that the capitalist economies are inherently stable. The case of instability is considered a scarce event that can largely emerge as a result of extreme exogenous shocks.

The recent crisis has posed a significant challenge to the prevailing macroeconomic paradigm. The crisis has indicated that finance, fragility and instability are important missing elements in the conceptual framework of mainstream macroeconomics. Having been motivated by the crisis events, many scholars have attempted to extend this conceptual framework by introducing financial factors in the baseline analysis. However, the issues of financial fragility and instability have not yet been explored sufficiently within the mainstream macroeconomic paradigm. Moreover, when these issues are investigated, fundamental differences from Minsky's original analysis are observed.

The aim of this chapter is to provide a review of the literature on the issue of financial fragility, instability and the macroeconomy. We begin by presenting the concepts of financial fragility and instability according to the Post Keynesian/Minskyan perspective as well as according to the mainstream macroeconomic view. We then describe the various macro models in which the issues of financial fragility and instability have been explored. Lastly, we review the related empirical research.

2.2 The concepts of financial fragility and instability in the macroeconomic theoretical frameworks

2.2.1 The Post Keynesian/Minskyan perspective

In Minsky's (1975, 1982, 2008) theoretical framework, which largely draws on Keynes, monetary and financial factors are interrelated with the real sphere of the economy. Fundamental uncertainty and expectations play a decisive role in economic units' behaviour and financial institutions and structures can significantly affect the stability of the macroeconomic system. Moreover, central in Minsky's analysis is his financial theory of investment (the 'two price' theory), which places emphasis on the way that perceived financial risks (of both borrowers and lenders) influence investment and, thus, macroeconomic fluctuations.[1]

The notions of financial fragility and instability are at the core of Minsky's theoretical framework. According to him, the financial fragility of economic units at the micro level is determined by the relationship between expected cash inflows and expected cash outflows. The less the expected cash inflows relative to cash outflows the more an economic unit has to rely on refinancing and, hence, the more prone it is to adverse shocks. Based on this conceptualisation, Minsky has suggested a well-known classification between hedge, speculative and Ponzi finance regimes. In a hedge finance regime, the inflows are expected to be higher than the sum of interest and principal repayment commitments. A hedge unit is deemed viable and debt financing is not expected. In speculative finance, economic unit's expected inflows can cover

[1] For a detailed analysis of Minsky's economic theory see, *inter alia*, Dymski and Pollin (1992), Kregel (1992, 2007), Papadimitriou and Wray (1998), Fazzari *et al*. (2001), De Antoni (2007), Arestis and De Antoni (2009), Tymoigne (2009A), Wray and Tymoigne (2009), Nasica (2010), Argitis (2013A) and Keen (2013).

the interest payments but not the principal repayment commitments. As a result, a speculative economic unit is expected to take new debt in order to cover (partially or totally) the amortisation of debt commitments. Finally, in the case of a Ponzi finance regime, the economic unit cannot repay neither the interest nor the principal repayment commitments and must refinance its entire position with new debt. The Ponzi finance regime corresponds to the more financially fragile situation.

The financial fragility at the macro level stems from the financial fragility of economic units at the micro level: a macroeconomic system is more financially fragile the higher is the proportion of economic units that participate in Ponzi financial relationships and economic activities (see e.g. Minsky, 1982, p. 22; Minsky, 2008, p. 233; Tymoigne, 2011). In a financially fragile economy the stability of the system is highly dependent on refinancing. A disruption of this refinancing is very likely to cause a widespread financial distress.[2]

Minsky's 'financial instability hypothesis' states that the capitalist economy has the tendency to endogenously become financially fragile.[3] This hypothesis largely relies on Minsky's view that stability is destabilising. In particular, Minsky argues that in a period of tranquillity, in which hedge finance is dominant and firms and banks are conservative in their investment decisions, the success of the investment projects, the favourable credit history and the fact that the last crisis gradually becomes a distant memory set the stage for a reduction in the perceived risk of economic units. This reduction translates into lower desired margins of safety, leading to higher debt-financed investment. Since there are no substantial problems in refinancing and debt repayment, the euphoria is generalised reducing further the perceived financial risks. According to Minsky, this growing optimism leads gradually to higher indebtedness and to a higher proportion of speculative and Ponzi units in the economy.[4] The

[2] Interestingly enough, Vercelli (2011) defines the financial fragility of a system by using the concept of structural instability. The latter refers to the case in which a relatively small disturbance can cause a qualitative change in the dynamic behaviour of the system.
[3] For a synopsis of Minsky's 'financial instability hypothesis' by himself see e.g. Minsky (1982, ch. 3) and Minsky (1992B).
[4] This point in Minsky's 'financial instability hypothesis' has often been criticised from a Kaleckian perspective (see e.g. Lavoie and Seccareccia, 2001). It is argued that an increase in the willingness of firms to invest and take on debt may not lead to higher indebtedness and financial fragility. The rationale is that higher investment leads to higher aggregate demand and, thus, to higher retained

fragility of economy's financial structure can be reinforced by a potential rise in the interest rates resulting either from a rise in the policy interest rate of the central bank (due to inflationary pressures that accompany the investment boom) or from higher risk premiums (due to the deterioration in economic units' financial position).

Higher financial fragility increases the likelihood of a financial instability phase, i.e. of a phase of widespread economic and financial problems that can destabilise the macroeconomic system. Financial instability can emerge as a result of a change in expectations that adversely affects refinancing. This change in expectations can be the outcome of the deterioration in economic units' financial position. The financial instability phase is characterised by significant difficulties in the repayment of debts and, thus, by an increasing rate of default. In their attempt to meet their financial commitments, economic units are also likely to be prompted to a distress selling of their assets placing downward pressures on asset prices. The rise in the desired margins of safety, the increase in the liquidity preference of both businessmen and banks and the widespread attempt for a decrease in indebtedness brings the economy into a deep recession.

The financial instability phase may ultimately lead to a new investment and financial cycle: after a significant number of defaults hedge financing dominates and the conditions for a new tranquillity period are created. However, the duration and the severity of the financial instability process as well as the capability of the economy to enter into a new tranquillity period crucially relies on two factors: (i) economy's institutional arrangements; (ii) the phase of the underlying long wave.

Regarding the first factor, Minsky has stressed the stabilising role of thwarting mechanisms, i.e. of mechanisms which set ceilings and floors that constraint an explosive contraction or expansion (see Ferri and Minsky, 1992; Minsky, 1995).[5] Some important thwarting mechanisms are the labour market institutions, the 'lender of last resort' facility of the central bank and the countercyclical fiscal policy. For instance, a rise in government expenditures when the economy enters into a financial

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profits. If the rise in retained profits outweighs the rise in investment, indebtedness may not increase. This is often called the 'paradox of debt'.

[5] See also Papadimitriou and Wray (1998) and Nasica (1999).

instability phase can set a floor to incomes and aggregate demand, preventing a severe crisis and facilitating the return to economic expansion. The nature and the magnitude of the thwarting mechanisms crucially affect the endogenous tendencies of the capitalist economies towards instability.

Concerning the second factor, Minsky has made a distinction between short cycles (or basic cycles) and long waves (or super cycles) in the evolution of the macroeconomic system (see Minsky, 1964, 1995; Ryoo, 2010; Palley, 2011). The short cycle leads to a mild recession while a long wave results in a deep recession. According to Palley (2011), the short cycle is generated from the psychological and financial mechanisms described in Minsky's 'financial instability hypothesis'. The long wave is the chain of short cycles and should be seen as a long-run evolutionary process. During the long wave the financial structures become more and more fragile (even if there are some passing reductions in their fragility during the short cycles) and the thwarting mechanisms relax, weakening the floors and ceilings in the macroeconomic system. Financial innovation, cultural changes and memory loss have a central role to play in the mechanisms of the long wave.[6] The more the economy is close to the end of a long wave the more likely it is that the financial instability phase described in Minsky's 'financial instability hypothesis' will be severe.

From the above it becomes clear that in the Post Keynesian/Minskyan framework cycles and instability are the natural outcome of complex macroeconomic systems in which sophisticated financial institutions and relationships have a prominent role to play in the determination of investment and aggregate demand. The cyclical and the secular movements in the economic activity are the result of the interplay between the financial and the real spheres of the economy. Financial fragility and instability emerge from evolutionary processes that include complex interactions between financial structures, institutions and economic behaviours in a world of fundamental uncertainty. Certain types of institutional arrangements and of government intervention are necessary in order to prevent the natural tendency of capitalist economies towards instability and reduce economic fluctuations.

[6] Ryoo (2010) provides a different interpretation of Minsky's distinction between short cycles and long waves. According to him, the short cycle is not linked with the mechanics of the 'financial instability hypothesis'; this cycle stems from the interaction between effective demand and the labour market. The mechanics of the 'financial instability hypothesis' are exclusively related with the long wave.

2.2.2 The mainstream approach

As mentioned before, finance is not at the core of the basic mainstream macroeconomic analysis. However, over the last two decades or so there have been various attempts to integrate financial factors into the mainstream theoretical macro framework; remarkably, these attempts have been especially intense since the onset of the financial crisis. In the context of this literature, the concepts of financial fragility and instability have often been analysed in terms of their meaning and implications. Two points are, though, of particular importance. First, there is not a common definition of financial fragility and instability in the mainstream approach. Second, no clear distinction is made between financial fragility and financial instability; in many cases these concepts are used interchangeably. This is in contrast with the Post Keynesian/Minskyan approach described above in which financial fragility is clearly portrayed as the cause of financial instability (see Tymoigne, 2010).

The currently dominant approach in mainstream macroeconomics is the so-called 'new consensus' view which constitutes a synthesis of the real business cycle theories and the most important features of New Keynesian economics (for a detailed presentation of this synthesis see e.g. Goodfriend, 2007; Galí and Gertler, 2007; Galí, 2008; Woodford, 2009). The 'new consensus' view is encapsulated in the Dynamic Stochastic General Equilibrium (DSGE) models. In the baseline DGSE models financial factors have a limited role to play in the short run; they are also neutral in the long run.[7] The role of finance can only be found in the extensions of the baseline analysis. In these extensions two views on financial fragility/instability can be traced.

The first, more traditional, view draws on the problems arising from asymmetric information. The asymmetric information in financial relationships refers to the situation in which the borrowers have more information than the lenders about the quality of the investment projects that they intend to undertake. This creates the well-known problems of adverse selection and moral hazard that induce the lenders to

[7] For a critical appraisal of the 'new consensus macroeconomics' from a Minskyan perspective see Argitis (2013B). For a more general critique see e.g. Arestis and Sawyer (2008) and Hein and Stockhammer (2010).

increase the cost of external finance (in order to cover their agency costs) reducing the efficiency of investment and the amount of loans that they might otherwise provide. Importantly, the cost of external finance becomes higher when the net worth of the financial and the nonfinancial sector reduces or when uncertainty in the financial markets increases.

Within this context, Bernanke and Gertler (1990) state that the situation in the economy is financially fragile when the potential borrowers have low wealth in comparison with the size of their investment project; this results in high agency costs and thus in low and inefficient investment. The likelihood of such a situation is considered to be higher in the early stages of economic development or after a prolonged recession. Similarly, Mishkin (1999) argues that financial instability takes place when an adverse shock in the financial system reinforces the problems arising from asymmetric information and causes thereby a severe disruption of the channeling of funds to those that desire to undertake investment projects. These asymmetric information-based definitions of financial fragility/instability have been implicitly used in the DSGE model of Bernanke *et al*. (1999) and all the subsequent models that have extended their approach.

The second, more recent, approach to the concept of financial fragility/instability has been developed by Tsomocos (2003A, 2003B), Goodhart *et al*. (2004, 2005, 2006A, 2006B), Aspachs *et al*. (2007) and Goodhart and Tsomocos (2011). According to this approach, financial fragility/instability is defined as a situation in which there is a substantial increase in the default of economic agents in conjunction with a significant decline in the aggregate profitability of the banking sector. Default is considered an equilibrium phenomenon that stems from the utility optimisation of economics agents. Moreover, the view advocated by these authors is that the analysis of the interbank market and of bank heterogeneity is essential for an integrated consideration of financial fragility/instability issues. Goodhart *et al*. (2009) have incorporated this perception of financial fragility/instability in the baseline 'new consensus' framework.

Since both of the above-mentioned approaches have been analysed within DGSE models, it is crucial to highlight that in these models the economy has the tendency to converge towards the steady-state equilibrium. As Hume and Sentence (2009) explain, this is due to the efficient market hypothesis, the rational expectations hypothesis and the optimising behaviour of the agents. Out of equilibrium fluctuations take place due to shocks and not due to endogenous forces in the economic system. Thus, in contrast to Minsky's framework, stability, and not instability, is the natural outcome of free market economies.

However, it should be pointed out that within the mainstream macroeconomic paradigm there have recently been various attempts to develop new theoretical frameworks in which endogenous instability is more seriously taken into account. These frameworks draw on some Minskyan insights and to some extent depart from the 'new consensus' approach. Furthermore, in these frameworks some new perspectives on the definition of financial fragility/instability are traced, although it is clear that no consensus exists about the definition of these concepts. In section 2.3.2 some features of these recent approaches will be decribed.

2.3 Theoretical macroeconomic models of financial fragility and instability

2.3.1 Post Keynesian/Minskyan models

The Post Keynesian literature that has formalised various aspects of the Minskyan theoretical framework is quite extensive. Early contributions include the models of Taylor and O' Connell (1985), Downe (1987), Foley (1987), Semmler (1987), Lavoie (1986-7), Franke and Semmler (1989), Delli Gatti and Gallegati (1990), Jarsulic (1990), Delli Gatti *et al*. (1994), Palley (1994), Keen (1995) and Skott (1995).

Taylor and O' Connell (1985) were the first who attempted to formalise some Minskyan arguments. Drawing on Minsky's 'two price' theory the investment demand in their model relies on the difference between the demand and the supply price of capital, which ultimately makes investment a positive function of the current rate of profit and a confidence variable, as well as a negative function of the interest rate. The confidence variable reflects the anticipated rate of return on capital relative to the current rate and is assumed to increase when the interest rate becomes lower than a 'normal' long-run level. In the model workers do not save and rentiers hold money, bonds and equity. The portfolio choice of rentiers depends on the interest rate, the rate of profit and the confidence variable. When the confidence variable increases rentiers allocate their wealth from money and bonds towards equities. In the dynamic system that has been developed the two endogenous variables are the confidence indicator and the ratio of money to the public debt (the latter is equal to money plus bonds). This dynamic system has been used to examine under what conditions a debt-deflation process is likely to emerge.

Downe (1987) has incorporated a wage determination process into the model of Taylor and O' Connell (1985). This has allowed him to examine how the analysis of Taylor and O' Connell (1985) is modified when the effects of the business cycle on unit labour costs and inflation are taken into account. The model of Taylor and O' Connell (1985) has also been extended by Franke and Semmler (1989) who have explicitly incorporated the debt-financing of firms from banks.

Foley (1987) has developed a model that places emphasis on the potential destabilising role of firms' financial decisions. In the model of particular importance is the decision of firms about their level of borrowing. Their borrowing to capital ratio is assumed to be a positive function of the difference between the rate of profit and the interest rate. According to the dynamic analysis, an increase in the elasticity of borrowing with respect to the profit rate-interest rate differential can transform a stable economic system into a system that exhibits a limit cycle.

Semmler (1987) has examined how financial variables can change the dynamic properties of a simple system that has only real variables and relies on the interaction between profits and capital accumulation. He has shown that the introduction of financial variables in such a system can affect not only the dynamic properties of the equilibrium point but also the dynamics of outer boundaries. With the use of simulations, he has also indicated the conditions under which financial instability is likely to emerge.

Lavoie (1986-7) has developed a simple model in which the leverage ratio of firms has been utilised to capture their financial fragility. By using a neo-Passinetti investment equation and a wage-cost mark-up equation, and by postulating a positive impact of inflation on the interest rate, he has shown how an investment boom can lead to higher leverage ratios and higher interest rates.

Delli Gatti and Gallegati (1990) have put forward an IS-LM model in which the IS curve is based on Minsky's 'two price' theory and the LM curve is derived from a formulation of Keynes's liquidity preference theory. As in Lavoie (1986-7), the financial fragility is captured by the leverage of firms. It is assumed that the leverage ratio increases as profits rise. The model has been used to indicate how an economy can shift from tranquillity into instability. Delli Gatti *et al*. (1994) have developed a similar model in which the demand for investment depends positively on the price of capital assets and the internal finance while the leverage of firms is a concave function of the profits. The authors have set up a dynamic system in which profits and debt are the endogenous variables. They have used this system to illustrate the possibility of cycles and to stress the stabilsing role of a fiscal policy.

Jarsulic (1990) has developed a non-linear dynamic system with the rate of capital accumulation and the debt to capital ratio as endogenous variables. The system exhibits two equilibrium points with different stability properties. The author has explored how the fragility of the system is affected by changes in the distribution of income and the long-run expectations as well as by alternative specifications of the interest rate and the profit rate.

Palley (1994) has paid attention to household debt. In his model creditor households lend to debtor households. The latter have a higher propensity to consume than the former. Of particular importance in Palley's model is the allowable debt to income ratio. In one of the versions of the model this ratio has been allowed to be positively affected by the change in income. This, according to the author, captures the argument of Minsky that in periods of economic expansion borrowers and lenders become more optimistic and are therefore more willing to accept higher debt to income ratios. Palley has shown that the introduction of a positive link between the allowable debt to income ratio and economic expansion makes the model more unstable.

Keen (1995) has introduced finance into Goodwin's limit cycle model. He has shown that the introduction of finance eliminates the limit cycle and leads the system either to stability or instability. According to numerical simulations, instability is more likely when the base interest rate is high and when the sensitivity of the interest rate to the debt to income ratio is large. Importantly, instability in the model emerges after a period of apparent stability, which is broadly in line with Minsky's theory. The model constructed by Keen has also been used to show how government intervention can reduce the possibility of a breakdown of the economic system.

Skott (1995) has developed a model in which the interaction between fragility and tranquillity plays a central role. Fragility is captured by a variable that describes the degree of laxity in financial behaviour. Tranquillity is inversely related to a variable that describes the degree of trouble in financial markets. The change in the degree of laxity is a negative function of the degree of trouble in financial markets. The degree of trouble depends positively on the degree of laxity and negatively on the output to capital ratio. The rate of capital accumulation is a positive function of the degree of laxity and a negative function of the degree of trouble. The constructed model has been employed to show how tranquillity is likely to cause risky financial behaviour that renders the system more fragile and, thus, more prone to instability. Hence, the model provides some support to Minsky's 'financial instability hypothesis'.

More recently, attention has been paid to the development of models in which particular emphasis is placed on the formulation of Minsky's classification between hedge, speculative and Ponzi finance regimes. Foley (2003) was the first who incorporated this Minskyan categorisation in a Kaleckian model. In his framework firms are deemed as hedge when their profits are higher than the sum of investment and interest payments. If profits are lower than the sum of investment and interest payments, but higher than interest payments, firms are classified as speculative. Ponzi firms are those in which profits fall below the interest payments. In his model this categorisation of firms has been applied to a national economy that consists of many firms. This has been done by assuming that the firms of a nation can be averaged into one representative firm. The constructed model has been used to analyse the dynamic relationship between the growth rate of capital stock and the interest rate and examine the conditions under which an economy is more likely to be in each of the above-mentioned finance regimes.

Drawing on Foley's (2003) categorisation of finance regimes, Lima and Meirelles (2007) have developed a Kaleckian model from which they have derived a dynamic system with the debt to capital ratio of firms and the interest rate as state variables. In this system they have examined the stability properties of the equilibrium points that are located in the hedge, speculative and Ponzi finance areas. They have shown that the system becomes more prone to instability as the firms become more financially fragile.

In Charles (2008) the classification of firms between hedge, speculative and Ponzi is based on the interest payments to profits ratio. When this ratio is lower than one the firms are hedge, when it is equal to one the firms are speculative and when it is higher than one the firms are Ponzi. Charles has developed a dynamic model with the rate of capital accumulation and the interest to profits ratio as endogenous variables. He has analysed the conditions under which stability and instability are more likely to occur.

Nishi (2012) has combined the Post Keynesian literature on debt-led and debt-burdened debt growth regimes with Minsky's finance regimes. He has developed a Kaleckian model in which the debt to capital ratio of firms is allowed to have either a positive or a negative effect on growth, depending on the values of specific parameters. Firms are classified as hedge when their profits cover the sum of the interest payments and the change in debt. When this is not the case but the interest payments are lower than the profits, firms are speculative. Finally, when the interest payments exceed profits, firms are classified as Ponzi. Nishi has examined the conditions under which the various finance regimes arise as well as the conditions under which stability or instability emerges.

Vercelli (2011) has developed a version of Minsky's finance regimes that relies on the utilisation of both liquidity and solvency indices. The liquidity index is given by the ratio of the economic units' current realised outflows to their current realised inflows. The solvency index is equal to the ratio of the expected outflows to the expected inflows. Vercelli has assumed that economic units choose a maximum value for their solvency ratio (which is their desired margin of safety) beyond which they do not desire to place themselves. Using the liquidity and solvency indices, Vercelli has defined six finance regimes and has explored how a change in the desired margins of safety, induced by increasing euphoria, can render the economic system more financially fragile.

There are various other recent formal papers that have examined Minsky's arguments without paying explicit attention to his finance regimes classifications. Setterfield (2004) has incorporated the financial fragility of both households and firms in a shifting equilibrium model of effective demand. The financial fragility of firms and households equals their outstanding debt minus their accumulated savings. Both the actual financial fragility and the acceptable financial fragility by commercial banks are a positive function of nominal income. Setterfield has shown how the endogenous response of interest rates and credit rationing to financial fragility can contribute to income fluctuations.

Nasica and Raybaut (2005) have developed a model with Minskyan features that pays particular attention to the effects of fiscal policy on macroeconomic stability. In the model the ratio of fiscal deficit to private spending is inversely related to private investment. The postulated economy becomes more stable the higher is the sensitivity of this ratio to private investment. Thus, the analysis provides support to the view that countercyclical fiscal policy has a stabilising role.

Fazzari *et al*. (2008) have constructed a model that can reproduce Minsky cycles. In the model the level of investment depends on the change in real output as well as on cash inflows. Consumption is determined by a combination of forward-looking and 'rule of thumb' behaviour. The rate of inflation is specified via a Phillips curve. In the simulations conducted the responsiveness of investment to cash flows plays a critical role in the (in)stability of the model. As this responsiveness increases the model becomes more unstable. When it is equal to a benchmark value, a cyclical behaviour emerges. The resulting cycles are driven by the interaction between capital accumulation, debt, interest rates and inflation.

Bhaduri (2011) has examined the passage from financial fragility to crisis via a model in which special emphasis is given to the interaction between the debt-financed consumption boom and asset price inflation and to the explicit distinction between the positive and the negative effects of debt on output. Bhaduri has first presented a version of the model in which a debt ceiling imposed by the lenders is the reason behind the stop of an economic boom. He has then modified the model to consider a more realistic, according to him, possibility for the end of the boom: the imprudent bahaviour of financial institutions which ignore systemic illiquidity. In this modified version the financial sector not only accommodates fully the demand for credit but it may also stimulate it. This behaviour is considered to stem from the innovative credit instruments and the financial arrangements that enhance the supply of credit.

Ryoo (2010) has constructed a stock-flow consistent model of endogenous financial fragility which places emphasis on the dynamics of firms' leverage and on households' portfolio decisions. In the model the change in the leverage of firms is a positive function of the ratio of their profits to their interest payments; this is explained by the optimism of firms and banks when firms' financial position is favourable. Moreover, households are presumed to reallocate wealth from deposits to equities when the rate of return on equities increases relative to the deposit interest rate. Ryoo has shown that the interaction between firms' leverage and households' portfolio decisions can produce a long cycle that is in line with Minsky's 'financial instability hypothesis'. Ryoo (2013A) has used the previous model to examine the extent to which Minsky's 'financial 'instability hypothesis' is invalidated by the 'paradox of debt'.[8] Moreover, Ryoo (2013B) has developed a similar model in which special attention is given to the behaviour of banks' credit supply, which is assumed to rely on bank profitability and firms' profits to interest ratio. The model has been used to examine the potential destabilising effects of the behaviour of the banking sector.

Charpe *et al*. (2009) have explored the macroeconomic (in)stability in a Keynes-Goodwin model with workers' loans and debt default. In their setup workers take on debt from asset holders to finance their consumption and the purchase of houses. It has been shown that the credit rationing increases the possibility of instability and that a monetary policy that decreases the loan interest rate and purchases defaulted loans can stabilise an otherwise unstable economy. Charpe *et al*. (2012) have developed a similar model where the loans to workers are provided by banks instead of asset

[8] For a brief description of the 'paradox of debt' see section 2.2.1.

holders. Credit rationing depends on bank profitability. The model has been used to identify various mechanisms through which financial fragility is likely to emerge. Charpe and Flaschel (2013) have put forward a similar model that pays particular attention to the simultaneous examination of the demand-side and the supply-side explanations of household debt dynamics. The capital adequacy ratio of banks determines the degree of credit rationing. In their dynamic analysis they have, among others, explored the effects of debt default and capital adequacy ratio on financial instability.

Keen (2013) has extended the model of Keen (1995) by explicitly considering the endogenous creation of money by the banking sector, the monetary flows between the sectors of the economy and the price dynamics. According to his simulation analysis, the dynamics of this extended model are broadly in line with Minsky's 'financial instability hypothesis'. Moreover, the model can generate some monetary and real phenomena of the Great Moderation and of the recent financial distress.

Lastly, it is worthy to mention some recent agent-based models with Post Keynesian features in which various aspects of Minsky's analytical framework have been incorporated. Chiarella and Di Guilmi (2011) have developed a model that associates the aggregate performance of the economy with microeconomic financial variables. In the model a distinction is made between the speculative firms that need to take on debt or issue new equity in order to finance their investment and the hedge firms whose investment is entirely financed with retained profits. The formulation of the investment behaviour is based on Taylor and O'Connell (1985) whose specification has been extended by linking the confidence variable with the developments in the stock market. Investors, who keep their wealth in the form of equities, firms' bonds and liquid assets, are categorised into two groups: the chartists and the fundamentalists. The constructed model has been solved by using both a stochastic aggregation method and numerical simulations. It has been shown that the model can replicate some dynamics that are in line with Minsky's propositions. Chiarella and Di Guilmi (2012) have extended the aforementioned model to examine the effects of a countercyclical fiscal policy in a financially fragile economy. They have shown that, in line with Minsky's arguments, countercyclical fiscal policy can reduce the volatility of output and prevent deep recessions.

De Carvalho and Di Guilmi (2013) have constructed a macro stock-flow consistent model with heterogeneous firms. Similarly with Chiarella and Di Guilmi (2011), the firms are categorised into the borrowing ones that finance part or all their investment with bonds and/or stocks and the hedge ones that use only internal funds in order to finance their investment. The investment expenditures in the model rely positively on the valuation ratio, the capacity utilisation and the retained profits. Importantly, the investment of borrowing firms is more sensitive to internal funds than the investment of hedge firms. The rationale is that the borrowing firms face a higher risk of bankruptcy and thus they take more seriously into account their internal funds when they decide their level of investment. With the use of numerical simulations the authors have explored how changes in the propensity to save, the distribution of income and the liquidity preference are likely to affect the dynamics of leverage and the instability in the economy.

Dosi *et al*. (2013) have developed an agent-based model that pays particular attention to the credit rationing of firms' demand for loans. Banks decide about their credit availability by taking into account firms' stock of liquid assets relative to their sales. The simulation analysis reproduces some Minskyan dynamics: there are regimes in which higher investment and production gradually increase the level of firms' debt and thus the degree of credit rationing; this in turn decreases credit availability causing a recession in the economy.

2.3.2 Mainstream models

The most characteristic macro models in which the asymmetric information approach to financial fragility/instability (see section 2.2.2) was first analysed are those of Bernanke and Gertler (1989), Greenwald and Stiglitz (1993) and Kiyotaki and Moore (1997). Bernanke and Gertler (1989) have constructed a simple overlapping generations model in which firms need to borrow in order to finance a part of their investment expenditures. Due to the existence of asymmetric information the agency costs of lenders (and thus the cost of external finance) are higher the lower is the net worth of borrowers. Accordingly, the shocks that affect the net worth of borrowers influence the financial relationships and the finance of investment. The implication of this analytical framework is that the financial contracts propagate the shocks to the economy: in the case of favourable shocks the positive effects on investment are reinforced due to the rise in the net worth of firms; in the case of adverse shocks the decline in the net worth of firms enhances the recessionary effects.

Greenwald and Stiglitz (1993) have developed a similar model in which debt is the only external source of fund for firms, asymmetric information affects the decisions in the financial markets and firms are inclined to the possibility of bankruptcy. Financial factors affect not only the level of investment (as in the model of Bernanke and Gertler, 1989) but also the level of inputs in the production process. Greenwald and Stiglitz have used their model in order to investigate various aspects of the actual business cycles, such as the fluctuations in real wages and the high sensitivity of the economy to small shocks.

The model of Kiyotaki and Moore (1997) has paid particular attention to the role of durable assets (in particular land) as collateral for loans. Changes in the price of land produce fluctuations in the net worth of borrowers and therefore in the provision of credit. At the same time, fluctuations in the provision of credit affect the investment in land, producing changes in the price of land. This interdependency between asset prices and the provision of credit is the reason that a small adverse shock (e.g. to productivity) has in their model important negative effects on economic activity.

The above-mentioned papers have been used as a basis for the ‘financial accelerator’ DSGE model developed by Bernanke *et al*. (1999). The ‘financial accelerator’ term refers to the fact that the financial frictions related to asymmetric information amplify the production effects of shocks that influence the net worth of borrowers (see also Bernanke *et al*., 1996). The economy in the model of Bernanke *et al*. (1999) comprises households, entrepreneurs, retailers, a government and a financial intermediary (that plays a passive role). The authors impose various shocks to their model (e.g. a monetary policy shock, a technology shock and a government expenditure shock) and examine how the ‘financial accelerator’ influences the business cycles dynamics.

Recent DSGE models, motivated by the 2007-8 crisis events, have extended the analytical framework of Bernanke *et al*. (1999) by introducing the agency problem of asymmetric information into the procedures through which financial intermediaries (banks) obtain their funding. For instance, Gertler and Karadi (2011) have formulated an agency problem between banks and depositors. In their model banks acquire funds from households in order to lend them to firms. Bankers have an incentive to transfer a part of banks' assets to their families which leads to default. This possibility of default restricts the amount that the depositors are willing to lend to banks, implying that a borrowing constraint may arise. In turn, this borrowing constraint may increase the cost of credit for firms with negative effects on economic activity. Gertler and Kiyotaki (2011) have introduced in their model a similar agency problem in the interbank market (which in their setup coexists with the agency problem in the banks-depositors relationship). This agency problem may disrupt the borrowing and lending in the interbank market, leading to higher loan rates. Moreover, Gertler *et al*. (2012) have developed a DSGE model in which the agency problem between banks and depositors is extended by allowing banks to use both deposits and external equity to finance their asset position. Banks' decision about their balance sheet structure relies on their perception of risk. In the aforementioned models calibration exercises have been used to investigate how a financial crisis can be created and how the central bank's interventions are likely to mitigate crisis' adverse effects on the macroeconomy.

We now turn to the models that have used the second approach to financial fragility/instability which, as mentioned in section 2.2.2, emphasises the role of default and bank profitability. This approach was first developed and analysed in the works of Tsomocos (2003A, 2003B) and Goodhart *et al*. (2004, 2005, 2006A, 2006B). Tsomocos (2003A, 2003B) has constructed a two-period general equilibrium model in which markets are incomplete, heterogeneous banks maximise their expected profitability (subject to capital requirements) and the default of both households and banks emerges as an equilibrium phenomenon. The heterogeneity of banks stems from their different initial capital endowments, risk preferences and assessments of future scenarios. Banks borrow from households and from the central bank in the interbank market. They also have equity held by their shareholders. It is assumed that in the first period the agents in the model are uncertain about the state of the economy; the latter is revealed in the second period. In this context, the agents, who have rational expectations, make choices using their subjective probabilities. The model has been used to derive the analytical conditions under which financial fragility emerges. Moreover, various comparative static exercises have been conducted to examine the effects of shocks to the economy.

Goodhart *et al*. (2004, 2005, 2006A, 2006B) have extended the model of Tsomocos (2003A, 2003B) by considering the possibility of capital requirements' violation, introducing a secondary market for the equity of banks and allowing for different loan interest rates among banks as well as for endogenous credit spreads between loan and deposit rates. They have also explored how various policy responses and shocks (e.g. expansionary monetary policy, restrictive regulatory policy, changes in the loan risk weights applied to capital requirements etc.) are likely to affect the fragility and the welfare in the economy.

The analytical framework developed in the above-mentioned papers has been incorporated in a DSGE model by Goodhart *et al*. (2009).[9] The model consists of two heterogeneous households, two heterogeneous banks and a central bank. Default is endogenous and affects individuals' ability to borrow in the future. A distinction is made between outside money and inside money. Outside money refers to injections of liquidity from the government or the external sector. Inside money has to do with the liquidity injections of the central bank in the interbank market. The simulation analysis conducted by the authors compares their model with the standard New Keynesian one. The results suggest that the inclusion of an active banking sector, agent heterogeneity, liquidity and default in the standard New Keynesian model permits a more comprehensive analysis of the issues related to monetary and financial stability policy.

Very recently, the growing popularity of Minsky's economic analysis has induced various economists to construct mainstream models in which certain Minskyan perceptions are incorporated or a type of a 'Minsky moment' is reproduced. In particular, Eggertsson and Krugman (2012) have put forward a simple new

[9] Note that this framework has also been recently extended by Goodhart *et al*. (2010) to analyse the market for mortgages but not within the context of a DSGE model.

Keynesian-style model which pays particular attention to the macroeconomic role of private debt. In their analytical framework 'impatient' agents borrow from 'patient' ones. Borrowing is restricted by a debt limit which can be set exogenously or in relation to borrowers' income. A 'Minsky moment' is regarded to occur when the debt limit falls suddenly as a result of a change in expectations and in the evaluation of assets. In this case deleveraging and debt deflation takes place putting the economy into a liquidity trap. The adverse effect of price deflation on the real burden of debt creates the possibility for a positively-sloped aggregate demand curve, which gives rise to three macroeconomic paradoxes: (i) the collective attempt to save more depresses the economy; (ii) higher productivity reduces output; (iii) wage flexibility increases unemployment. Furthermore, it has been shown that expansionary fiscal policy can be effective when the economy has been pushed to a debt-induced recession.

Farmer (2013) has developed a rational expectations model in which asset prices can increase forever due to the absence of physical or behavioural constraints that may prevent their rise. Thus, the expansion is considered to be fully rational. Within this framework multiple equilibrium unemployment rates exist and financial crises occur as a result of changing expectations in the financial markets.

The model of Gorton and Ordoñez (2013) explains financial fragility by concentrating on the role of information in short-term debt markets. Short-term debt is issued by firms to fund their projects. It is assumed that the information about the underlying collateral is costly and it is not optimal for lenders to produce information every period. Therefore, information depreciates over time. If information-insensitive lending occurs for a long time, only a small fraction of the actual collateral's quality is known. Within this framework, the authors introduce aggregate shocks that are likely to decrease the perceived value of the collateral and, thus, to remove the economy from a regime without the fear of asymmetric information to a regime in which asymmetric information plays a crucial role; this can lead to a credit crunch. In the model the fragility is defined as the probability that aggregate consumption decreases more than a specific level. Systemic fragility is considered to increase during credit booms.

Bhattacharya *et al*. (2011) have developed a model that attempts to capture a specific aspect of Minsky's 'financial instability hypothesis': that over periods of prolonged prosperity the optimism about the future prompts economic agents to invest more in risky assets rendering the economic system more prone to crisis. In their setup financial agents are Bayesian learners with incomplete information who form their expectations about the future outcomes taking into account the previous experience. When good news prevail in the economy for a long period of time the improvement in the expectations leads financial agents to invest in riskier assets. This results in higher leverage and riskier financial structures. After such a period, the realisation of bad news leads to high default and has significant adverse effects on financial stability. The model has been used to examine the extent to which specific regulatory policies are capable of attenuating the excess risk-taking and controlling the leverage cycle.

Lastly, LeBaron (2012) has incorporated some 'Minsky like effects' in an agent-based model. In his postulated economy there are both adaptive and fundamental traders. The adaptive traders use recent returns as a basis for their expectations of future returns. The fundamental traders form expectations using the deviations of asset price from the level of dividends. There are two assets: a risky and a risk free one. The portfolio choice of traders relies on the conditional expected return and the variance of future stock returns. The model produces irregular cycles around fundamentals. Instability is generated by the movement of traders toward extreme portfolio positions.

2.4 Empirical research

The empirical research on the measurement and the determinants of financial fragility/instability include both contributions that directly rely on the Minskyan theoretical framework and works that concentrate on the issues of financial distress without a direct link with Minsky. We first pay attention to the first strand of the literature. Minsky and Meyer (1972) have utilised various indicators to measure the illiquidity and insolvency risks of the private sector. The risks of the non-financial sector are captured by indices like the ratio of corporations' fixed investment to their cash flow and the corporations' liabilities to their cash flows or to their liquid and safe assets. The risks of households are measured, *inter alia*, by the ratio of their liabilities to their disposable personal income and to their total or more liquid assets. Lastly, the financial structure of the commercial banks is represented by the loans to deposits ratio, the ratio of various assets (with high or low risk) to total financial assets and the ratio of less stable liabilities to total liabilities. The authors have applied these illiquidity and insolvency indices to the US economy over the period 1946 to 1971. They have found that in the period under consideration most of the indices followed un upward trend, revealing higher illiquidity and insolvency risks in the private sector of the US economy in the late 1960's and early 1970's relative to the early post-war period.

Arza and Español (2008) have employed the Minskyan taxonomy between hedge, speculative and finance regimes to measure the financial fragility of firms in Argentina over the period 1992-2001. With the use of a micro panel data set they have estimated the number of firms in each financial category and have found that over the period under study the speculative and Ponzi firms had a higher leverage, a higher proportion of debt from financial institutions and a higher proportion of short-term debt. They have also found that the hedge firms were financially unconstrained while the speculative and Ponzi firms used internal funds in order to finance their investment. The interpretation that have made to the latter finding is that the financial structure of firms plays a significant role in the decision of the financial system to provide funds for long-term investment.

The Minskyan categorisation of firms has also been used by Mulligan (2013) to explore the financial structure of various North American industries over the period 2002-2009. The categorisation of firms is based on value of the interest coverage which is defined as the ratio: (net income plus interest)/interest. Hedge finance occurs when this ratio is higher than 4, speculative finance is the case in which this ratio lies between 0 and 4, and Ponzi finance is considered to exist when interest coverage ratio takes negative values. Mulligan (2013) has examined whether, in line with the 'financial instability hypothesis', speculative and Ponzi firms increased over the expansion phase and decreased in the recession phase. His results suggest that this was the case in the most sectors under investigation.

Tymoigne (2010) has focused on the measurement of the financial fragility in the household sector, and in particular in the housing activities of this sector. Ponzi finance is considered to exist when financial obligations are increasing relative to cash inflows and, at the same time, refinancing needs are growing and liquidity ratios are declining. Based on this definition, Tymoigne has constructed three categorical indices of Ponzi finance. The first is equal to one (which implies that Ponzi finance exists) when the growth rate of home prices, the growth rate of mortgage debt and the growth rate of the mortgage financial obligation ratio are all positive. The second index is equal to one when the first index equals one and, at the same time, the ratio of households' monetary assets to mortgage debts increases. The third index is the same as the second one with the only difference being that it also takes into account the trends in refinancing. The suggested indices have been applied to the US economy over the period 1987:Q1 to 2009:Q1 and have identified the time points in which the financial practices can be considered as unsustainable.

Tymoigne (2011) has constructed financial fragility indices for the whole private sector, namely households, the non financial corporate sector and the financial business sector. The financial fragility of the household sector is represented by two indices: (i) a general index that refers to the funding practices of households and includes variables such as households' net worth, their debt-service ratio and their monetary instruments as a proportion of outstanding liabilities; (ii) an index that concentrates on households' financial practices associated with the acquisition of a house and contains variables such as the mortgages of households, the price of houses and the mortgage financial obligation ratio. Similar variables have been used for the development of the indices of the other two sectors. In the construction of all indices weights are assigned to the various variables and financial fragility is assumed to increase when the growth rate of the variables under investigation is positive. The application of the indices to the US economy over the last decades shows that the financial fragility of the households sector increased the years before the financial crisis, the fragility of the financial sector was high at the end of 1980's, at the end of 1990s and in the period 2004-2007, while the fragility of the non-financial corporate sector was high at the end of 1980's and at the end of 1990s.

Tymoigne (2012) has used a similar approach with the previous paper to estimate the fragility of household finance in the US, the UK and France. He has constructed an index that is a weighted average of various variables that capture financial fragility issues. The index has been utilised both to measure the change in financial fragility in a given country and to compare financial fragility across countries. The analysis of the data shows that the financial fragility in housing increased substantially in the early 2000s in all countries under investigation. Remarkably, the rise in the US and the UK was much more important than the rise in France. Furthermore, the cross-country comparison indicates that the fragility in the US was much higher than the fragility in France over the last two decades.

De Paula and Alves (2000) have examined Brazil's external financial fragility in the 1990s. In their framework the external financial fragility is defined as the degree to which an economy is vulnerable to changes in external interest rates or in exchange rates. The authors have developed an index that compares a country's actual and potential foreign currency liabilities with its current revenues and sources of longer-term refinancing. The external financial fragility of an economy is higher the greater is its reliance on refinancing or the use of reserves in order to meet its external obligations. The use of this index in the case of Brazil illustrates the growing external fragility of the Brazilian economy before the 1998-1999 currency crisis.

Arestis and Glickman (2002) also have applied Minsky's theoretical framework to the open economy. They have put forward a distinction between four finance regimes: (i) a hedge regime in which the economy seems to be able to meet its financial obligations without being vulnerable to exchange rate movements; (ii) a speculative regime in which the fulfillment of financial obligations is prone to exchange rate movements; (iii) a super-speculative regime in which the economy is vulnerable to exchange rate movements but it is also prone to changes in the interest rates due to the fact that it has borrowed short-term in foreign currency to finance domestic long-term assets; (iv) a Ponzi regime in which the economy increases its debt to fulfill its financial commitments. They have also used Minsky's 'financial instability hypothesis' to explain how financial innovation and euphoria can lead to higher financial fragility in an open economy without capital controls. Their analytical framework has been utilised to explain the Southeast Asia financial crisis in the late

1990s. In their analysis particular emphasis has been placed on the role of financial liberalisation as a major euphoria-inducing factor.

Schroeder (2002, 2009) has used Foley's (2003) distinction between hedge, speculative and Ponzi economies (see section 2.2.1). A national economy is hedge when the rate of profit is larger than the rate of accumulation or the rate of interest. When the rate of accumulation is greater than the profit rate, the economy is considered to be speculative. Ponzi finance corresponds to the situation in which the interest rate is higher than the profit rate. Schroeder (2002) has applied this categorisation to the Thailand economy. According to her analysis, this economy was in the hedge regime in the period 1986-1990, in the speculative regime in the period 1991-1994 and in the Ponzi regime in the 1995-1998 time span. Schroeder (2009) has also explored the finance regimes of New Zealand and Australia. Her analysis indicates that the New Zealand was hedge from 1993 to 2003, speculative in 2004 and Ponzi over the period 2005-2007. Australia was in the hedge position for most of the period 1990-2007.

Ferrari-Filho *et al*. (2010) have extended Minsky's financial classification to the public sector. According to their definition, the public sector is deemed as hedge when it runs a primary surplus that covers both the interest and the principal repayment. If there is a primary surplus that is not enough to cover these financial obligations the public sector is considered to be speculative. The Ponzi finance regime exists when the public sector runs a deficit. The application of their classification to the Brazilian economy shows that the public sector of Brazil was speculative over the period 2000-2008.

Wolfson (1990) has explored empirically the determinants of financial instability. In his framework financial instability is represented by a dummy variable that equals 1 in the years in which financial crises occur and 0 otherwise. In the econometric analysis the main explanatory variables of financial instability (which capture both cyclical and secular forces) are the following: (i) the ratio of non-financial corporate sector's net interest payments to its gross capital income; (ii) the ratio of net loan losses to average total loans; (iii) the bank credit availability; (iv) various indices that capture the impact of the regulatory structure on financial instability. The empirical evidence that refers to the US economy for the period 1946-1987 suggests that his independent variables have the expected sign and can explain to a great extent the financial instability episodes. In a later paper Wolfson (1995) used a similar framework to explain the financial crisis in the US economy in 1990-91.

Knutsen and Lie (2002) have used Minsky's framework to explain the banking crisis in Norway in the period 1987-1992. The banking crisis is most notably captured by the significant loan losses reported in Norwegian banks over this period. Their analysis has placed emphasis on increasing credit availability, asset price inflation, expansionary monetary policy, financial deregulation and euphoric bank management behaviour in the years before the emergence of the crisis.

We now proceed to present some other empirical contributions that are not directly linked with the Minskyan framework. Kaminsky and Reinhart (1999) have employed various financial and macroeconomic indicators to examine banking and currency crises in a sample of both developed and emerging countries over the period 1970 to mid 1995. Their empirical investigation illustrates that banking and currency crises were interlinked and that, typically, a banking crisis preceded a currency crisis. Importantly, their analysis shows that the root cause of both crises was a financial shock (such as financial liberalisation or easier access to international financial markets) which facilitated a credit boom and increased financial vulnerability.

Demirgüç-Kunt and Detragiache (1998) have employed a multivariate logit econometric model to scrutinise the factors that explain the emergence of banking crises. This model has been applied to a sample of both developed and developing countries over the period 1980 to 1994. In their empirical investigation the banking crises are captured by a dummy variable that is equal to 1 when at least one of the following conditions is satisfied in the year under investigation: (i) the non-performing loans to total assets ratio was above 10 percent, (ii) the cost of the rescue operation was over 2 percent of GDP, (iii) there was a large nationalisation of banks as a result of banking problems and (iv) bank runs or emergency measures (e.g. deposit freezes) occurred. Their results suggest that a low GDP growth, a high real interest rate, a high inflation rate and the presence of an explicit deposit insurance scheme are associated with a higher probability of a banking crisis. Demirgüç-Kunt and Detragiache (2005) have applied the same econometric method for an extended sample of countries and for the period 1980 to 2002. Their results are largely consistent with those of their previous work.

González-Hermosillo (1999) has examined some episodes of banking system distress and, based on data for about 4,000 banks, she has been led to the conclusion that increasing non-performing loans and declining capital ratios are good signals of a high probability of a near-term bank failure. She has also proposed an indicator of bank fragility, which is given by the ratio of capital equity plus loan reserves minus non-performing loans to total assets (the coverage ratio). When this ratio is below a specific threshold banks are considered to be in distress.

Lewis (2006) has applied a semi-parametric technique to estimate the impact of bank-specific features (e.g. the ratio of non-performing loans, the loans to deposits ratio, the asset growth and the regulatory capital to risk-weighted asset) as well as of macroeconomic variables on the probability of a banking crisis. The analysis refers to the commercial banks of Jamaica over the period 1996:Q1-2006:Q3. The results pinpoint the importance of macroeconomic volatility in the assessment of banks' financial fragility.

A more recent literature has paid attention to the development of financial stress indices that are continuous and rely on the composition of various financial and macroeconomic variables of a country. These indices have the role of supporting an early warning system by identifying time points in which the financial system is more prone to adverse shocks. There are various alternative methods that have been used in the procedure of the composition. The most common of them are the variance-equal weight method, the state space representation of the financial stress, the logit modelling, the factor analysis and the portfolio theory-based approach. Illing and Liu (2006), van den End (2006), Albulescu (2010), Brave and Butters (2010), Morris (2010) and Louzis and Vouldis (2012), *inter alia*, have developed such indices and have applied them to specific countries.

Finally, particular attention should be paid to the empirical works of Goodhart *et al*. (2005), Goodhart *et al*. (2006B) and Aspachs *et al*. (2007) who have used a version of the concept of financial fragility/instability that is based on the role of default and the profitability of the banking sector (see section 2.1.2). Goodhart *et al*. (2005) and Goodhart *et al*. (2006B) have shown that their model (see section 2.2.2) can replicate satisfactorily the time series properties of the UK banking data and have argued that it can thereby be used as a risk assessment tool for the UK banking sector. Furthermore, Aspachs *et al*. (2007) have investigated empirically the effect of bank default and profitability (which are used as proxies for fragility/instability) on GDP (a proxy for economic agents' welfare). They have applied panel VAR techniques to a sample consisted of data for Finland, Norway Sweden, Korea, UK, Germany and Japan over the period 1990-2004. Their results show that an adverse shock to banks' probability of default and equity values reduces GDP.

3. Margins of safety and instability in a macrodynamic model with Minskyan insights

3.1 Introduction

The financial crisis that hit the world economy in 2007-8 has brought to the fore the crucial role of economic agents' desired margins of safety in the emergence of financial fragility and macroeconomic instability. The prolonged period of stable and high growth witnessed by many developed countries during the last decades, in conjunction with the absence of important financial episodes, boosted the euphoria of economic agents inducing them to accept lower margins of safety. This provided the ground for increasing financial fragility, which was not confined to the production sector, but was also remarkably associated with the banking sector. The growing financial fragility rendered the macro systems prone to instability and crisis.

The financial crisis has also put at the centre of the stage the potential stabilising role of fiscal policy. Scholars who draw on Minsky's macroeconomic analysis have pointed out that fiscal policy is a major vehicle for ensuring the stability of the macroeconomic system when private consumption and investment are weak (see e.g. Papadimitriou and Wray, 1998; Tymoigne, 2009A). It has been argued that government expenditures can place a floor to incomes and economic activity, reducing the possibility of financial breakdown. Although expansionary fiscal policy was initially used by many governments as a response to the crisis (see Arestis and Sawyer, 2010), concerns about fiscal deficits and rising public indebtedness quickly produced a change in attitude toward the implementation of austerity measures.

The purpose of this chapter is to formalise some theoretical aspects of the above-mentioned developments and considerations within a macrodynamic model with Minskyan insights. The chapter draws on the extensive literature that has modelled various dimensions of Minsky's (1975, 1982, 2008) macroeconomic analysis.[1] The

[1] See e.g. Ryoo (2010) and the references therein.

contribution of the chapter, compared to this literature, lies on the explicit examination of the following two issues within a stock-flow consistent framework.[2]

First, the constructed model allows the desired margins of safety of firms and banks to change endogenously during the investment cycle. Although the role of economic agents' desired margins of safety is critical to Minsky's analysis for the emergence of financial fragility and instability,[3] the formal literature has so far paid little attention to the distinction between the actual and the desired margins of safety.[4] Most importantly, this literature has not sufficiently analysed the endogenous character of these margins of safety and the exact mechanisms through which the change in the desired margins of safety is conducive to macroeconomic instability.[5] The current chapter shows both analytically and via simulations the destabilising role of endogenous movements in the desired margins of safety. In our framework the margins of safety of firms and banks are captured by their leverage ratios.[6]

The analysis of this chapter focuses on the case of a debt-burdened regime. In our debt-burdened regime the capacity utilisation and the investment rate are both negatively affected by the leverage of firms.[7] Nishi (2012) argues that in the Minskyan analytical framework the debt-burdened regime corresponds to the downturn phases, when the leverage ratio affects negatively investment, while the debt-led regime is consistent with the boom phase, in which leverage and capital accumulation both increase. This chapter indicates that the incorporation of endogenous desired margins of safety in an economy characterised by a debt-burdened regime can produce cycles during which investment and leverage move both in the same and in the opposite direction. This implies that the Minskyan boom and downturn phases can be

[2] For the stock-flow consistent approach to macro modelling see Godley and Lavoie (2007).
[3] See e.g. Kregel (1997), Tymoigne (2009A) and Vercelli (2011).
[4] For some exceptions see Dafermos (2012), Le Heron (2008, 2011, 2012, 2013) and Le Heron and Mouakil (2008).
[5] Some recent attempts to endogenise the desired margins of safety can be found in Le Heron (2011, 2013) where the conventional leverage ratio is a function of the state of confidence or the growth rate. Ryoo (2010) has investigated some macro effects of the endogenous change in the desired margins of safety. However, in his model the desired margins of safety are basically driven by households' behaviour in the stock market and not by the endogenous changes in the euphoria of firms and banks during the investment cycle, as is the case in this chapter.
[6] As Minsky (2008, p. 266) points out, 'increased leverage by banks and ordinary firms decreases the margins of safety'.
[7] For the distinction between the debt-burdened and debt-led regimes see Hein (2013), Nishi (2012) and Sasaki and Fujita (2012).

reproduced without being necessary to switch from a debt-burdened to a debt-led regime. Furthermore, the chapter shows that the endogeneity of the desired margins of safety can generate instability in an otherwise stable debt-burdened economy.

Second, the model of this chapter examines the extent to which fiscal policy is capable of preventing in a debt-burdened economy the instability that stems from the endogenous changes in firms' and banks' desired margins of safety. In particular, it sets forth a fiscal rule according to which the government expenditures increase (decrease) when the desired margins of safety tend to rise (fall) relative to the actual ones. Numerical simulations show that this rule has a stabilising role which is broadly in line with Minsky's arguments about the capacity of the government to reduce destabilising forces in the macro system. Although the stabilising effects of fiscal policy have been examined within similar frameworks (see e.g. Charpe *et al.*, 2011, ch. 9; Keen, 1995; Yoshida and Asada, 2007), our model provides a new perspective on this issue by linking fiscal policy with the desired margins of safety and the leverage of firms and banks.

Importantly, the above-mentioned issues are examined within a framework that incorporates an active banking sector. Following various recent contributions in macro modelling (see e.g. Charpe and Flaschel, 2013; Dafermos, 2012; Le Heron, 2008, 2011, 2012, 2013; Le Heron and Mouakil, 2008; Ryoo, 2013B), it is assumed that banks impose credit rationing when they provide loans to firms. In our setup, the degree of credit rationing depends upon the financial position of both firms and banks.

The chapter is organised as follows. Section 3.2 sets out the structure of the model. Section 3.3 presents the main properties, the dynamic equations and the steady state of the macro system. Section 3.4 explores analytically and via simulations the destabilising effects of the endogenous changes in the desired margins of safety of firms and banks. It also illustrates how fiscal policy can stabilise an otherwise unstable debt-burdened economy. Section 3.5 summarises and concludes.

3.2 Structure of the model

The economy of the model is composed of households, firms, banks, the central bank and the government. Table 1 displays the balance sheet matrix. Table 2 depicts the transactions matrix. Households receive wage income, interest income and the distributed profits of firms and banks.[8] They keep their wealth only in the form of bank deposits. They do not take out loans from banks. Firms finance their investment expenditures using loans and retained profits. Banks provide loans to firms, hold treasury bills and high-powered money; their liabilities comprise household deposits and advances from the central bank. Banks' undistributed profits are used to build capital. Central bank holds treasury bills and advances on the asset side of its balance sheet and high-powered money on the liability side. Its profits are distributed to the government. Government issues treasury bills to finance its expenditures.[9] Inflation is assumed away and the level of prices is set, for simplicity, equal to unity. There is only one type of product which can be used for both consumption and investment purposes.

Table 1. *Balance sheet matrix*

	Households	Firms	Commercial banks	Government	Central bank	Total
Deposits	$+D$		$-D$			0
Loans		$-L$	$+L$			0
Treasury bills			$+B_b$	$-B$	$+B_{cb}$	0
High-powered money			$+HPM$		$-HPM$	0
Advances			$-A$		$+A$	0
Capital		$+K$				$+K$
Total (net worth)	$+D$	$+V_f$	$+K_b$	$-B$	0	$+K$

[8] Households are the owners of firms and banks. To avoid complications, it is assumed that firms and banks do not issue shares.
[9] For simplicity, there are no taxes in the model. Thus, fiscal policy is implemented via changes only in the government expenditures.

Table 2. *Transactions matrix*

	Households	Firms		Commercial banks		Government	Central bank	Total
		Current	Capital	Current	Capital			
Investment		$+I$	$-I$					0
Consumption	$-C$	$+C$						0
Government expenditures		$+GOV$				$-GOV$		0
Wage bill	$+W$	$-W$						0
Interest on loans		$-i_l L$		$+i_l L$				0
Interest on treasury bills				$+i_b B_b$		$-i_b B$	$+i_b B_{cb}$	0
Interest on deposits	$+i_d D$			$-i_d D$				0
Interest on advances				$-i_a A$			$+i_a A$	0
Commercial banks' profits	$+PB_d$			$-PB$	$+PB_u$			0
Central bank's profits						$+PCB$	$-PCB$	0
Firms' profits	$+PF_d$	$-PF$	$+PF_u$					0
Change in deposits	$-\dot{D}$				$+\dot{D}$			0
Change in loans			$+\dot{L}$		$-\dot{L}$			0
Change in treasury bills					$-\dot{B}_b$	$+\dot{B}$	$-\dot{B}_{cb}$	0
Change in advances					$+\dot{A}$		$-\dot{A}$	0
Change in high-powered money					$-\dot{HPM}$		$+\dot{HPM}$	0
Total	0	0	0	0	0	0	0	0

Equation (1) gives the disposable income of households (Y_d):

$$Y_d = W + i_d D + PF_d + PB_d \tag{1}$$

where W is the wage bill, i_d is the interest rate on deposits, D is the amount of deposits, PF_d denotes the distributed profits of firms and PB_d denotes the distributed profits of banks.

The wage bill of households is written as:

$$W = s_w Y \tag{2}$$

where s_w is the income share of wages and Y is the level of output.

Households' consumption (C) depends on their disposable income and deposits:

$$C = c_1 Y_d + c_2 D \tag{3}$$

where $0 < c_2 < c_1 < 1$.

The change in deposits is determined by the following equation:

$$\dot{D} = Y_d - C \quad (4)$$

Equation (5) shows the profits of firms (PF):

$$PF = Y - W - i_l L \quad (5)$$

where i_l is the lending interest rate and L is the amount of firms' loans.

The undistributed profits of firms (PF_u) are determined as a proportion (s_f) of their total profits:

$$PF_u = s_f PF \quad (6)$$

Equation (7) gives the distributed profits of firms (PF_d):

$$PF_d = PF - PF_u \quad (7)$$

In the formulation of investment expenditures, the distinction between the desired investment of firms (I^d) and the effective one (I) is adopted (Dafermos, 2012; Le Heron and Mouakil, 2008). The effective investment is equal to the desired one minus the amount of new loans that are credit rationed by banks (NL^{cr}). In particular, it holds that:

$$I = I^d - NL^{cr} \quad (8)$$

From Equation (8) it is straightforward that credit rationing exerts a negative impact on effective investment. The desired investment scaled by capital stock (g^d) is given by:

$$g^d = \frac{I^d}{K} = \delta_0 + \delta_1 u - \delta_2 \left(lf - lf^T \right) \tag{9}$$

where $\delta_0, \delta_1, \delta_2 > 0$, K is the capital stock, δ_0 denotes the 'animal spirits' of entrepreneurs and u is the rate of capacity utilisation. The utilisation rate is written as $u = Y/(vK)$, where v is the exogenously given full-capacity output-to-capital ratio. Equation (9) shows that the desired investment rate is affected by endogenous changes in capacity utilisation and in the leverage ratio relative to the target one.[10] It is postulated that the leverage ratio (i.e. the loans to capital ratio, $lf = L/K$) is used by firms as a proxy for their actual margins of safety: a high (low) leverage ratio implies low (high) margins of safety. The desired margins of safety are reflected in the value of firms' target leverage ratio $\left(lf^T \right)$. Equation (9) suggests that the lower the actual leverage ratio relative to the target one, the higher the investment rate (and vice versa).[11] This formulation is broadly in line with Minsky's (2008) emphasis on the role of leverage and desired margins of safety in the capital accumulation process (see, e.g., Minsky, 2008, p. 209).

It is important to point out that our formulation does not imply that a rise in the target leverage ratio of firms always leads to a higher actual leverage ratio. The induced increase in desired investment, which tends to make lf higher, might be overcompensated by the increase in undistributed profits (due to higher economic activity) and the rise in capital stock (due to higher investment), both of which tend to reduce lf. If this happens, a 'paradox of debt' occurs: although firms try to increase their leverage ratio by increasing investment they end up with a lower leverage ratio.[12] Interestingly, the overall result on lf is also affected by the credit rationing behaviour of banks.

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[10] Obviously, capital accumulation may also rely on other variables, such as the rate of profit, the interest rate or the Tobin's q. In this chapter, we use a simple specification to focus on the effects of firms' margins of safety.

[11] For some similar formulations that capture the impact of desired and actual margins of safety on investment see Dafermos (2012) and Le Heron (2008, 2011, 2013).

[12] For a detailed discussion of the 'paradox of debt' in formal models see Hein (2007, 2013), Lavoie (1995) and Ryoo (2013A).

The change in loans $(\dot{L})$ is given by the following formula:

$$\dot{L} = NL^d - NL^{cr} - repL \tag{10}$$

where NL^d stands for the demanded amount of new loans and rep for the loan repayment ratio. Since the amount of credit rationed loans are always a fraction of demanded loans it invariably holds that $NL^{cr} < NL^d$.

The demanded amount of new loans are determined as follows:

$$NL^d = I^d - PF_u + repL \tag{11}$$

The amount of new loans that are credit rationed, scaled by capital stock, are given by the following formula:

$$\frac{NL^{cr}}{K} = b_0 + b_1 lf + b_2\left(lb - lb^T\right) \tag{12}$$

where $b_0, b_1, b_2 > 0$. The term b_0 captures exogenous factors that affect credit rationing (such as the 'animal spirits' of banks, the degree of securitisation etc.). The second term illustrates that a higher leverage of firms reduces the willingness of banks to provide credit: when the leverage of firms increases banks conceive the risk of borrowers' default to increase.[13] Equation (12) also suggests that the bank leverage plays a crucial role in the determination of credit availability. The leverage of banks (lb) is given by their assets-to-capital ratio:

$$lb = \frac{lf + b_b + hpm}{lf + b_b + hpm - d - a} \tag{13}$$

where $b_b = B_b/K$ is the banks' treasury bills (B_b)-to-capital ratio, $hpm = HPM/K$ is the high-powered money (HPM)-to-capital ratio, $d = D/K$ is the deposits-to-capital

[13] See Le Heron and Mouakil (2008) for a similar assumption.

ratio and $a = A/K$ is the advances (A)-to-capital ratio. Note that according to the balance sheet matrix (see Table 1) the bank capital (K_b) is equal to $L + B_b + HPM - D - A$. Minsky (2008, ch. 10) emphasises the importance of banks' leverage in the processes that lead the macroeconomy toward higher financial fragility. In Minsky's analysis, the inducement of banks to increase their leverage as a means to heighten the return on equity is one of the principal factors that increase the supply of financing by banks. In our framework, a higher bank leverage increases, *ceteris paribus*, banks' concerns about their own financial position. Thus, credit rationing is positively affected by bank leverage. However, any rise in the target bank leverage ratio (lb^T), which as will be shown below changes endogenously during the investment cycle, decreases credit rationing. This implies that, in broad line with Minsky's arguments, any inducement of banks to accept higher leverage ratios pushes up the accumulation of firm debt.[14]

Equations (8)-(12) suggest that the undistributed profits of firms have both first-round and second-round effects on the leverage of firms. The first-round effects stem from the fact that higher retained profits reduce, *ceteris paribus*, firms' demand for new loans driving down their leverage. This fall in leverage produces, however, some second-round feedback effects because it boosts the desired investment of firms and decreases credit rationing. These second-round effects tend to increase both the numerator and the denominator in the leverage ratio with the overall result being ambiguous.

Banks' profits (PB) are given by:

$$PB = i_l L + i_b B_b - i_d D - i_a A \qquad (14)$$

where i_b is the interest rate on treasury bills and i_a is the interest rate on advances; i_a is determined by the central bank. For simplicity, it is assumed that $i_b = i_a$.

[14] Charpe and Flaschel (2013) use a similar formulation in which credit rationing is connected with banks' net wealth. Ryoo (2013B), who also relies on Minsky's framework, postulates a positive effect of bank leverage on credit availability.

Banks retain a proportion (s_b) of their profits:

$$PB_u = s_b PB \tag{15}$$

The distributed profits of banks (PB_d) are equal to:

$$PB_d = PB - PB_u \tag{16}$$

The interest rates on deposits and loans are determined as follows:

$$i_d = h_d i_a \tag{17}$$

$$i_l = h_l i_a \tag{18}$$

where $h_d < 1$ is the mark-down and $h_l > 1$ is the mark-up over the interest rate on advances. Note that h_d and h_l are exogenously given in our analysis.

Banks hold reserves, which are a fixed proportion (h_1) of deposits:

$$HPM = h_1 D \tag{19}$$

Banks also hold treasury bills as a fixed proportion (h_2) of deposits:

$$B_b = h_2 D \tag{20}$$

The advances act as a residual in the balance sheet of banks :[15]

$$\dot{A} = H\dot{P}M + \dot{B}_b + \dot{L} - \dot{D} - PB_u \tag{21}$$

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[15] Note that $\dot{K}_b = PB_u$.

The change in government's treasury bills (B) is determined by its budget constraint:

$$\dot{B} = GOV + i_b B - PCB \tag{22}$$

where PCB denotes the profits of the central bank (recall that these profits are distributed to the government) and $GOV = govK$ denotes the government expenditures.

The profits of the central bank are equal to the sum of the interest on treasury bills (B_{cb}) and the interest on advances:

$$PCB = i_b B_{cb} + i_a A \tag{23}$$

The treasury bills held by the central bank are given by Equation (24):

$$B_{cb} = HPM - A \tag{24}$$

Equation (25) gives the output of the economy:

$$Y = C + I + GOV \tag{25}$$

Note that the redundant equation of the model is:

$$B_{cb-red} = B - B_b \tag{26}$$

This equation should be verified in our simulations so as to ensure that the model is stock-flow consistent.

Having presented the main structure of the model, we are now in a position to describe the law of motion of the target leverage ratios (desired margins of safety) of firms and banks. As shown above, the target leverage ratios play a central role in the behaviour of the macroeconomy since they influence the investment and lending decisions.

The law of motion of firms' target leverage ratio is captured by the following formula:

$$\dot{lf}^T = \xi_1(g - g_n) + \xi_2(lf_0^T - lf^T) \tag{27}$$

where $\xi_1, \xi_2 > 0$. Equation (27) suggests that the change in the target leverage ratio of firms relies on the difference between the effective investment rate $(g = I/K)$ and what is conceived as a normal rate of investment (g_n), which is used as a reference point. When the rate of effective investment in the economy is higher than g_n, there is a rise in the euphoric expectations of firms, since the economy appears to perform much better than what is normally expected. With everything else given, this leads firms to relax their desired margins of safety or, equivalently stated, to increase their target leverage ratio: what before was conceived as a risky project may now be evaluated as a safe investment due to the general good performance of the economy. The parameter ξ_1 reflects the sensitivity of firms' target leverage ratio to differences between the effective and the normal investment rate. The higher this parameter the more prone the expectations of firms to the investment cycle.

The second term in equation (27) implies that firms do not allow their target leverage ratio to deviate significantly from a reference value (lf_0^T). When the target leverage ratio increases (decreases) relative to the reference value, firms are prompted to reduce (increase) their target leverage ratio.

Minsky (2008, p. 255) points out that in an environment of favourable expectations, the higher willingness of firms to invest is accompanied by a higher willingness of bankers to finance investment projects: '[b]ecause bankers live in the same expectational climate as businessmen, profit-seeking bankers will find ways of accommodating their customers; this behavior by bankers reinforces the disequilibrating pressures'. In order to capture this Minskyan idea we allow the target leverage ratio of banks to co-move with the target leverage ratio of firms:

$$lb^T = \phi lf^T \tag{28}$$

where ϕ is a positive parameter. Equations (27)-(28) imply that both firms' and banks' desired margins of safety change during the investment cycle. When, for instance, the effective investment rate is higher than the normal one, not only firms increase their target leverage ratio, placing upward pressures on investment, but also banks become more willing to target a higher leverage ratio and increase thereby credit availability. The reason is that the expansionary environment improves the repayment history of borrowers and, hence, banks become less concerned about the repercussions of an increase in their own leverage ratios.[16]

Overall, equations (27) and (28) are consistent with Minsky's (2008, p. 209) argument that '[a] history of success will tend to diminish the margin of safety that business and bankers require…a history of failure will do the opposite'. It will be shown below that this endogenous change in the desired margins of safety of both firms and banks is likely to transform an otherwise stable debt-burdened economy into an unstable one.

As mentioned in the introduction, one of the additional purposes of this chapter is to examine whether fiscal policy can play a stabilising role in our macrodynamic system. In an economy in which the desired margins of safety change endogenously, this stabilising role could be attained if the government expenditures adjust adequately to variations in the divergence between the actual and the desired margins of safety. The fiscal rule described in equation (29) captures this idea:

$$g\dot{o}v = e_1\left[\left(lf - lf^T\right) - \left(lf_0 - lf_o^T\right)\right] + e_2\left[\left(lb - lb^T\right) - \left(lb_0 - lb_o^T\right)\right] + e_3\left(gov_r - gov\right) \qquad (29)$$

Note that $e_1, e_2, e_3 > 0$. Equation (29) states that, other things equal, the government expenditures-to-capital ratio increases (decreases) when the difference between the actual and the target leverage ratio of firms and banks becomes higher (lower) than their difference in the steady state. The economic intuition of this rule is the following: when the actual leverage ratios are much higher than the target leverage ratios there is

[16] For the endogenous change in the desired margins of safety of banks during the economic cycle see also Kregel (1997) and Tymoigne (2009A). Moreover, for macro models in which the endogenous changes in the lender's risk play a crucial role in the credit rationing procedure see Le Heron (2011, 2013).

a tendency for investment to decrease since firms and banks are less willing to participate in new debt contracts; this produces contractionary forces in the economy. By increasing its expenditures the government can counteract theses forces, stabilising economic activity and thereby the leverage ratios. The same stabilising role can be played when government expenditures are driven down in response to a decline in the difference between the actual and the target leverage ratios.

The third term in Equation (29) has been introduced to capture the fact that the government attempts to avoid excessive expenditures; gov_r is a reference value. When $gov > gov_r$, the government expenditures-to-capital ratio tends to decrease, and vice versa (see Charpe *et al*. 2011, ch. 9 for a similar assumption).

3.3 The 5D macroeconomic system

The equilibrium in the product market is brought about by changes in the rate of capacity utilisation.[17] We insert equations (3) and (8) into (25) and divide through by capital stock. Making the necessary substitutions and solving for the equilibrium rate of capacity utilisation (u^*) we obtain:

$$u^* = \frac{\delta_0 - b_0 + (\delta_2 + b_2\phi)lf^T + gov + (c_1\Gamma_1 + c_2)d + (c_1\Gamma_2 - \delta_2 - b_1)lf - c_1\Gamma_3 a - b_2 lb}{\Delta} \quad (30)$$

where $\Gamma_1 = i_d + (1-s_b)i_a h_2 - (1-s_b)i_d > 0$, $\Gamma_2 = (1-s_b)i_l - (1-s_f)i_l$, $\Gamma_3 = (1-s_b)i_a > 0$ and $\Delta = v - c_1 v(1 - s_f(1-s_w)) - \delta_1$. The product market equilibrium requires that the denominator of (30) be positive (i.e. $\Delta > 0$). We also assume that the numerator in equation (30) is positive to obtain a positive u^*.

Substituting equation (30) into equation (8) we get the equilibrium rate of effective investment (g^*):

[17] In the current chapter the rate of capacity utilisation is endogenously determined both in the short run and the long run. For the debate over the long-run endogeneity of capacity utilisation see Hein *et al*. (2012) and Skott (2012).

$$g^* = \delta_0 - b_0 + (\delta_2 + b_2\phi)lf^T + \delta_1 u^* - (\delta_2 + b_1)lf - b_2 lb \tag{31}$$

Differentiating equations (30) and (31) with respect to lf, d, a, lf^T and gov yields:[18]

$$\partial u^*/\partial lf = u^*_{lf} = \frac{c_1\Gamma_2 - \delta_2 - b_1 - b_2 lb_{lf}}{\Delta} \tag{32}$$

$$\partial u^*/\partial d = u^*_d = \frac{c_1\Gamma_1 + c_2 - b_2 lb_d}{\Delta} \tag{33}$$

$$\partial u^*/\partial a = u^*_a = \frac{-c_1\Gamma_3 - b_2 lb_a}{\Delta} < 0 \tag{34}$$

$$\partial u^*/\partial lf^T = u^*_{lf^T} = \frac{\delta_2 + b_2\phi}{\Delta} > 0 \tag{35}$$

$$\partial u^*/\partial gov = u^*_{gov} = \frac{1}{\Delta} > 0 \tag{36}$$

$$\partial g^*/\partial lf = g^*_{lf} = \delta_1 u^*_{lf} - \delta_2 - b_1 - b_2 lb_{lf} \tag{37}$$

$$\partial g^*/\partial d = g^*_d = \delta_1 u^*_d - b_2 lb_d \tag{38}$$

$$\partial g^*/\partial a = g^*_a = \delta_1 u^*_a - b_2 lb_a < 0 \tag{39}$$

$$\partial g^*/\partial lf^T = g^*_{lf^T} = \delta_2 + b_2\phi + \delta_1 u^*_{lf^T} > 0 \tag{40}$$

$$\partial g^*/\partial gov = g^*_{gov} = \delta_1 u^*_{gov} > 0 \tag{41}$$

where[19]

$$\partial lb/\partial lf = lb_{lf} = lb^2 \frac{-a-d}{(lf + (h_1 + h_2)d)^2} < 0 \tag{42}$$

$$\partial lb/\partial d = lb_d = lb^2 \frac{lf - (h_1 + h_2)a}{(lf + (h_1 + h_2)d)^2} \tag{43}$$

$$\partial lb/\partial a = lb_a = \frac{lb^2}{lf + (h_1 + h_2)d} > 0 \tag{44}$$

[18] It can be easily shown that the economic activity in the model is wage-led (i.e. $\partial u^*/\partial s_W > 0$).

[19] Scaling equations (19) and (20) by capital stock and substituting into (13), yields: $lb = [lf + (h_1 + h_2)d]/[lf - (1 - h_1 - h_2)d - a]$.

The impact of firms' leverage on capacity utilisation and effective investment cannot be unambiguously determined (see equations (32) and (37)). In the model there are three unfavourable and two favourable effects of a higher firms' leverage on economic activity (see Table 3). An increase in the leverage of firms tends to depress investment due to the direct adverse impact on desired investment and credit rationing. Moreover, it places downward pressures on consumption because it affects negatively firms' distributed profits. These are the unfavourable effects. The favourable effects are associated with the expansionary impact of banks' distributed profits on consumption as well as with the inverse link between the leverage of firms and the leverage of banks (see equation (42)); the latter implies that, other things equal, when the firm leverage increases (decreases) the bank leverage falls (rises), increasing (reducing) thereby credit availability.

Table 3. *Effects of firms' leverage ratio and deposits-to-capital ratio on economic activity*

Effect	Parameter(s) that capture the effect
Effects of firms' leverage ratio on economic activity	
Direct negative effect on desired investment	δ_2
Direct negative effect on credit availability	b_1
Indirect negative effect on consumption via the distributed profits of firms	$c_1(1-s_f)i_l$
Indirect positive effect on consumption via the distributed profits of banks	$c_1(1-s_b)i_l$
Indirect positive effect on credit availability via the leverage of banks	b_2
Effects of deposits-to-capital ratio on economic activity	
Indirect positive or negative effect on consumption via the distributed profits of banks	$c_1(1-s_b)(i_a h_2-i_d)$
Direct positive effect on consumption via wealth	c_2
Direct positive effect on consumption via interest payments	$c_1 i_d$
Indirect negative effect on credit availability via the leverage of banks	b_2

As mentioned at the outset, this chapter focuses on the case of a debt-burdened regime in which, according to the definition adopted, the partial derivatives of capacity utilisation and effective investment with respect to the leverage of firms are both negative. This is ensured by assuming that δ_2, s_b and b_1 are sufficiently large and s_f and b_2 are sufficiently small (and, hence, Γ_2 is small) so as for the negative effects of the firm leverage on aggregate demand to outweigh the positive ones; this implies that (32) and (37) are postulated to be negative.

Table 3 shows that an increase in the deposits-to-capital ratio on economic activity has both favourable and unfavourable effects on economic activity. Therefore, the sign of equations (33) and (38) is ambiguous. On the one hand, a rise in d tends to boost consumption via the wealth effect and the induced increase in the interest income of households. On the other hand, a higher d increases, *ceteris paribus*, the leverage of banks and hence credit rationing (throughout the chapter we adopt the plausible assumption that h_1 and h_2 are sufficiently small so as for $lb_d > 0$; see equation (43)). Moreover, there is an ambiguous impact on consumption from the distributed profits of banks: a higher d increases the interest paid by banks on deposits but it also increases the interest received on treasury bills (recall that treasury bills are a proportion of deposits).

Equations (34) and (39) show that an increase in the advances-to-capital ratio produces unambiguously a decrease in capacity utilisation and effective investment rate: a rise in advances-to-capital ratio leads, other things equal, to more liabilities and to a higher bank leverage (see equation (42)), enhancing thereby credit rationing; it also reduces the distributed profits of banks with negative effects on consumption. Equations (35) and (40) show that a higher target leverage ratio of firms increases the rate of capacity utilisation and the effective investment rate; the same holds for the target leverage ratio of banks which is a linear function of lf^T (see equation (28)). Lastly, equations (36) and (41) show that, when government expenditures-to-capital ratio increases, u^* and g^* become higher.

For the purposes of our analysis, attention is confined to the system of the five dynamic equations for the leverage of firms $(\dot{lf})$, the deposits-to-capital ratio $(\dot{d})$, the advances-to-capital ratio $(\dot{a})$, the target leverage of firms $(\dot{lf}^T)$, and the government expenditures-to-capital ratio $(g\dot{o}v)$.[20] It is assumed that in the dynamic evolution of the system the equilibrium values of u and g are always attained. We have that:

[20] Note that this 5D system is independent of the treasury bills held by the commercial banks, the central bank and the government. The treasury bills are determined as a residual, without having feedback effects on the 5D system (see equations (20), (22) and (24)).

$$lf = \left(\frac{\dot{L}}{K}\right) = \delta_0 - b_0 + (\delta_2 + b_2\phi)lf^T + \left[\delta_1 - s_f(1-s_w)v\right]u^* + \left(s_f i_l - \delta_2 - b_1 - g^*\right)lf - b_2 lb \tag{45}$$

$$\dot{d} = \left(\frac{\dot{D}}{K}\right) = (1-c_1)\left[1-s_f(1-s_w)\right]vu^* + \left[(1-c_1)\Gamma_1 - c_2 - g^*\right]d + (1-c_1)\Gamma_2 lf - (1-c_1)\Gamma_3 a \tag{46}$$

$$\dot{a} = \left(\frac{\dot{A}}{K}\right) = l\dot{f} - (1-h_1-h_2)\dot{d} - \left(s_b i_l - g^*\right)lf - \left[\Gamma_4 + (1-h_1-h_2)g^*\right]d + \left(s_b i_a - g^*\right)a \tag{47}$$

$$l\dot{f}^T = \xi_1(g - g_n) + \xi_2\left(lf_0^T - lf^T\right) \tag{48}$$

$$g\dot{o}v = e_1\left[\left(lf - lf^T\right) - \left(lf_0 - lf_o^T\right)\right] + e_2\left[\left(lb - lb^T\right) - \left(lb_0 - lb_o^T\right)\right] + e_3\left(gov_r - gov\right) \tag{49}$$

$$lb^T = \phi lf^T \tag{50}$$

The steady-state values of the variables are estimated by setting the above differential equations equal to zero.[21] The unique steady state of the system denoted by a subscript *0* is the following:

$$g_0 = g_n,\ gov_0 = gov_r,\ lf_0 = \frac{s_f(1-s_w)vu_0 - g_n}{s_f i_l - g_n},\ lb_0 = lb_0^T = \frac{lf_0 + (h_1+h_2)d_0}{lf_0 - (1-h_1-h_2)d_0 - a_0},$$

$$d_0 = \frac{(1-c_1)(\varepsilon_0 + \varepsilon_2 lf_0)}{g_n + c_2 - (1-c_1)\varepsilon_1},\ a_0 = \frac{(s_b i_l - g_n)lf_0 + \left[\Gamma_4 + (1-h_1-h_2)\right]d_0}{s_b i_a - g_n},$$

$$u_0 = \frac{g_n + gov_r + (c_1\Gamma_1 + c_2)d_0 + c_1\Gamma_2 lf_0 - c_1\Gamma_3 a_0}{\Delta_0} \text{ and}$$

$$lf_0^T = \frac{g_n - \left(\delta_0 - b_0 + \delta_1 u_0 - (\delta_2 + b_1)lf_0 - b_2 lb_T\right)}{\delta_2 + b_2\phi}$$

where $\Gamma_4 = s_b(i_a h_2 - i_d)$, $\Delta_0 = v - c_1 v\left[1 - s_f(1-s_w)\right]$, $\varepsilon_0 = \left[\left(1 - s_f(1-s_w)\right)v(g_n + gov_r)\right]/\Delta_0$,
$\varepsilon_1 = \left[\Gamma_1 v + \left(1 - s_f(1-s_w)\right)c_2 v\right]/\Delta_0 - \left[\Gamma_3 v(\Gamma_4 + (1-h_1-h_2)g_n)\right]/\left[(s_b i_a - g_n)\Delta_0\right]$ and
$\varepsilon_2 = \left[v\Gamma_2\right]/\Delta_0 - \left[v\Gamma_3(s_b i_l - g_n)\right]/\left[(s_b i_a - g_n)\Delta_0\right]$.

---

[21] In the mathematical analysis and the simulation exercises presented in section 4 it is assumed that $g_n > (\delta_0 - b_0 + \delta_1 u_0 - (\delta_2 + b_1)lf_0 - b_2 lb_0)$, $s_b i_a < g_n$, $(s_b i_l - g_n)lf_0 + (\Gamma_4 + (1-h_1-h_2))d_0 < 0$, $s_f i_l > g_n$ and $s_f(1-s_w)vu_0 > g_n$. These conditions ensure that the values of the variables at the steady state are always positive.

3.4 Instability, cycles and the stabilising role of fiscal policy

3.4.1 The macro system with exogenous desired margins of safety and government expenditures

We initially focus on the 3D subsystem given by the laws of motion for lf, d and a; lf^T and gov are kept at their steady-state values. The interactions between the endogenous variables in this subsystem are quite complex. As described in section 3.3, lf, d and a affect the investment rate and the capacity utilisation rate. Simultaneously, any change in investment and capacity utilisation influences lf, d and a through various channels. This implies that the three endogenous variables are all interconnected in a complex way.

It is worth mentioning briefly the channels through which investment and capacity utilisation influence lf, d and a. A common effect of investment on the loans-to-capital ratio, the deposits-to-capital ratio and the advances-to-capital ratio is the impact on the denominator of these ratios though the resulting changes in capital stock. Remarkably, the higher these ratios the more important the impact of capital stock variations.

Regarding the law of motion of lf, an increase in capacity utilisation exerts counteracting effects on new loans (and therefore on the numerator of the leverage ratio). On the one hand, there is a tendency of new loans to increase since desired investment is positively affected by a higher capacity utilisation rate. On the other hand, new loans tend to decline because higher economic activity increases the sales of firms and, thus, their undistributed profits. The deposits-to-capital ratio is positively influenced by a rise in capacity utilisation and investment: higher economic activity tends to increase the income of households and, therefore, their saving and deposits. The advances-to-capital ratio is not directly affected by economic activity; however, the balance sheet of banks implies that there are indirect effects through the change in loans and deposits.

The stability properties of the 3D subsystem are summarised in Proposition 1.

Proposition 1. *Consider the 3D subsystem of equations (45)-(47). Suppose that economic activity is debt-burdened (i.e.* δ_2*,* s_b *and* b_1 *are sufficiently large and* s_f*,* b_2 *and* Γ_2 *are sufficiently small). If* lf_0*,* d_0*,* a_0*,* Γ_1 *and* Γ_3 *are sufficiently small, the steady state of the 3D subsystem is locally stable (see Appendix A for the proof).*

The economic rationale behind Proposition 1 can be explained as follows. Sufficiently low values of s_f and lf_0 ensure that any increase (decrease) in investment and capacity utilisation translates into a higher (lower) lf: the new loans created by the inducement of firms to invest more (less) outweigh the increase (decline) in undistributed profits and the increase (decrease) in capital stock. Therefore, the existence of a debt-burdened regime in conjunction with a low lf_0 ensures a stabilising relationship between the investment rate and the leverage of firms: a rise in lf reduces investment, lower investment decreases lf and the decline in lf brings the investment rate back to its steady-state value (and vice versa). Moreover, sufficiently low values of d_0 and a_0, Γ_1 and Γ_3 ensure that there is a similar stabilising relationship between economic activity, the deposits-to-capital ratio and the advances-to-capital ratio. Recall that Γ_1 and Γ_3 are related with the impact of d and a on capacity utilisation: the lower they are the lower this impact. Hence, if the conditions described in Proposition 1 are satisfied, the system becomes overall stable.

3.4.2 Making the desired margins of safety endogenous

We now turn to analyse the stability properties of the subsystem in which the target leverage ratios change endogenously. This is the 4D subsystem consisting of equations (45)-(48); gov is kept at its steady-state value. Its stability properties are described in Proposition 2.

Proposition 2. *Consider the 4D subsystem of equations (45)-(48). Suppose that the conditions described in Proposition 1 hold (i.e. the 3D subsystem is stable). Suppose also that the Conditions (51)-(54) hold.*

$$g_{lf^T} < \frac{a_1^{(3)} + \xi_2}{\xi_1} \quad (51)$$

$$g_{lf^T} < \frac{\Omega}{a_1^{(3)}} \quad (52)$$

$$g_{lf^T} < \frac{-(\Omega_1 + \Omega_2 + \Omega_3)}{a_2^{(3)}} \quad (53)$$

$$g_{lf^T} < \frac{\Psi}{a_3^{(3)}} \quad (54)$$

Then, the steady state of the 4D subsystem is locally stable, unstable or exhibits a limit cycle depending on the value of ξ_1 (the sensitivity of target leverage ratios to the investment cycle). In particular, it holds that:
(I) The system is locally stable for sufficiently small values of ξ_1.
(II) The system is locally unstable for sufficiently high values of ξ_1.
(III) There is a parameter value ξ_1^b at which a simple Hopf bifurcation occurs and the subsystem exhibits a limit cycle.
(See Appendix B for the proof).

The endogenous change in the target leverage ratios can generate destabilising forces in an otherwise stable system in which economic activity is debt-burdened. The reason is briefly the following: As the effective investment rate increases (decreases) relative to the normal rate, the target leverage ratios become higher (lower) (see equations (48) and (50)). Consequently, the negative stabilising effect of the leverage of firms and banks on desired investment and credit availability becomes less (more) strong due to the higher (lower) euphoria of firms and banks and the decline (increase) in perceived risk.

Proposition 2 suggests that the stability of the 4D subsystem is guaranteed only if the sensitivity of the target leverage ratios to the investment cycle is below a critical value, as well as if the partial derivative of effective investment with respect to the firms' target leverage ratio is not high enough (see Conditions (51)-(54)). These conditions ensure that the destabilising forces of increasing euphoria and lower perceived risk are not sufficiently large. If these conditions are not met instability emerges.

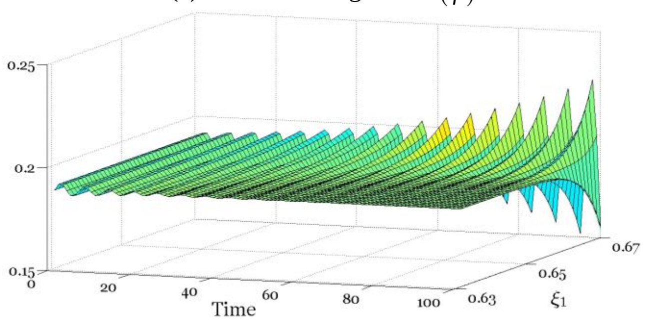
In order to analyse in greater detail the destabilising effects of endogenous alterations in the target leverage ratio we have conducted some simulations using the parameter values reported in Appendix C.[22] In the simulation analysis ξ_1 has been used as the critical parameter for the stability properties of the subsystem.[23] Moreover, the underlying 3D subsystem described in section 3.4.1 is always stable.

Figure 1 shows the effects of an increasing ξ_1 on the stability of the subsystem, in the aftermath of an exogenous rise in the target leverage ratios. It can be readily seen that, as the sensitivity of the target leverage ratios to the investment cycle rises, the subsystem gradually turns from stability to instability.[24]

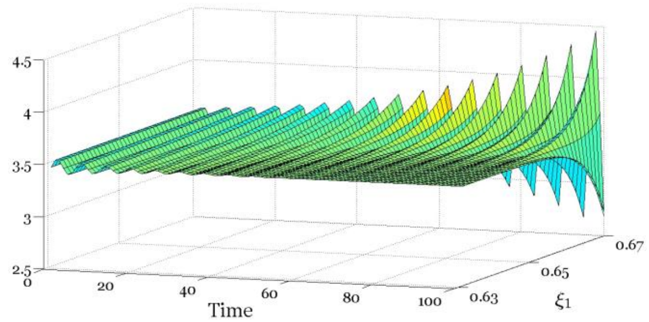
[22] The Matlab codes for the simulation exercises are reported in Appendix D.
[23] The simulation exercises presented in Figure 1 as well as in Figure 4 have been inspired by Chiarella *et al*. (2012).
[24] The system turns from stability to instability at $\xi_1 = 0.659$.

Fig. 1. *Dynamic adjustments of the 4D subsystem to a 1% increase in the target leverage ratios for varying values of target leverage ratios' sensitivity to the investment cycle* (ξ_1)

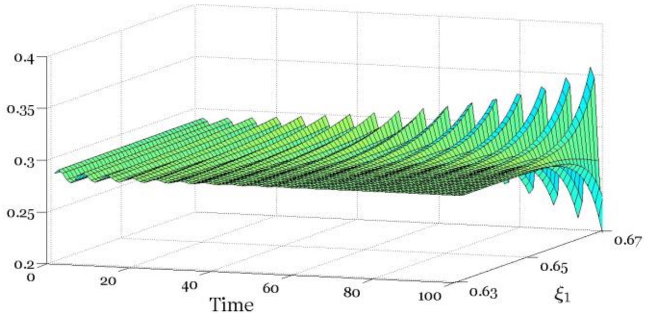
(a) Firms' leverage ratio (lf)



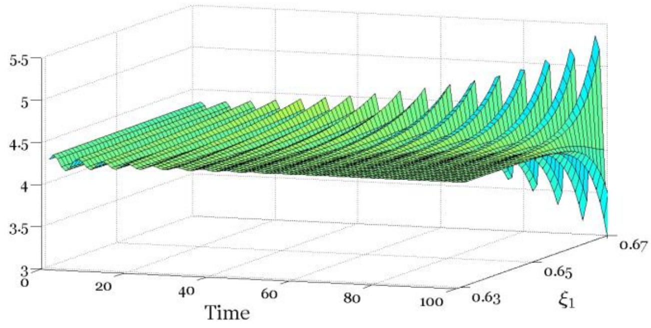
(b) Banks' leverage ratio (lb)



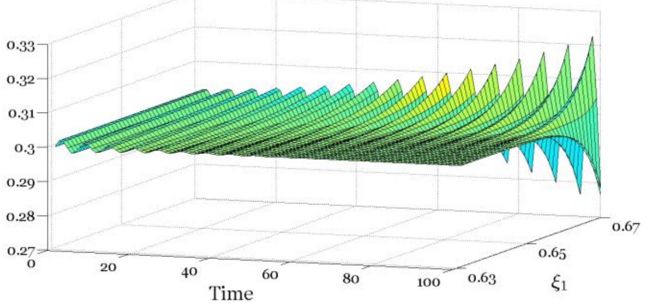
(c) Firms' target leverage ratio (lf^T)



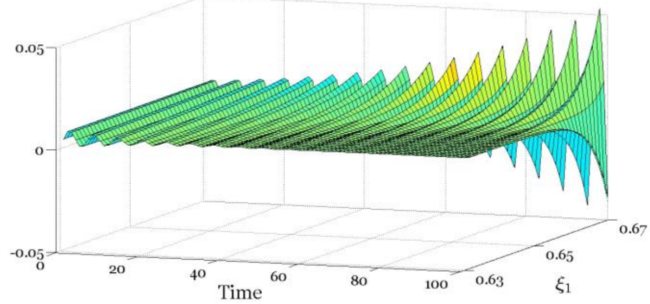
(d) Banks' target leverage ratio (lb^T)



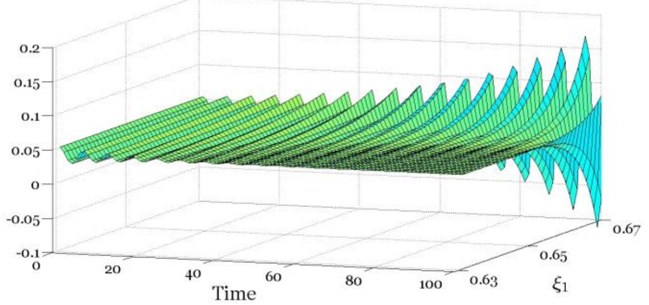
(e) Deposits-to-capital ratio (d)



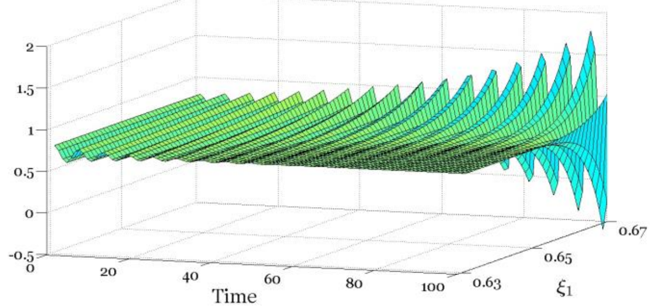
(f) Advances-to-capital ratio (a)



(g) Effective investment rate (g)



(h) Capacity utilisation rate (u)



In order to understand the underlying mechanisms, it is useful first to outline the case in which $\xi_1 = 0$. In this case an exogenous rise in the target leverage ratios leads to higher desired investment and greater credit availability. The resulting higher effective investment increases firm and bank leverage (in our simulations it also leads to a higher level of deposits and advances relative to capital stock). Since economic activity is debt-burdened, the increasing firm leverage generates lower investment which, in turn, brings loans, deposits and advances to their steady-state values.

On the other hand, when the target leverage ratios are endogenous, an exogenous increase in these targets does not only increase effective investment and new loans, but also positively affects, via higher accumulation, the euphoria of firms and banks. This euphoria combined with the lower perceived risk tends to further increase loan accumulation. If ξ_1 is high enough, this new second-round effect is likely to produce an excessive increase in the leverage of firms and banks, giving rise to a destabilising mechanism. The inverse mechanisms are at work when the effective investment rate falls short of the normal one. Overall, the higher the value of ξ_1 the stronger the destabilising forces, as Figure 1 illustrates.

Proposition 2 suggests that there is a critical value for ξ_1 at which the destabilising forces exactly offset the stabilising ones, producing a limit cycle. Figure 2 illustrates the trajectories of the main variables of the 4D subsystem in our simulations when a limit cycle emerges. Figure 3 shows the relationship between the leverage ratio of firms and the effective investment rate under the case of a limit cycle.

Fig. 2. *Dynamic trajectories under the case of a limit cycle in the 4D subsystem*

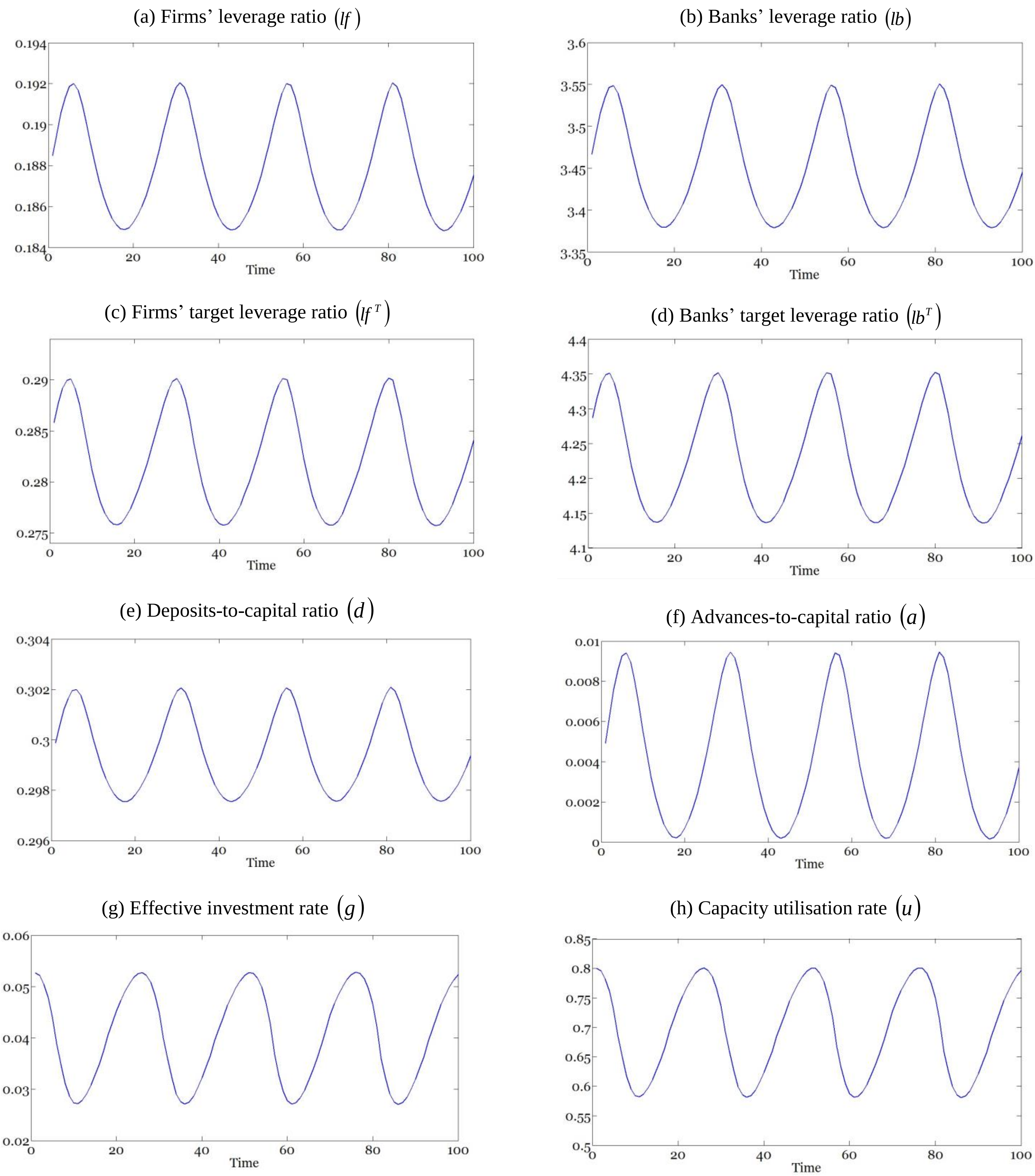
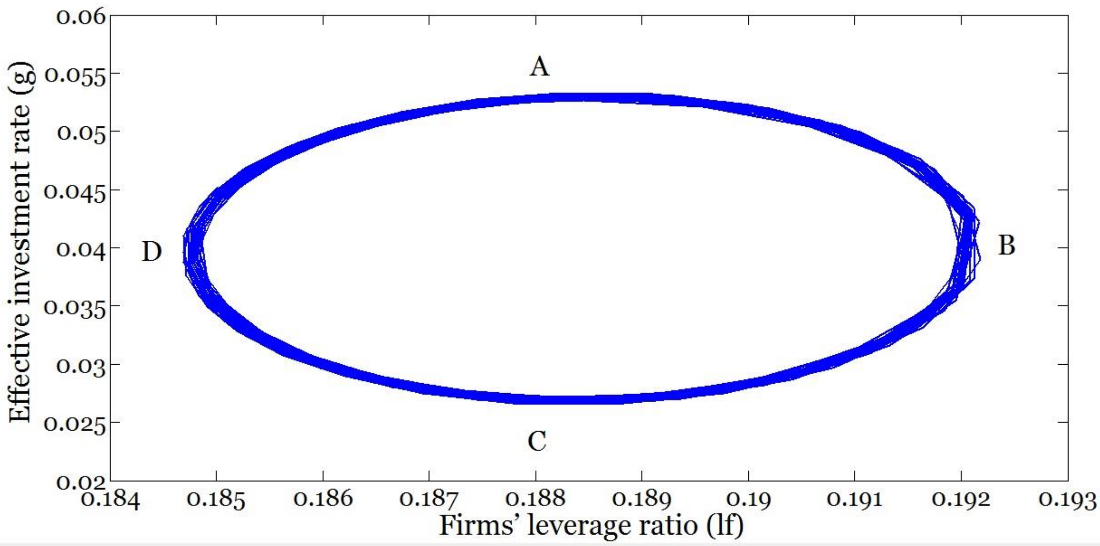


Fig. 3. *Relationship between firms' leverage ratio and effective investment rate under the case of a limit cycle in the 4D subsystem*



The cyclical behaviour of the economy can be described as follows. Initially, the effective investment rate is driven up, following the exogenous increase in the target leverage ratios; the economy is located at point A in Figure 3. Since the effective investment rate becomes higher than the normal one (the latter is equal to 0.04 in our simulations), a second-round endogenous increase in the target leverage ratio occurs. The firm leverage increases as a result of the higher capital accumulation and the greater willingness of both firms and banks to undertake more risky projects. The rise in the firm leverage produces in our simulations an increase in bank leverage.

The higher leverage of both firms and banks has negative feedback effects on the effective investment rate. Eventually, this rate falls short of the normal one (point B in Figure 3), generating a fall in the target leverage ratio of firms and banks. As a consequence, the leverage of firms and banks start falling. When these variables reach a sufficiently low value (point C in Figure 3), the effective investment rate starts increasing. Yet, the economy continues to experience a fall in lf and lb for some periods: the pessimism of economic agents keeps rising and the effective investment rate is still low to cause a sufficient increase in new loans. When the effective investment rate passes the g_n threshold (point D in Figure 3), the euphoric expectations begin to dominate again, producing a rise in the leverage ratio of firms and banks. Simultaneously, the effective investment rate continues to increase until the leverage ratios of firms and banks become high enough to cause a fall in the effective investment rate. When this happens, a new cycle begins.

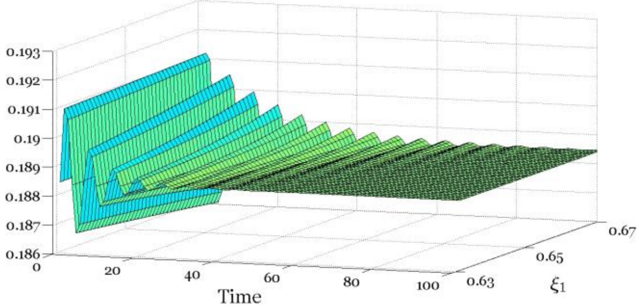
Interestingly enough, during the cycles investment and leverage move both in the same and in the opposite direction. In particular, during the investment boom periods, in which the investment rate is high and growing, the leverage ratios also increase; in the investment bust periods the leverage ratios decline. This movement of leverage and investment towards the same direction is caused by the endogenous change in the desired margins of safety that weakens the debt-burdened effect. However, there are also phases in which the effective investment rate moves inversely with the leverage ratios of firms and banks. In particular, when the effective investment rate starts rising (declining), the leverage ratios continue to fall (increase) until the effective investment rate becomes high (low) enough to trigger a rise (decline) in the target leverage ratios. It becomes thereby clear that the relationship between leverage and effective investment rate crucially relies on the way that the desired margins of safety change during the investment cycle.

3.4.3 The role of fiscal policy

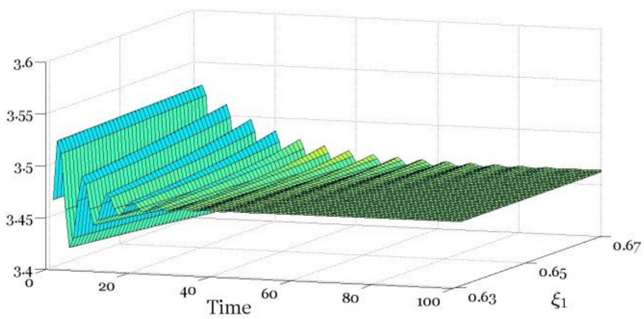
We now turn to investigate whether fiscal policy can reduce the destabilsing forces generated by the endogenous changes in the desired margins of safety. The government expenditures-to-capital ratio is allowed to change endogenously according to the fiscal rule described in equation (49). We examine whether, for identical parameter values as in Figure 1 and for the same range of values for ξ_1, the 5D system is characterised by higher stability. Figure 4 indicates that this is indeed the case: the rise in the sensitivity of target leverage ratios to the investment cycle does not increase the fluctuation of the macroeconomic variables, as it is the case in Figure 1.

Fig. 4. *Dynamic adjustments of the 5D system to a 1% increase in the target leverage ratios for varying values of target leverage ratios' sensitivity to the investment cycle* (ξ_1)

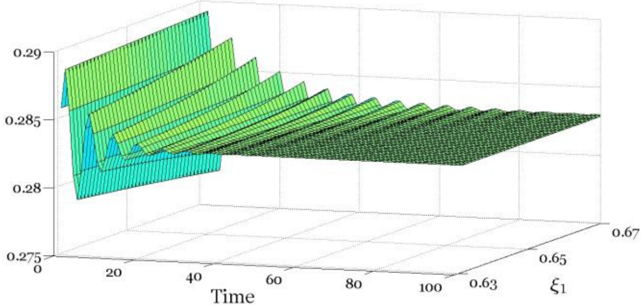
(a) Firms' leverage ratio (lf)



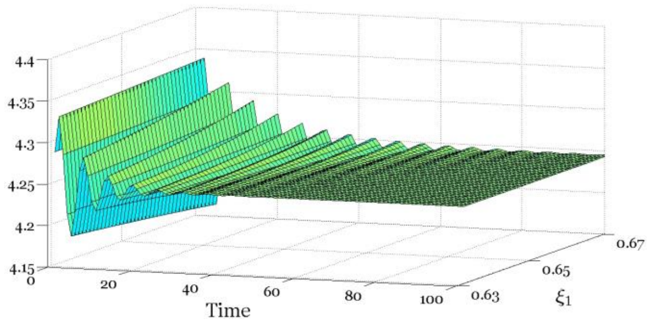
(b) Banks' leverage ratio (lb)



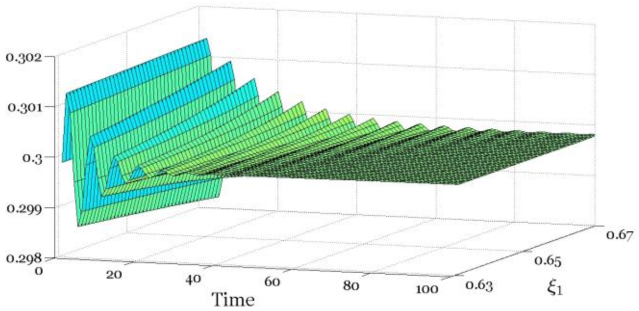
(c) Firms' target leverage ratio (lf^T)



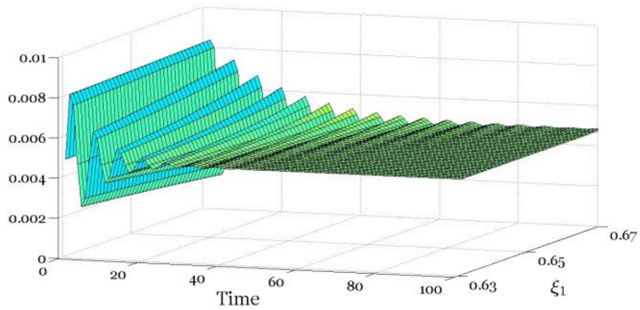
(d) Banks' target leverage ratio (lb^T)



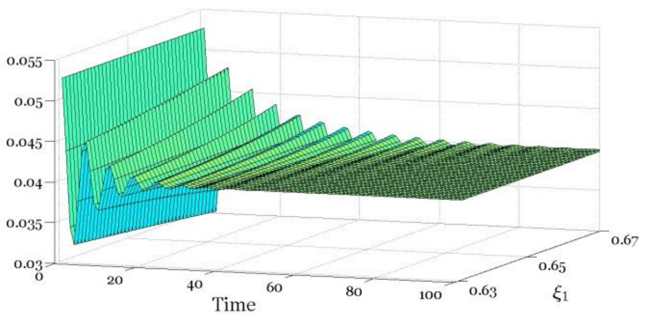
(e) Deposits-to-capital ratio (d)



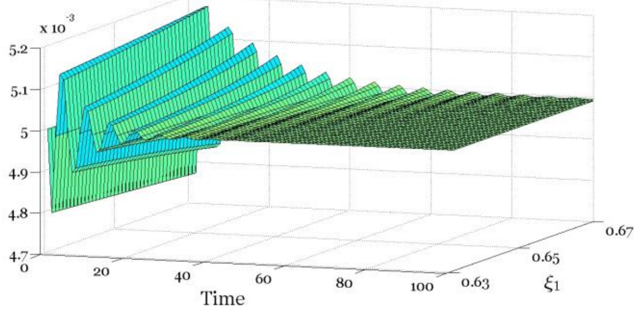
(f) Advances-to-capital ratio (a)



(g) Effective investment rate (g)



(h) Government expenditures-to-capital ratio (gov)



The economic interpretation is the following. In the 4D subsystem in which gov is exogenous the rise in the target leverage ratio of firms and banks leads to an economic expansion that produces second-round destabilising forces in the system due to the positive impact of investment on target leverage ratios. In the 5D system the fiscal rule mitigates these second-round forces. By generating a reduction in gov as a response to the rise in the target leverage ratios, the induced increase in the investment rate is less strong and, hence, the increase in the target leverage ratios is less significant. Moreover, in the periods in which the expectations deteriorate and the target leverage ratios decline relative to the actual ones the fiscal rule causes a rise in gov preventing a significant reduction in economic activity. Consequently, the fiscal rule put forward in this chapter dampens the large oscillations in the macroeconomic variables, which are fuelled by the rise in ξ_1, rendering the macro system more stable.

3.5 Conclusion

This chapter presented a stock-flow consistent macrodynamic model in which firms' and banks' desired margins of safety play a central role in the behaviour of the macroeconomy. The model incorporates an active commercial banking sector, allowing us to pay particular attention to the evolution of the leverage of both firms and banks during the investment cycle. Dynamic analysis illustrated that a higher sensitivity of firms' and banks' desired margins of safety to the investment cycle makes the macro system more prone to instability. Therefore, the euphoria and low perceived risk of both firms and banks during an investment boom and the excessively high desired margins of safety during an investment bust can be important sources of instability. Moreover, simulation analysis showed that leverage and investment can move both in the same and in the opposite direction during the cycles without being necessary to turn from a debt-burdened regime to a debt-led one.

The chapter also analysed the stabilising role of fiscal policy in an economy in which desired margins of safety change endogenously. The chapter put forward a fiscal rule that produces a rise (decline) in government expenditures when firms and banks have excessively high (low) desired margins of safety. Simulation analysis indicated that this rule has stabilising effects. Therefore, a fiscal policy that responds adequately to the endogenous changes in the desired margins of safety appears to be essential for the stability of the macroeconomic system.

Appendices

Appendix A. Proof of Proposition 1

The Jacobian matrix of the 3D subsystem (J_{3D}) consisting of equations (45)-(47) evaluated at the steady state is written as:

$$J_{3D} = \begin{pmatrix} J_{11} & J_{12} & J_{13} \\ J_{21} & J_{22} & J_{23} \\ J_{31} & J_{32} & J_{33} \end{pmatrix}$$

where

$$J_{11} = \partial \dot{lf} \big/ \partial lf = H_1 - b_1\left(1 - lf_0 + \frac{X_0}{\Delta}\right)$$

$$J_{12} = \partial \dot{lf} \big/ \partial d = X_0 u_d - (1 - lf_0) b_2 lb_d$$

$$J_{13} = \partial \dot{lf} \big/ \partial a = X_0 u_a - (1 - lf_0) b_2 lb_a$$

$$J_{21} = \partial \dot{d} \big/ \partial lf = H_2 - b_1\left(\frac{Z_0}{\Delta} - d_0\right)$$

$$J_{22} = \partial \dot{d} \big/ \partial d = Z_0 u_d + (1 - c_1)\Gamma_1 - c_2 - g_n + b_2 lb_d d_0$$

$$J_{23} = \partial \dot{d} \big/ \partial a = Z_0 u_a - (1 - c_1)\Gamma_3 + d_0 b_2 lb_a$$

$$J_{31} = \partial \dot{a} \big/ \partial lf = H_3 - b_1\left(\frac{\Gamma_5 - a_0\delta_1}{\Delta} + 1 - a_0\right)$$

$$J_{32} = \partial \dot{a} \big/ \partial d = (\Gamma_5 - a_0\delta_1) u_d - b_2 lb_d (1 - a_0) - \Gamma_4 - (1 - h_1 - h_2)[(1 - c_1)\Gamma_1 - c_2]$$

$$J_{33} = \partial \dot{a} \big/ \partial a = (\Gamma_5 - a_0\delta_1) u_a - b_2 lb_a (1 - a_0) + s_b i_a - g_n + (1 - h_1 - h_2)(1 - c_1)\Gamma_3$$

We have that $X_0 = \delta_1(1 - lf_0) - s_f(1 - s_w)v$, $Z_0 = (1 - c_1)[1 - s_f(1 - s_w)]v - d_0\delta_1$,

$\Gamma_5 = \delta_1 - s_f(1 - s_w)v - (1 - h_1 - h_2)(1 - c_1)[1 - s_f(1 - s_w)]v$,

$H_1 = s_f i_l - g_n - (\delta_2 + b_2 lb_{lf})\left(1 - lf_0 + \frac{X_0}{\Delta}\right) + \frac{X_0 c_1 \Gamma_2}{\Delta}$,

$$H_2 = -(\delta_2 + b_2 lb_{lf})\left(\frac{Z_0}{\Delta} - d_0\right) + c_1\Gamma_2 + \frac{Z_0}{\Delta}(1-c_1)\Gamma_2 \text{ and}$$

$$H_3 = s_f i_l - s_b i_l - (1-h_1-h_2)(1-c_1)\Gamma_2 - (\delta_2 + b_2 lb_{lf})\left(\frac{\Gamma_5 - a_0\delta_1}{\Delta} + 1 - a_0\right) + \frac{\Gamma_5 - a_0\delta_1}{\Delta} c_1\Gamma_2 .$$

The Routh-Hurwitz necessary and sufficient conditions for the stability of the 3D subsystem require that the coefficients $a_1^{(3)}, a_2^{(3)}, a_3^{(3)}, b^{(3)}$ be all positive in the steady state (see Gandolfo, 2010). These coefficients are as follows:

$$a_1^{(3)} = -Tr(J_{3D}) = \Theta_1 + \left(1 - lf_0 + \frac{X_0}{\Delta}\right)b_1 \tag{A.1}$$

$$a_2^{(3)} = \begin{vmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{vmatrix} + \begin{vmatrix} J_{11} & J_{13} \\ J_{31} & J_{33} \end{vmatrix} + \begin{vmatrix} J_{22} & J_{23} \\ J_{32} & J_{33} \end{vmatrix} = \Theta_2 + \Theta_3 b_1 \tag{A.2}$$

$$a_3^{(3)} = -Det(J_{3D}) = \Theta_4 + \Theta_5 b_1 \tag{A.3}$$

$$b^{(3)} = a_1^{(3)}a_2^{(3)} - a_3^{(3)} = \Theta_3\left(1 - lf_0 + \frac{X_0}{\Delta}\right)b_1^2 + \left(\Theta_1\Theta_3 + \Theta_2\left(1 - lf_0 + \frac{X_0}{\Delta}\right) - \Theta_5\right)b_1 + \Theta_1\Theta_2 - \Theta_4 \tag{A.4}$$

where $\Theta_1 = -H_1 - J_{22} - J_{33}$, $\Theta_2 = H_1(J_{22} + J_{33}) - H_3 J_{13} + J_{22}J_{33} - H_2 J_{12} - J_{32}J_{23}$,

$$\Theta_3 = -\left(1 - lf_0 + \frac{X_0}{\Delta}\right)(J_{22} + J_{33}) + \left(\frac{Z_0}{\Delta} - d_0\right)J_{12} + \left(\frac{\Gamma_5 - a_0\delta_1}{\Delta} + 1 - a_0\right)J_{13},$$

$$\Theta_4 = -H_1(J_{22}J_{33} - J_{32}J_{23}) + H_2(J_{12}J_{33} - J_{13}J_{32}) + H_3(J_{13}J_{22} - J_{12}J_{23}) \text{ and}$$

$$\Theta_5 = \left(1 - lf_0 + \frac{X_0}{\Delta}\right)(J_{22}J_{33} - J_{32}J_{23}) - \left(\frac{Z_0}{\Delta} - d_0\right)(J_{12}J_{33} - J_{13}J_{32}) - \left(\frac{\Gamma_5 - \delta_1 a_0}{\Delta} + 1 - a_0\right)(J_{13}J_{22} - J_{12}J_{23}).$$

We have $a_1^{(3)} > 0$ since $J_{11}, J_{22}, J_{33} < 0$. In particular, $J_{11} < 0$ due to the assumptions that lf_0, b_2, s_f, and Γ_2 are sufficiently small; $J_{22} < 0$ because of the assumptions that $lb_d > 0$ and that d_0, Γ_1, b_2 are sufficiently small; $J_{33} < 0$ due to the assumptions that $s_b i_a < g_n$ (see footnote 21) and that a_0, Γ_3 are sufficiently small.

It holds that $a_2^{(3)} > 0$ since $\Theta_2, \Theta_3 > 0$. We have $\Theta_2 > 0$ because the terms $H_1(J_{22} + J_{33})$, $J_{22}J_{33}$ are positive and adequately large. In particular, $H_1(J_{22} + J_{33})$ is positive because $J_{22}, J_{33} < 0$ (see above) and $H_1 < 0$ due to a sufficiently small lf_0; $J_{22}J_{33}$ is positive because $J_{22}, J_{33} < 0$ (see above). The terms $H_1(J_{22} + J_{33})$, $J_{22}J_{33}$ are sufficiently large because of the assumption that a_0 is low enough. Moreover, $\Theta_3 > 0$ since the term $-\left(1 - lf_0 + \frac{X_0}{\Delta}\right)(J_{22} + J_{33})$ is positive and adequately large. This term is positive because $J_{22}, J_{33} < 0$ (see above) and lf_0 is sufficiently small. Additionally, the term $-\left(1 - lf_0 + \frac{X_0}{\Delta}\right)(J_{22} + J_{33})$ is adequately large due to a sufficiently small a_0.

We have $a_3^{(3)} > 0$ because $\Theta_4, \Theta_5 > 0$. In particular, $\Theta_4 > 0$ because the term $-H_1 J_{22} J_{33}$ is positive and adequately large; it is positive since $J_{22}, J_{33}, H_1 < 0$ (see above) and it is adequately large due to a sufficiently small a_0. Moreover, $\Theta_5 > 0$ because the term $\left(1 - lf_0 + \frac{X_0}{\Delta}\right) J_{22} J_{33}$ is positive and adequately large; it is positive since $J_{22}, J_{33} < 0$ (see above) and due to a sufficiently small lf_0; it is adequately large due to a sufficiently small a_0.

Finally, $b^{(3)} > 0$ because a sufficiently small d_0 and a sufficiently small lf_0 ensure that $\Theta_1\Theta_2 - \Theta_4 > 0$ and $\Theta_1\Theta_3 + \Theta_2\left(1 - lf_0 + \frac{X_0}{\Delta}\right) - \Theta_5 > 0$.

Appendix B. Proof of Proposition 2

The Jacobian matrix of the 4D subsystem $\left(J_{4D}\right)$ consisting of equations (45)-(48) evaluated at the steady state is written as:

$$J_{4D}=\begin{pmatrix} J_{11} & J_{12} & J_{13} & J_{14} \\ J_{21} & J_{22} & J_{23} & J_{24} \\ J_{31} & J_{32} & J_{33} & J_{34} \\ J_{41} & J_{42} & J_{43} & J_{44} \end{pmatrix}$$

where

$$J_{14}=\partial l\dot{f}/\partial lf^{T}=\left(\delta_2+b_2\phi\right)\left(1-lf_0+\frac{X_0}{\Delta}\right)$$

$$J_{24}=\partial\dot{d}/\partial lf^{T}=\left(\delta_2+b_2\phi\right)\left(\frac{Z_0}{\Delta}-d_0\right)$$

$$J_{34}=\partial\dot{a}/\partial lf^{T}=\left(\delta_2+b_2\phi\right)\left(1-a_0+\frac{\Gamma_5-a_0\delta_1}{\Delta}\right)$$

$$J_{41}=\partial l\dot{f}^{T}/\partial lf=\xi_1 g_{lf}$$

$$J_{42}=\partial l\dot{f}^{T}/\partial d=\xi_1 g_{d}$$

$$J_{43}=\partial l\dot{f}^{T}/\partial a=\xi_1 g_{a}<0$$

$$J_{44}=\partial l\dot{f}^{T}/\partial lf^{T}=\xi_1 g_{lf^{T}}-\xi_2$$

The rest entries of the Jacobian matrix are reported in Appendix A.

The conditions of Proposition 1 suggest that $J_{14}, J_{24}, J_{34}>0$ and $J_{41}<0$. In particular, a sufficient low value of lf_0 implies that $J_{14}>0$; a sufficient low value of d_0 suggests that $J_{24}>0$; a sufficient low value of a_0 implies that $J_{34}>0$; the existence of debt-burdened regime suggests that $J_{41}<0$.

The Routh-Hurwitz necessary and sufficient conditions for the stability of the 4D subsystem require that the coefficients $a_1^{(4)}, a_2^{(4)}, a_3^{(4)}, a_4^{(4)}, b^{(4)}$ be all positive in the steady state (see Gandolfo, 2010). These coefficients are written as follows:

$$a_1^{(4)} = -Tr(J_{4D}) = a_1^{(3)} + \xi_2 - \xi_1 g_{lf^T} \tag{B.1}$$

$$a_2^{(4)} = \begin{vmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{vmatrix} + \begin{vmatrix} J_{11} & J_{13} \\ J_{31} & J_{33} \end{vmatrix} + \begin{vmatrix} J_{22} & J_{23} \\ J_{32} & J_{33} \end{vmatrix} + \begin{vmatrix} J_{11} & J_{14} \\ J_{41} & J_{44} \end{vmatrix} + \begin{vmatrix} J_{22} & J_{24} \\ J_{42} & J_{44} \end{vmatrix} + \begin{vmatrix} J_{33} & J_{34} \\ J_{43} & J_{44} \end{vmatrix} =$$

$$= a_2^{(3)} + \xi_2 a_1^{(3)} - \xi_1 \left(a_1^{(3)} g_{lf^T} - \Omega \right) \tag{B.2}$$

$$a_3^{(4)} = -\begin{vmatrix} J_{11} & J_{12} & J_{13} \\ J_{21} & J_{22} & J_{23} \\ J_{31} & J_{32} & J_{33} \end{vmatrix} - \begin{vmatrix} J_{22} & J_{23} & J_{24} \\ J_{32} & J_{33} & J_{34} \\ J_{42} & J_{43} & J_{44} \end{vmatrix} - \begin{vmatrix} J_{11} & J_{13} & J_{14} \\ J_{31} & J_{33} & J_{34} \\ J_{41} & J_{43} & J_{44} \end{vmatrix} - \begin{vmatrix} J_{11} & J_{12} & J_{14} \\ J_{21} & J_{22} & J_{24} \\ J_{41} & J_{42} & J_{44} \end{vmatrix} =$$

$$= a_3^{(3)} + \xi_2 a_2^{(3)} - \xi_1 \left(g_{lf^T} a_2^{(3)} + \Omega_1 + \Omega_2 + \Omega_3 \right) \tag{B.3}$$

$$a_4^{(4)} = Det(J_{4D}) = \xi_2 a_3^{(3)} - \xi_1 \left(a_3^{(3)} g_{lf^T} - \Psi \right) \tag{B.4}$$

$$b^{(4)} = a_1^{(4)} a_2^{(4)} a_3^{(4)} - \left(a_1^{(4)} \right)^2 a_4^{(4)} - \left(a_3^{(4)} \right)^2 = \Psi_0 + \Psi_1 \xi + \Psi_2 \xi_1^2 + + \Psi_3 \xi_1^3 \tag{B.5}$$

where $\Omega = -J_{14} g_{lf} - J_{34} g_a - J_{24} g_d$, $\Omega_1 = g_{lf} \left(J_{12} J_{24} - J_{14} J_{22} + J_{13} J_{34} - J_{14} J_{33} \right)$,

$\Omega_2 = g_d \left(-J_{24} J_{11} + J_{14} J_{21} + J_{23} J_{34} - J_{24} J_{33} \right)$,

$\Omega_3 = g_a \left(-J_{11} J_{34} + J_{14} J_{31} - J_{22} J_{34} + J_{24} J_{32} \right)$,

$\Psi = g_a \left[J_{11} \left(-J_{22} J_{34} + J_{24} J_{32} \right) - J_{12} \left(-J_{21} J_{34} + J_{24} J_{31} \right) - J_{14} \left(J_{21} J_{32} - J_{22} J_{31} \right) \right]$

$\quad + g_d \left[J_{11} \left(J_{23} J_{34} - J_{24} J_{32} \right) + J_{13} \left(-J_{21} J_{34} + J_{24} J_{31} \right) - J_{14} \left(-J_{21} J_{33} + J_{23} J_{31} \right) \right]$

$\quad + g_{lf} \left[-J_{12} \left(J_{23} J_{34} - J_{24} J_{33} \right) + J_{13} \left(J_{22} J_{34} - J_{24} J_{32} \right) - J_{14} \left(J_{22} J_{33} - J_{23} J_{32} \right) \right]$,

$\Psi_0 = \left(a_3^{(3)} + \xi_2 a_2^{(3)} \right) b^{(3)} + \left(a_1^{(3)} + \xi_2 \right) \xi_2^2 b^{(3)} > 0$ and

$\Psi_3 = -\left(g_{lf^T} + \Omega_1 + \Omega_2 + \Omega_3 \right) g_{lf^T} \left(a_1^{(3)} g_{lf^T} - \Omega \right) + g_{lf^T}^2 \left(a_3^{(3)} g_{lf^T} - \Psi \right) < 0$.

Note that Ψ_1 and Ψ_2 are independent of ξ_1.

Proof of 2 (I). Differentiating equations (B.1)-(B.4) with respect to ξ_1, yields:

$$\partial a_1^{(4)} / \partial \xi_1 = -g_{lf^T} < 0 \tag{B.6}$$

$$\partial a_2^{(4)} / \partial \xi_1 = -\left(a_1^{(3)} g_{lf^T} - \Omega\right) \tag{B.7}$$

$$\partial a_3^{(4)} / \partial \xi_1 = -\left(g_{lf^T} a_2^{(3)} + \Omega_1 + \Omega_2 + \Omega_3\right) \tag{B.8}$$

$$\partial a_4^{(4)} / \partial \xi_1 = -\left(a_3^{(3)} g_{lf^T} - \Psi\right) \tag{B.9}$$

Equation (B.6) implies that $a_1^{(4)}$ is a decreasing function of ξ_1; recall that $g_{lf^T} > 0$ (see equation (40)). The coefficient $a_1^{(4)}$ becomes equal to zero for $\xi_1 = \xi_1^{a_1} = \left(a_1^{(3)} + \xi_2\right) / g_{lf^T}$; note that $\xi_1^{a_1} > 0$ because $a_1^{(3)} > 0$ (see Appendix A). Therefore, $a_1^{(4)} > 0$ if $\xi_1 < \xi_1^{a_1}$ and $a_1^{(4)} < 0$ if $\xi_1 > \xi_1^{a_1}$. Moreover, since $a_2^{(3)}, a_3^{(3)} > 0$ (see Appendix A) and $\xi_2 > 0$, the coefficients $a_2^{(4)}, a_3^{(4)}$ and $a_4^{(4)}$ are all positive under the Conditions (52), (53) and (54).

By setting equation (B.5) equal to zero we obtain:

$$b^{(4)} = \Psi_3 \xi_1^3 + \Psi_2 \xi_1^2 + \Psi_1 \xi_1 + \Psi_0 = 0 \tag{B.10}$$

At $\xi_1 = 0$ we have $b^{(4)} = \Psi_0 > 0$. At $\xi_1 = \xi_1^{a_1}$, we have $b^{(4)} = -\left(a_3^{(4)}\right)^2 < 0$. Therefore, due to continuity, we obtain that for sufficiently positive low values of ξ_1 all of the Routh-Hurwitz conditions are satisfied (i.e. $a_1^{(4)}, a_2^{(4)}, a_3^{(4)}, a_4^{(4)}, b^{(4)} > 0$) and the system is thereby stable.

Proof of 2 (II). For sufficiently high values of ξ_1 we have $b^{(4)} < 0$ and, therefore, one of the Routh-Hurwitz conditions is violated. This implies that the system is unstable.

Proof of 2 (III). At $\xi_1 = 0$ we have $b^{(4)} > 0$ and at $\xi_1 = \xi_1^{a_1}$ we have $b^{(4)} < 0$. Hence, the cubic equation $b^{(4)}(\xi_1) = 0$ has at least one solution, ξ_1^b, such that $0 < \xi_1^b < \xi_1^{a_1}$

with the property that $b^{(4)} \neq 0$ for all ξ_1 near but not equal to ξ_1^b. Furthermore, at $\xi_1 = \xi_1^b$ we have $a_1^{(4)}, a_2^{(4)}, a_3^{(4)}, a_4^{(4)} > 0$. According to Asada and Yoshida (2003), these properties are sufficient for the existence of a simple Hopf bifurcation at $\xi_1 = \xi_1^b$.

Appendix C. Parameter values in simulations

δ_0	0.02	b_2	0.01	h_2	0.75
δ_1	0.1	c_1	0.7	ξ_2	0.5
δ_2	0.5	c_2	0.1	e_1	0.8
s_f	0.6	h_l	4	e_2	0.05
s_w	0.6	h_d	0.5	e_3	20
v	0.25	i_b	0.02	φ	15
b_0	0.01	s_b	0.3	gov_r	0.005
b_1	0.5	h_1	0.05	g_n	0.04

Appendix D.

The Matlab programme of the simulation analysis is as follows:

Figure 1

```
%-------------------------------------
%       Model Parametrisation
%-------------------------------------
% Goods Markets
delta0=0.02; delta1 = 0.1; delta2 = 0.5; sf = 0.6; sw = 0.6; v = 0.25;% Desired
investment
b0 = 0.01; b1 = 0.5; b2 = 0.01; % Credit rationing
c1 = 0.7; c2 = 0.1;  %Consumption function
ia= 0.02; ib=ia; hd=0.5; hl=4; il = hl*ia; id=hd*ia;   %Interest rates
govr = 0.005; sb= 0.3; h1=0.05; h2 = 0.75; gn=0.04; phi=15;
xi2=0.5;
e1=0; e2=0; e3=0;
% Parameters and steady state
bita1=v-sf*(1-sw)*v;
bita2=ia*h2-sb*(ia*h2-id);
bita3=c1*(sf-sb)*il-delta2-b1;
bita4=delta1-sf*(1-sw)*v;
bita5=(1-c1)*(sf-sb)*il;
bita6=sf*il-delta2-b1;
bita7=sf*(1-sw);
delta_0=v-c1*bita1;
delta=v-c1*bita1-delta1;
alpha0=bita1*(gn+govr)/delta_0;
alpha1=((v*bita2)/delta_0)+(c2*bita1/delta_0)-(v*(1-sb)*ia*(sb*(ia*h2-id)-(h1+h2-
1)*gn)/(delta_0*(sb*ia-gn)));
alpha2=v*(sf-sb)*il/delta_0-v*(1-sb)*ia*(sb*il-gn)/((sb*ia-gn)*delta_0);
lf0nom=gn-bita7*(alpha0+gn+govr)-bita7*(alpha1-gn)*(1-c1)*alpha0/(gn+c2-(1-
c1)*alpha1);
lf0den=bita7*alpha2-sf*il+gn+bita7*(alpha1-gn)*(1-c1)*alpha2/(gn+c2-(1-
c1)*alpha1);
lf0 =lf0nom/lf0den ;
d0 =((1-c1)*alpha0+(1-c1)*alpha2*lf0)/(gn+c2-(1-c1)*alpha1);
a0=((sb*il-gn)*lf0+(sb*(ia*h2-id)-(h1+h2-1)*gn)*d0)/(sb*ia-gn);
lb0=(lf0+(h1+h2)*d0)/(lf0+(h1+h2-1)*d0-a0);
lfT0=(delta0-b0+delta1*(gn+govr+(c1*bita2+c2)*d0+c1*(sf-sb)*il*lf0-c1*(1-
sb)*ia*a0)/delta_0-(delta2+b1)*lf0-b2*lb0-gn)/(-delta2-b2*phi);
lbT0=lfT0*phi;
u0=(delta0-b0+(delta2+b2*phi)*lfT0+govr+(c1*bita2+c2)*d0+bita3*lf0-c1*(1-
sb)*ia*a0-b2*lb0)/delta;
g=delta0-b0+(delta2+b2*phi)*lfT0+delta1*u0-(delta2+b1)*lf0-b2*lb0;
```

```
function [ dy ] = Banking(~,y,~, xi1)

Banking_Parameters;
lb=(y(1)+(h1+h2)*y(2))/(y(1)+(h1+h2-1)*y(2)-y(3));
u=(delta0-b0+(delta2+b2*phi)*y(4)+y(5)+(c1*bita2+c2)*y(2)+bita3*y(1)-c1*(1-
sb)*ib*y(3)-b2*lb)/delta;
g=delta0-b0+(delta2+b2*phi)*y(4)+delta1*u-(delta2+b1)*y(1)-b2*lb;

dy = zeros(5,1);
dy(1) = delta0-b0+(delta2+b2*phi)*y(4)+bita4*u+(bita6-g)*y(1)-b2*lb;
dy(2) =(1-c1)*bita1*u+((1-c1)*bita2-c2-g)*y(2)+bita5*y(1)-(1-c1)*(1-sb)*ib*y(3);
dy(3)=dy(1)+(h1+h2-1)*dy(2)+(g-sb*il)*y(1)+((h1+h2-1)*g-sb*(ib*h2-
id))*y(2)+(sb*ib-g)*y(3);
dy(4)=xi1*(g-gn)+xi2*(lfT0-y(4));
dy(5)=e1*((y(1)-y(4))-(lf0-lfT0))+e2*((lb-phi*y(4))-(lb0-lbT0))+e3*(govT-y(5));
end

clear
Banking_Parameters;

xi1max = 40;
for i= 1:1:xi1max
xi1(i)=0.63+i/1000;
options =odeset('RelTol',1e-10,'AbsTol',1e-10);
[t,y]=ode23s(@Banking,[0:100],[lf0,d0,a0,lfT0*1.01,govr],[], options, xi1(i));
out1(i,:) = y(:,1);
lf(i,:) = out1(i,:);
out2(i,:) = y(:,2);
d(i,:) = out2(i,:);
out3(i,:) = y(:,3);
a(i,:) = out3(i,:);
out4(i,:) = y(:,4);
lfT(i,:) = out4(i,:);
out5(i,:) = y(:,5);
govern(i,:) = out5(i,:);

leverage(i,:)=( lf(i,:) +(h1+h2)* d(i,:))./( lf(i,:) +(h1+h2-1)* d(i,:) - a(i,:));
capacity(i,:)=(delta0-b0+(delta2+b2*phi)* lfT(i,:) + govern(i,:) +(c1*bita2+c2)* d(i,:)
+bita3* lf(i,:) -c1*(1-sb)*ib* a(i,:) -b2* leverage(i,:))/delta;
leverageT(i,:)= phi*lfT(i,:);
investment(i,:)=delta0-b0+(delta2+b2*phi)* lfT(i,:) +delta1* capacity(i,:) -
(delta2+b1)* lf(i,:) -b2* leverage(i,:);
end

set(0,'DefaultAxesFontName','Georgia')
set(0,'defaultTextFontName','Georgia')
figure
set(gca,'FontSize',20);surfl(lf);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
```

```
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
zlim([0.15,0.25])

figure
set(gca,'FontSize',20);surfl(leverage);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
zlim([2.5,4.5])

figure
set(gca,'FontSize',20);surfl(lfT);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
zlim([0.2,0.4])

figure
set(gca,'FontSize',20);surfl(leverageT);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
zlim([3,5.5])

figure
set(gca,'FontSize',20);surfl(d);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
zlim([0.27,0.33])

figure
set(gca,'FontSize',20);surfl(a);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
```

```
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
zlim([-0.05,0.05])

figure
set(gca,'FontSize',20);surfl(investment);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
zlim([-0.1,0.2])

figure
set(gca,'FontSize',20);surfl(capacity);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
zlim([-0.5,2])
```

Figures 2 and 3

```
%-------------------------------------
%       Model Parametrisation
%-------------------------------------
% Goods Markets
delta0=0.02; delta1 = 0.1; delta2 = 0.5; sf = 0.6; sw = 0.6; v = 0.25;% Desired
investment
b0 = 0.01; b1 = 0.5; b2 = 0.01; % Credit rationing
c1 = 0.7; c2 = 0.1;  %Consumption function
ia= 0.02; ib=ia; hd=0.5; hl=4; il = hl*ia; id=hd*ia;   %Interest rates
govr = 0.005; sb= 0.3; h1=0.05; h2 = 0.75; gn=0.04; phi=15;
xi2=0.5; xi1= 0.659;
e1=0; e2=0; e3=0;
% Parameters and steady state
bita1=v-sf*(1-sw)*v;
bita2=ia*h2-sb*(ia*h2-id);
bita3=c1*(sf-sb)*il-delta2-b1;
bita4=delta1-sf*(1-sw)*v;
bita5=(1-c1)*(sf-sb)*il;
bita6=sf*il-delta2-b1;
bita7=sf*(1-sw);
```

```
delta_0=v-c1*bita1;
delta=v-c1*bita1-delta1;
alpha0=bita1*(gn+govr)/delta_0;
alpha1=((v*bita2)/delta_0)+(c2*bita1/delta_0)-(v*(1-sb)*ia*(sb*(ia*h2-id)-(h1+h2-
1)*gn)/(delta_0*(sb*ia-gn)));
alpha2=v*(sf-sb)*il/delta_0-v*(1-sb)*ia*(sb*il-gn)/((sb*ia-gn)*delta_0);
lf0nom=gn-bita7*(alpha0+gn+govr)-bita7*(alpha1-gn)*(1-c1)*alpha0/(gn+c2-(1-
c1)*alpha1);
lf0den=bita7*alpha2-sf*il+gn+bita7*(alpha1-gn)*(1-c1)*alpha2/(gn+c2-(1-
c1)*alpha1);
lf0 =lf0nom/lf0den ;
d0 =((1-c1)*alpha0+(1-c1)*alpha2*lf0)/(gn+c2-(1-c1)*alpha1);
a0=((sb*il-gn)*lf0+(sb*(ia*h2-id)-(h1+h2-1)*gn)*d0)/(sb*ia-gn);
lb0=(lf0+(h1+h2)*d0)/(lf0+(h1+h2-1)*d0-a0);
lfT0=(delta0-b0+delta1*(gn+govr+(c1*bita2+c2)*d0+c1*(sf-sb)*il*lf0-c1*(1-
sb)*ia*a0)/delta_0-(delta2+b1)*lf0-b2*lb0-gn)/(-delta2-b2*phi);
lbT0=lfT0*phi;
u0=(delta0-b0+(delta2+b2*phi)*lfT0+govr+(c1*bita2+c2)*d0+bita3*lf0-c1*(1-
sb)*ia*a0-b2*lb0)/delta;
g=delta0-b0+(delta2+b2*phi)*lfT0+delta1*u0-(delta2+b1)*lf0-b2*lb0;

function [ dy ] = Banking( t,y )

Banking_Parameters;
lb=(y(1)+(h1+h2)*y(2))/(y(1)+(h1+h2-1)*y(2)-y(3));
u=(delta0-b0+(delta2+b2*phi)*y(4)+y(5)+(c1*bita2+c2)*y(2)+bita3*y(1)-c1*(1-
sb)*ib*y(3)-b2*lb)/delta;
g=delta0-b0+(delta2+b2*phi)*y(4)+delta1*u-(delta2+b1)*y(1)-b2*lb;

dy = zeros(5,1);
dy(1) = delta0-b0+(delta2+b2*phi)*y(4)+bita4*u+(bita6-g)*y(1)-b2*lb;
dy(2) =(1-c1)*bita1*u+((1-c1)*bita2-c2-g)*y(2)+bita5*y(1)-(1-c1)*(1-sb)*ib*y(3);
dy(3)=dy(1)+(h1+h2-1)*dy(2)+(g-sb*il)*y(1)+((h1+h2-1)*g-sb*(ib*h2-
id))*y(2)+(sb*ib-g)*y(3);
dy(4)=xi1*(g-gn)+xi2*(lfT0-y(4));
dy(5)=e1*((y(1)-y(4))-(lf0-lfT0))+e2*((lb-phi*y(4))-(lb0-lbT0))+e3*(govr-y(5));
end

clear
Banking_Parameters;

[T,Y] = ode23s (@Banking,[0 100],[ lf0 d0 a0 lfT0*1.01 govr])
lb=(Y(:,1)+(h1+h2)*Y(:,2))./(Y(:,1)+(h1+h2-1)*Y(:,2)-Y(:,3));
lbT=phi* Y(:,4)
u=(delta0-b0+(delta2+b2*phi)*Y(:,4)+Y(:,5)+(c1*bita2+c2)*Y(:,2)+bita3*Y(:,1)-
c1*(1-sb)*ib*Y(:,3)-b2*lb)/delta;
g=delta0-b0+(delta2+b2*phi)*Y(:,4)+delta1*u-(delta2+b1)*Y(:,1)-b2*lb;
```

Figure 2

```
set(0,'DefaultAxesFontName','Georgia')
set(0,'defaultTextFontName','Georgia')
plot(Y(:,1),g,'-o')
set(gca, 'FontSize',20);plot(Y(:,1),g);
set(gcf, 'color', 'white');
set(get(gca,'XLabel'),'String',' Firms’ leverage ratio (lf)','FontSize',24);
set(get(gca,'YLabel'),'String',' Effective investment rate (g)','FontSize',24);
xlim([0.184,0.193])
ylim([0.02,0.06])
```

Figure 3

```
set(0,'DefaultAxesFontName','Georgia')
set(0,'defaultTextFontName','Georgia')
figure
set(gca, 'FontSize',24);plot(Y(:,1));
set(gcf, 'color', 'white');
xlabel('Time','FontSize',24)
xlim([0,100])
ylim([0.184,0.194])

figure
set(gca, 'FontSize',24);plot(lb(:));
set(gcf, 'color', 'white');
xlabel('Time','FontSize',24)
xlim([0,100])
ylim([3.35,3.6])

figure
set(gca, 'FontSize',24);plot(Y(:,4));
set(gcf, 'color', 'white');
xlabel('Time','FontSize',24)
xlim([0,100])
ylim([0.274,0.294])

figure
set(gca, 'FontSize',24);plot(lbT(:));
set(gcf, 'color', 'white');
xlabel('Time','FontSize',24)
xlim([0,100])
ylim([4.1,4.4])

figure
set(gca, 'FontSize',24);plot(Y(:,2));
```

```
set(gcf, 'color', 'white');
xlabel('Time','FontSize',24)
xlim([0,100])
ylim([0.296,0.304])

figure
set(gca, 'FontSize',24);plot(Y(:,3));
set(gcf, 'color', 'white');
xlabel('Time','FontSize',24)
xlim([0,100])
ylim([0,0.01])

figure
set(gca, 'FontSize',24);plot(g(:));
set(gcf, 'color', 'white');
xlabel('Time','FontSize',24)
xlim([0,100])
ylim([0.02,0.06])

figure
set(gca, 'FontSize',24);plot(u(:));
set(gcf, 'color', 'white');
xlabel('Time','FontSize',24)
xlim([0,100])
ylim([0.5,0.85])
```

Figure 4

```
%-------------------------------------
%       Model Parametrisation
%-------------------------------------
% Goods Markets
delta0=0.02; delta1 = 0.1; delta2 = 0.5; sf = 0.6; sw = 0.6; v = 0.25;% Desired
investment
b0 = 0.01; b1 = 0.5; b2 = 0.01; % Credit rationing
c1 = 0.7; c2 = 0.1;  %Consumption function
ib= 0.02; hd=0.5; hl=4; il = hl*ib; id=hd*ib;   %Interest rates
govr = 0.005; sb= 0.3; h1=0.05; h2 = 0.75; gn=0.04; phi=15;
xi2=0.5;
e1=0.8; e2=0.05; e3=20;
% Parameters and steady state
bita1=v-sf*(1-sw)*v;
bita2=ib*h2-sb*(ib*h2-id);
bita3=c1*(sf-sb)*il-delta2-b1;
bita4=delta1-sf*(1-sw)*v;
bita5=(1-c1)*(sf-sb)*il;
bita6=sf*il-delta2-b1;
bita7=sf*(1-sw);
```

```
delta_0=v-c1*bita1;
delta=v-c1*bita1-delta1;
alpha0=bita1*(gn+govr)/delta_0;
alpha1=((v*bita2)/delta_0)+(c2*bita1/delta_0)-(v*(1-sb)*ib*(sb*(ib*h2-id)-(h1+h2-
1)*gn)/(delta_0*(sb*ib-gn)));
alpha2=v*(sf-sb)*il/delta_0-v*(1-sb)*ib*(sb*il-gn)/((sb*ib-gn)*delta_0);
lf0nom=gn-bita7*(alpha0+gn+govr)-bita7*(alpha1-gn)*(1-c1)*alpha0/(gn+c2-(1-
c1)*alpha1);
lf0den=bita7*alpha2-sf*il+gn+bita7*(alpha1-gn)*(1-c1)*alpha2/(gn+c2-(1-
c1)*alpha1);
lf0 =lf0nom/lf0den ;
d0 =((1-c1)*alpha0+(1-c1)*alpha2*lf0)/(gn+c2-(1-c1)*alpha1);
a0=((sb*il-gn)*lf0+(sb*(ib*h2-id)-(h1+h2-1)*gn)*d0)/(sb*ib-gn);
lb0=(lf0+(h1+h2)*d0)/(lf0+(h1+h2-1)*d0-a0);
lfT0=(delta0-b0+delta1*(gn+govr+(c1*bita2+c2)*d0+c1*(sf-sb)*il*lf0-c1*(1-
sb)*ib*a0)/delta_0-(delta2+b1)*lf0-b2*lb0-gn)/(-delta2-b2*phi);
lbT0=lfT0*phi;
u0=(delta0-b0+(delta2+b2*phi)*lfT0+govr+(c1*bita2+c2)*d0+bita3*lf0-c1*(1-
sb)*ib*a0-b2*lb0)/delta;
g=delta0-b0+(delta2+b2*phi)*lfT0+delta1*u0-(delta2+b1)*lf0-b2*lb0;

function [ dy ] = Banking(~,y,~, xi1)

Banking_Parameters;
lb=(y(1)+(h1+h2)*y(2))/(y(1)+(h1+h2-1)*y(2)-y(3));
u=(delta0-b0+(delta2+b2*phi)*y(4)+y(5)+(c1*bita2+c2)*y(2)+bita3*y(1)-c1*(1-
sb)*ib*y(3)-b2*lb)/delta;
g=delta0-b0+(delta2+b2*phi)*y(4)+delta1*u-(delta2+b1)*y(1)-b2*lb;

dy = zeros(5,1);
dy(1) = delta0-b0+(delta2+b2*phi)*y(4)+bita4*u+(bita6-g)*y(1)-b2*lb;
dy(2) =(1-c1)*bita1*u+((1-c1)*bita2-c2-g)*y(2)+bita5*y(1)-(1-c1)*(1-sb)*ib*y(3);
dy(3)=dy(1)+(h1+h2-1)*dy(2)+(g-sb*il)*y(1)+((h1+h2-1)*g-sb*(ib*h2-
id))*y(2)+(sb*ib-g)*y(3);
dy(4)=xi1*(g-gn)+xi2*(lfT0-y(4));
dy(5)=e1*((y(1)-y(4))-(lf0-lfT0))+e2*((lb-phi*y(4))-(lb0-lbT0))+e3*(govr-y(5));
end

clear
Banking_Parameters;

xi1max = 40;
for i= 1:1:xi1max
xi1(i)=0.63+i/1000;
options =odeset('RelTol',1e-10,'AbsTol',1e-10);
[t,y]=ode23s(@Banking,[0:100],[lf0,d0,a0,lfT0*1.01,govr],[], options, xi1(i));
out1(i,:) = y(:,1);
lf(i,:) = out1(i,:);
out2(i,:) = y(:,2);
d(i,:) = out2(i,:);
```

```
out3(i,:) = y(:,3);
a(i,:) = out3(i,:);
out4(i,:) = y(:,4);
lfT(i,:) = out4(i,:);
out5(i,:) = y(:,5);
govern(i,:) = out5(i,:);

leverage(i,:)=( lf(i,:) +(h1+h2)* d(i,:))./( lf(i,:) +(h1+h2-1)* d(i,:) - a(i,:));
capacity(i,:)=(delta0-b0+(delta2+b2*phi)* lfT(i,:) + govern(i,:) +(c1*bita2+c2)* d(i,:)
+bita3* lf(i,:) -c1*(1-sb)*ib* a(i,:) -b2* leverage(i,:))/delta;
leverageT(i,:)= phi*lfT(i,:);
investment(i,:)=delta0-b0+(delta2+b2*phi)* lfT(i,:) +delta1* capacity(i,:) -
(delta2+b1)* lf(i,:) -b2* leverage(i,:);
end

set(0,'DefaultAxesFontName','Georgia')
set(0,'defaultTextFontName','Georgia')
figure
set(gca,'FontSize',20);surfl(lf);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
%zlim([0.15,0.25])

figure
set(gca,'FontSize',20);surfl(leverage);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
%zlim([2.5,4.5])

figure
set(gca,'FontSize',20);surfl(lfT);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
%zlim([0.2,0.4])

figure
set(gca,'FontSize',20);surfl(leverageT);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
```

```
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
%zlim([3,5.5])

figure
set(gca,'FontSize',20);surfl(d);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
%zlim([0.27,0.33])

figure
set(gca,'FontSize',20);surfl(a);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
%zlim([-0.05,0.05])

figure
set(gca,'FontSize',20);surfl(investment);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
%zlim([-0.1,0.2])

figure
set(gca,'FontSize',20);surfl(govern);
set(gca, 'Ytick',[1,20,40], 'YTickLabel', {'0.63';'0.65'; 0.67'});
set(get(gca,'YLabel'),'Interpreter','latex','String','$$\xi_1$$','FontSize',28);
set(gcf, 'color', 'white');
view(20,15)
xlabel('Time','FontSize',28)
xlim([0,100])
```

4. Securitisation, wage stagnation and financial fragility: A stock-flow consistent perspective

4.1 Introduction

Securitisation has been at the core of various academic analyses for the causes of the recent financial crisis. Broadly speaking, securitisation is a technique that transforms illiquid assets into liquid tradable instruments. In its more widespread form, this technique allows banks to remove loans from the asset side of their balance sheets and distribute the associated risks to other financial units. Securitisation has, therefore, given rise to the so-called 'originate and distribute' model of banking in which the default risk on granted loans is disconnected from loan originators. By doing so it has played a prominent role in facilitating excessive lending and in supporting speculative financial activities in money manager capitalism, with adverse effects on macroeconomy's financial fragility (see Minsky, 2008; Kregel, 2008; Wray, 2009; Lavoie, 2012-3).

Wage stagnation has been viewed as another main root cause of the recent crisis (Palley, 2010; Lysandrou, 2011; Stockhammer, 2012; van Treeck and Sturn, 2012; Wisman, 2013). It has been argued that the decline in the wage income share of workers in the pre-crisis period was conducive to the excessive rise in household debt, the deterioration of workers' financial position, and the growing tendency of the economies toward financial speculation. Wage stagnation has also been regarded as a factor that put downward pressures on domestic demand, giving rise to unsustainable growth regimes.

In this chapter, we employ the recently developed stock-flow consistent (SFC) approach to macroeconomics[1] to integrate into a coherent macro framework the complex mechanisms of securitisation and their interaction with functional income distribution. With the aid of simulations we study how a more widespread adoption of securitisation is likely to increase the financial fragility of an economy. We also examine the mechanisms through which wage stagnation can reinforce this tendency

[1] See Godley and Lavoie (2007).

of securitisation to increase the financial fragility. The simulation results of the chapter provide support to the view that the combination of risky financial practices and higher inequality can substantially increase the likelihood of financial instability in a macro system.

The chapter is structured as follows. Section 4.2 briefly describes the potential adverse effects of securitisation and wage stagnation on financial fragility. Section 4.3 develops the stock-flow consistent model. Section 4.4 presents the simulation experiments. Section 4.5 concludes.

4.2 Securitisation and wage stagnation: Their interconnected role in the emergence of financial fragility

The securitisation process begins when commercial banks (the originators) decide to securitise a part of their loans. There are various motives that may induce banks to do so. Among them are the need for liquidity, the minimisation of credit risk and the reduction of capital requirements (see e.g. Cardone-Riportella *et al*., 2010).[2] The loans decided to be securitised are pooled together and are sold off to administrators. The administrators set up the special purpose vehicles (SPVs) which purchase the pooled loans in exchange of fee income.[3] The SPVs issue asset-backed securities (ABSs) and distribute the cash inflows from loan repayment and interest to the holders of the ABSs. The ABSs are bought by institutional investors (typically with the aid of underwriters that receive fee income) and the proceeds are then used by the SPVs to purchase the loans from banks. Institutional investors finance their investment in ABSs either by repo transactions or shares that are bought by households. Remarkably, various credit enhancement techniques (e.g. excess spread, overcollateralisation, tranching etc.) are utilised to render ABSs attractive for

[2] Lysandrou (2011) has pointed out that securitisation can also be significantly prompted by the need of institutional investors to find new securities to invest the accumulated wealth of rich households.

[3] This chapter focuses on the modern, more widespread, form of securitisation in which securitised loans are removed from the balance sheet of banks. In other forms of securitisation the securitised loans remain within the bank that originates the loans (see Lavoie, 2012-3). Furthermore, there are cases in which the securitisation is utilised for banks' liabilities (Cardone-Riportella *et al*., 2010). For a detailed description of the securitisation process analysed in the current chapter see Gorton and Souleles (2007), Stein (2010) and Noeth and Sengupta (2011). See also Tymoigne (2009B) for the various complex forms that the securitisation procedure can take in the real world economies.

institutional investors.[4] The attractiveness of ABSs can also be enhanced by high grades from credit-rating agencies.

The securitisation process can be a significant source of financial fragility. First, by allowing banks to remove loans from their balance sheets, securitisation disrupts the traditional loan assessment procedure: since banks do not bear the cost of a loan default, they are induced to provide loans without paying sufficient attention to the creditworthiness of their borrowers (see e.g. Kregel, 2008; Tymoigne, 2009A; Cardone-Riportella *et al*., 2010; Acharya and Schnabl, 2010; Lavoie, 2012-3). Excessive loan expansion is also enhanced by the reduction of capital requirements. The overall result can be the provision of loans to borrowers with weak economic status and prospects, rendering them financially fragile.

Second, of particular importance is the fact that mortgage loans are among the main assets that tend to be securitised. This can foster excessive investment in housing market, generating a virtuous cycle in which easy access to credit increases housing prices, higher housing prices improve the net worth of borrowers, and higher net worth encourages new borrowing, further boosting housing prices. Such a virtuous cycle can be conducive to the development of Ponzi financing schemes since many borrowers may rely on housing price appreciation in order to acquire new loans that are necessary for meeting their debt commitments (see Kregel, 2008; Wray, 2009; Tymoigne, 2010).[5] Ponzi financing schemes can easily collapse as a result of small unexpected shocks. In such a case a virtuous cycle is transformed into a vicious one, which can lead to a widespread loan default, with adverse effects on the stability of the financial system.

Third, with the aim to promote investment in ABSs, credit-rating agencies may have a tendency to underestimate in their public assessments the risks associated with the holding of ABSs (see Minsky, 2008; Wray, 2009). Hence, although there is no

[4] Credit enhancement is a mechanism through which the holders of ABSs are protected from default and prepayment risk. For a presentation of the various credit enhancement techniques see Fabozzi and Kothari (2008, ch. 5).
[5] See also Gorton (2009) for the role of housing price appreciation in the refinancing of subprime mortgages.

credible market maker for securities like ABSs,[6] the investors can be prompted by the credit-rating agencies to act as if this was the case. This implies that the ABSs market can easily collapse when there is a widespread liquidation the ramifications of which cannot be countered by the credit enhancement techniques. This possibility is also reinforced by the short-term nature of the funding on which the ABSs market is usually based. In such a case, a sudden stop to loan expansion can occur, endangering the stability of the macroeconomic system.

Under specific circumstances, wage stagnation can reinforce these destabilising forces created by the securitisation process. First, by reducing worker households' income, wage stagnation can contribute to the deterioration of the financial position of workers that have acquired securitised loans. Such a deterioration can have important adverse effects on the ABSs market, since it makes higher the possibility of loan default.

Second, in an economy in which there are changes in income distribution in favour of profit earners, workers may try to maintain their relative consumption standards by demanding more loans (see e.g. Cynamon and Fazzari, 2008; Barba and Pivetti, 2009; Wisman, 2013). Since securitisation tends to decrease banks' credit rationing, its coexistence with wage stagnation can lead to extensive credit expansion which, under certain conditions, can reduce the robustness of households' financial structure.

Third, the redistribution of income from workers to wealthy individuals may increase the propensity of the economy to speculate (Stockhammer, 2012). The rationale behind this argument is that wealthy individuals tend to use the income that is added to their wealth for speculation activities (see also Lysandrou, 2011). So long as the ABSs market is a market in which speculation activities are encouraged, wage stagnation is a factor that can contribute to the further development of this market; and, hence, of its destabilising forces.

[6] A credible market maker is an agent that has the capacity to buy a significant amount of securities whenever there is a cascade of sell orders, ensuring that the investors will invariably liquidate their assets without significant losses (see Davidson, 2008A). Remarkably, in the financial distress of 2007 the underwriters of ABSs tried without success to act as market makers, with significant negative effects on their solvency position (see Davidson, 2008B).

Fourth, in wage-led economies wage stagnation can place downward pressures on economic activity, with negative effects on household income and, thus, on household fragility. Moreover, in wage-led economies macroeconomic performance can become more dependent on credit availability. Thus, the detrimental macroeconomic effects of a rise in securitisation, which is likely at a first stage to promote credit expansion, but gradually to create the conditions for a sharp credit restriction, may be much more important.

4.3 The macroeconomic model

The model developed in this section allows us to explore, within a coherent macro framework, the mechanisms through which securitisation and wage stagnation can jointly affect the financial fragility of the macroeconomy. To keep the analysis tractable and in line with the purposes of the chapter, various simplifying assumptions in the formulation of the securitisation process have been adopted.

First, the securitisation procedure is confined to home mortgages provided to workers. Home mortgages constitute the most prominent securitised asset class in both the US and the European economy (see Loutskina, 2011; ECB, 2011). Furthermore, the link between securitisation and home mortgage provision to workers was particularly intense in the pre-crisis period, especially in the US, and has greatly contributed to the sub-prime crisis.

Second, commercial banks are both originators and administrators in the securitisation process. Thus, in the model they receive fee income from the SPVs when they sell off the securitised loans.

Third, the SPVs and the underwriters are grouped into one single sector. The sector of SPVs-underwriters pays fee income to commercial banks, transforms securitised loans into MBSs and distributes coupon and principal payments to institutional investors. It also receives income by investing in treasury bills. Importantly, the SPVs-underwriters are postulated to issue only single class pass-through MBSs.[7] In particular, the

[7] For an analysis of the features of mortgage pass-through securities see Fabozzi (2000, ch. 11).

principal and the interest payments are 'passed-through' to institutional investors with a part of interest being held to cover the fees provided to commercial banks and to create the excess spread, which is the only credit enhancement technique in the model (note that administration fees for the services of SPVs and underwriters have been assumed away). The excess spread is retained with the purpose to cover a predetermined rate of default on securitised loans. If the actual rate of default is higher than the guaranteed one, the excess losses are transferred to institutional investors.[8] Lastly, note that the complications arising from prepayments are not part of the analysis in the model of this chapter.

Fourth, the investment in MBSs is exclusively financed in our model via shares which are purchased by investor households. Investor households in the model are basically wealthy agents that receive income from investment in various financial assets. They also receive the distributed profits of firms. Therefore, their income is positively affected, all other things being equal, by wage stagnation. This formulation allows us to concentrate on the link between wage stagnation and investment in MBSs.

Nine sectors comprise our macroeconomy: worker households of type I, worker households of type II, firms, commercial banks, SPVs-underwriters, institutional investors, investor households, government and the central bank. Table 1 displays the balance sheet matrix of the model. Table 2 depicts the transactions matrix. The number of households in each household type is constant and all households in the model are postulated to be of the same size and composition. In worker households there is one member that participates in the labour force.

Worker households of type I take out mortgages from commercial banks to partly finance the purchase of houses. A proportion of the housing loans are securitised and become a component of the asset side of the balance sheet of SPVs-underwriters. The later transform these loans into MBSs, which are acquired by institutional investors, who issue shares bought by investor households.[9] Worker households of type II take

[8] An alternative assumption would be to postulate that the SPVs-underwriters cover all loan losses so long as their capital is positive. However, this would complicate the model without changing the substance of the underlying mechanism.
[9] The institutional investors in the model refer basically to mutual and hedge funds. For a description of the features of institutional investors see Davis (2003).

out only consumer loans and dissave (as in Dutt, 2008). Except shares, investor households hold houses, firms' equities, deposits, treasury bills and money.[10] Firms build houses, invest in productive capital and produce goods. They pay wages to worker households and dividends to investor households. They issue equities and take out loans from commercial banks. Government finances its expenditures by issuing treasury bills, imposing income taxes and using the central bank's profits. Central bank holds treasury bills on the asset side of its balance sheet and high-powered money and advances on the liability side.

In what follows, we present the equations of the model for each sector of the economy. Note that inflation is assumed away and the price of output in the economy is set equal to unity. For simplicity, expected values of endogenous variables are proxied by their values in the previous period. Note also that, unless otherwise indicated, the parameters in the presented equations are positive.

[10] To avoid unnecessary complications, no housing transactions between worker and investor households are considered. Furthermore, we have assumed away any rental transaction.

Table 1. *Balance sheet matrix*

	Worker households - type I	Worker households - type II	Firms	Commercial banks	SPVs-underwriters	Institutional investors	Investor households	Government	Central bank	Σ
Houses	$+p_H H_{DW}$		$+p_H HU$				$+p_H H_{DI}$			$+p_H H$
Productive capital			$+K_F$							$+K_F$
High-powered money				$+HPM_B$			$+HPM_{IH}$		$-HPM$	
Consumer loans		$-LC$		$+LC$						
Housing loans	$-LH$			$+LH_{NS}$	$+LH_S$					
Firms' loans			$-LF$	$+LF$						
Treasury bills				$+TB_B$	$+TB_U$	$+TB_{II}$	$+TB_{IH}$	$-TB$	$+TB_{CB}$	
MBSs					$-p_M M$	$+p_M M$				
Deposits				$-D_{IH}$			$+D_{IH}$			
Instit. investors' shares						$-SH$	$+SH$			
Firms' equities			$-p_e e$				$+p_e e$			
Advances				$-A$					$+A$	
Total (net worth)	$+V_{W1}$	$-LC$	$+V_F$	$+K_B$	$+K_U$	$+K_{II}$	$+V_I$	$-TB$	0	$+K_F+p_H H$

Table 2. *Transactions matrix*

	Worker households - type I	Worker households - type II	Firms		Commercial banks		SPVs-underwriters		Institutional investors		Investor households	Government	Central bank	Σ
			Current	Capital	Current	Capital	Current	Capital	Current	Capital				
Housing investment			$+\Delta H$	$-\Delta H$										0
Investment in prod. capital			$+\Delta K_F$	$-\Delta K_F$										0
Consumption	$-C_{W1}$	$-C_{W2}$	$+C_{W1}+C_{W2}+C_{IH}$								$-C_{IH}$			0
Government expenditures			$+GOV$									$-GOV$		0
Income taxes	$-T_{W1}$	$-T_{W2}$									$-T_{IH}$	$T_{W1}+T_{W2}+T_{IH}$		0
Wages	$+W_{W1}$	$+W_{W2}$	$-W$											0
Interest on consumer loans		$-i_{LC}LC_{-1}$			$+i_{LC}LC_{-1}$									0
Interest on housing loans	$-i_{LH}LH_{-1}$				$+i_{LH}LH_{NS-1}$		$+i_{LH}LH_{S-1}$							0
Interest on firms' loans			$-i_{LF}LF_{-1}$		$+i_{LF}LF_{-1}$									0
Fees					$+FEE$		$-FEE$							0
Interest on treasury bills					$+i_T TB_{B-1}$		$+i_T TB_{U-1}$		$+i_T TB_{II-1}$		$+i_T TB_{IH-1}$	$-i_T TB_{-1}$	$+i_T TB_{CB-1}$	0
Interest on deposits					$-i_D D_{IH-1}$						$+i_D D_{IH-1}$			0
Interest on advances					$-i_A A_{-1}$								$+i_A A_{-1}$	0
SPVs-underwriters' profits							$-PU$	$+PU_U$	$+COUPON$					0
Instit. investors' profits									$-PI$	$+PI_U$	$+PI_D$			0
Firms' profits			$-PF$	$+PF_U$							$+PF_D$			0
CB's profits												$+PB_{CB}$	$-PB_{CB}$	0
Commercial banks' profits					$-PB_B$	$+PB_{BU}$					$+PB_{BD}$			0
Δdeposits						$+\Delta D_{IH}$					$-\Delta D_{IH}$			0
Δequities of firms				$+\Delta e p_e$							$-\Delta e p_e$			0
Δshares of instit. investors										$+\Delta SH$	$-\Delta SH$			0
Δadvances						$+\Delta A$							$-\Delta A$	0
Δhouses	$-\Delta H_{DW}p_H$		$+\Delta H_{DW}p_H+\Delta H_{DI}p_H$								$-\Delta H_{DI}p_H$			0
Δloans for housing	$+\Delta LH$					$-\Delta LH_{NS}$		$-\Delta LH_S$						0
Δloans for consumption		$+\Delta LC$				$-\Delta LC$								0
Δloans to firms				$+\Delta LF$		$-\Delta LF$								0
ΔMBSs								$+\Delta Mp_M$		$-\Delta Mp_M$				0
Δtreasury bills						$-\Delta TB_B$		$-\Delta TB_U$		$-\Delta TB_{II}$	$-\Delta TB_{IH}$	$+\Delta TB$	$-\Delta TB_{CB}$	0
Δhigh-powered money						$-\Delta HPM_B$					$-\Delta HPM_{IH}$		$+\Delta HPM$	0
Defaulted loans	$+DL$					$-DL_{NS}$		$-DL_{SU}$		$-DL_{SU}$				0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0

4.3.1 Worker households-type I

$$YD_{W1} = W_{W1} - i_{LH} LH_{-1} - T_{W1} \tag{1}$$

$$YD_{W1}^{G} = YD_{W1} + i_{LH} LH_{-1} \tag{2}$$

$$W_{W1} = \frac{n_1}{n_1 + n_2} W \tag{3}$$

$$C_{W1} = c_{11} YD_{W1-1} + c_{12} V_{W1-1} \tag{4}$$

$$CG_{HW} = \Delta p_H H_{DW-1} \tag{5}$$

$$NLH^{D} = \left(H_{DW}^{D} - H_{DW-1}\right) p_{H-1} + rep_L LH_{-1} + C_{W1} - YD_{W1} \tag{6}$$

$$LH = LH_{-1} + NLH - rep_L LH_{-1} - DL \tag{7}$$

$$DL = \varphi LH_{-1} \tag{8}$$

$$\varphi = \varphi_0 + \varphi_1 BUR_{W1-1} - \varphi_2 k_{H-1} \tag{9}$$

$$BUR_{W1} = \frac{\left(i_{LH} + rep_L\right) LH_{-1}}{YD_{W1}^{G}} \tag{10}$$

$$V_{W1} = V_{W1-1} + YD_{W1} - C_{W1} + CG_{HW} + DL \tag{11}$$

$$LEV_{W1} = \frac{LH}{p_H H_{DW}} \tag{12}$$

$$H_{DW}^{D} = H_{DW-1} + \left(h_{10} - h_{11} BUR_{W1-1} + h_{12} \left(\frac{\Delta p_H}{p_{H-1}} \right)_{-1} \right) H_{DW-1} \tag{13}$$

$$H_{DW} = H_{DW-1} + \frac{YD_{W1} + \Delta LH - C_{W1} + DL}{p_H} \tag{14}$$

Equation (1) defines the net disposable income of type I worker households $\left(YD_{W1}\right)$ as the difference between wages $\left(W_{W1}\right)$, the sum of taxes $\left(T_{W1}\right)$ and interest payments on housing loans; i_{LH} is the interest rate on housing loans and LH is the amount of loans that worker households take out to invest in the housing market. Equation (2) specifies the gross disposable income of type I worker households $\left(YD_{W1}^{G}\right)$. Equation (3) shows that the wage bill of type I worker households is a proportion $\left(n_1/\left(n_1 + n_2\right)\right)$ of the total wage bill $\left(W\right)$ paid by firms to worker households; n_1, n_2 is the number of worker households of type I and of type II, respectively. It is assumed that the employment rate in the two types of households is the same. Equation (4) gives the consumption of type I worker households (C_{W1}), which depends on their lagged net disposable income and wealth (V_{W1}). The capital gains due to changes in the price of houses (CG_{HW}) are defined in equation (5), where H_{DW} is the demand for houses from worker households of type I and p_H is the price of houses.

In the model there is a distinction between the desired amount of new loans and the actual amount of new loans. As will be explained below, the latter is a proportion of the former, since a part of the new loans demanded by worker household are not provided by banks due to credit rationing. The desired amount of new loans (NLH^D) are given by equation (6) as the sum of worker households' desired investment in the housing market and the repayment of outstanding loans, minus their saving; H_{DW}^D is the desired demand for houses and rep_L is the loan repayment ratio. Note that the lagged price of houses is used by households as a proxy for the current level of prices in the procedure of estimating the amount of money that they need to borrow from banks to acquire their desired houses.

The change in housing loans is depicted by equation (7) where NLH stands for the actual amount of new housing loans. The model explicitly introduces the possibility of default on the part of type I worker households. The amount of defaulted loans (DL) is defined in equation (8). The rate of default (φ) is a positive function of the lagged burden of debt (BUR_{W1}) of worker households and a negative function of the lagged degree of credit availability for housing loans (k_H)(see equation (9)). The burden of debt is defined, according to equation (10), as the ratio of the debt commitments of worker households to their gross disposable income.[11] It is assumed that, when the burden of debt of this sector increases, there is a higher likelihood that more worker households (at the unit level) will face liquidity problems. Thus, at the aggregate level, a higher burden of debt translates into a higher rate of default. Furthemore, the liquidity problems are reinforced when the degree of credit availability by banks

[11] See also van Treeck (2009) and Dafermos (2012).

declines, that is when there is a rise in the proportion of new housing loans that are credit rationed (for the exact defition of the degree of credit availability see equation (51) below). A lower credit availability implies that more households cannot attain their desired liquidity. This is important because the liquidity created by new loans can be partially used for the repayment of existing debt. Accordingly, the higher the unwillingness of banks to safisfy the demand for new loans the higher the rate of default.

Equation (11) shows worker households' wealth. Defaulted loans exert a positive impact on their wealth.[12] Equation (12) defines the leverage of worker households $\left(LEV_{W1}\right)$, expressed as the ratio of housing loans to the value of houses. In our model this variable plays a crucial role in the credit availability from commercial banks. Equation (13) shows worker households' desired demand for houses. It is assumed that this demand relies negatively on the lagged households' burden of debt and positively on the lagged growth rate of housing prices.[13] Equation (14) defines the change in the demand for houses as the difference between the sum of the change of housing loans and the amount of defaulted loans minus saving, divided by the price of houses. The higher the housing loans the larger, *ceteris paribus*, the demand for houses.

4.3.2 Worker households-type II

$$YD_{W2} = W_{W2} - i_{LC} LC_{-1} - T_{W2} \tag{15}$$

$$YD_{W2}^{G} = YD_{W2} + i_{LC} LC_{-1} \tag{16}$$

$$W_{W2} = \frac{n_2}{n_1 + n_2} W \tag{17}$$

$$C_{W2} = YD_{W2} + LC - LC_{-1} \tag{18}$$

$$CA_{W2}^{D} = \xi \frac{C_{IH-1}}{n_3} \tag{19}$$

$$C_{W2}^{D} = n_2 CA_{W2}^{D} \tag{20}$$

[12] For simplicity, we assume that there is no bankruptcy in the economy. See Charpe *et al*. (2011, ch. 9) for a SFC model in which both bankruptcy and default are explicitly considered.
[13] See Zezza (2008) for a similar formula and Andre (2010) for some empirical evidence regarding the main drivers of housing demand.

$$NLC^D = C_{W2}^D + rep_L LC_{-1} - YD_{W2} \quad (21)$$

$$LC = LC_{-1} + NLC - rep_L LC_{-1} \quad (22)$$

$$BUR_{W2} = \frac{(i_{LC} + rep_L)LC_{-1}}{YD_{W2}^G} \quad (23)$$

Equation (15) gives the net disposable income of type II worker households (YD_{W2}), which is equal to wages (W_{W2}) minus the sum of taxes (T_{W2}) and the interest payments on consumer loans; i_{LC} is the interest rate on consumer loans and LC is the amount of consumer loans. Equation (16) defines the gross disposable income of type II worker households (YD_{W2}^G). Their wages are a proportion $(n_2/(n_1 + n_2))$ of the total wage bill paid by firms.

Equation (18) gives the consumption of type II worker households (C_{W2}). These households consume all their net disposable income and take out consumer loans to finance part of their consumption expenditures. The amount of loans demanded by type II worker households for consumption purposes depends on their desired consumption. Following Cynamon and Fazzari (2008), Barba and Pivetti (2009) and Wisman (2013), it is assumed that these workers try to emulate the consumption of their reference group to maintain their relative social status. In our model, investor households constitute the reference group for type II worker households. Thus, according to equation (19), the average desired consumption of type II worker households (CA_{W2}^D) is a proportion $(\xi < 1)$ of the average consumption of investor households; (C_{IH}) is the aggregate consumption of investor households and n_3 is the number of investor households.[14] The aggregate desired consumption of type II worker households (C_{W2}^D) is defined in equation (20). Note that wage stagnation increases, *ceteris paribus*, the desired aggregate consumption of type II worker households, since it positively affects the income and the consumption of investor households.

The desired amount of new loans (NLC^D) is equal to the sum of the desired amount of consumption and the repayment of outstanding loans, minus the net disposable income

[14] See Dutt (2008) for a similar formula.

of type II worker households (see equation (21)). The amount of consumer loans is given by equation (22), where NLC is the actual amount of consumer loans. As in housing loans, the presence of credit rationing implies that the actual amount of new consumer loans is a fraction of the desired amount of new consumer loans. Notice that when the amount of amortised loans is higher than the amount of new loans, the change in loans is negative. In this case, consumption expenditures are lower than the net disposable income (see equation (18)). To avoid unnecessary complications, it is postulated that there is no default on consumer loans. The burden of debt of worker households-type II (BUR_{W2}) is equal to the ratio of households' debt commitments to their gross disposable income (see equation (23)).

4.3.3 Firms

$$Y = C_{W1} + C_{W2} + C_{IH} + INV + GOV + \Delta H \tag{24}$$

$$INV = (a_0 + a_1 u_{-1} + a_2 r_{F-1}) K_{F-1} \tag{25}$$

$$u = \frac{Y}{vK_F} \tag{26}$$

$$r_F = \frac{PF_U}{K_F} \tag{27}$$

$$K_F = K_{F-1} + INV \tag{28}$$

$$PF = Y - W - i_{LF} LF_{-1} \tag{29}$$

$$W = s_W Y_{-1} \tag{30}$$

$$PF_U = s_F PF_{-1} \tag{31}$$

$$PF_D = PF - PF_U \tag{32}$$

$$e = e_{-1} + \frac{xINV_{-1}}{p_e} \tag{33}$$

$$\Delta LF = INV + \Delta H - PF_U - \Delta H_{DW} p_H - \Delta H_{DI} p_H - \Delta e p_e \tag{34}$$

$$H = H_{-1} + \left(h_{21} \frac{H_{DW} + H_{DI}}{H} + h_{22} \frac{\Delta p_H}{p_{H-1}} \right) H_{-1} \tag{35}$$

$$\Delta HU = \Delta H - \Delta H_{DW} - \Delta H_{DI} \tag{36}$$

$$p_H = p_{H-1} + h_3 \left(\left(\frac{\Delta(H_{DW} + H_{DI})}{H_{DW-1} + H_{DI-1}} \right)_{-1} - \left(\frac{\Delta H}{H_{-1}} \right)_{-1} \right) p_{H-1} \quad (37)$$

Equation (24) shows that the output of the economy (Y) is equal to the sum of worker households' consumption, investor households' consumption, investment in productive capital (INV), investment in housing (ΔH) and government expenditures (GOV).[15] Equation (25) shows that investment in productive capital is affected by the lagged rate of capacity utilisation (u) and the lagged firms' rate of undistributed profits (r_F). Capacity utilisation, firms' rate of undistributed profits and productive capital (K_F) are given in equations (26), (27) and (28) respectively; v is the potential output to capital ratio. Equation (29) defines firms' profits (PF). It has been postulated that firms take out loans (LF) and, hence, they pay interest income; i_{LF} is the interest on firms' loans. Wages are determined as a fixed proportion of the lagged output produced (see equation (30)); s_W is income share of wages. Firms keep a part (s_F) of their profits (PF_U) while the rest profits (PF_D) are distributed to investor households (see equations (31) and (32)). A proportion (x) of firms' investment expenditures are financed by issuing equities (see equation (33)); e is the number of firms' equities and p_e is their price. Equation (34) suggests that firms' loans act as a residual in the budget constraint of firms; H_{DI} is the demand for houses from investor households.

The housing investment is positively affected by the ratio of demanded to existing houses as well as by the growth rate of the price of houses (see equation (35)).[16] Equation (36) defines the change in unsold houses (HU) as the difference between the change in existing and the change in demanded houses. The growth rate of the price of houses depends positively on the growth rate of the demanded houses relative to growth rate of the existing houses (see equation (37)).[17]

[15] For simplicity, the price of new houses is assumed to be equal to the general price level (recall that the latter is equal to unity). However, the price of existing houses in the housing market is different and not associated with the general price level. See Zezza (2008) for a similar assumption.
[16] For the role of housing price appreciation in the supply of houses see e.g. Andre (2010).
[17] This formulation relies on Eatwell *et al*. (2008).

4.3.4 Commercial banks

$$s = s_0 - s_1\left(y_{M-1} - y_M^T\right) \tag{38}$$

$$LH_S = sLH \tag{39}$$

$$LH_{NS} = (1-s)LH \tag{40}$$

$$PB_B = i_{LH} LH_{NS-1} + i_{LC} LC_{-1} + i_{LF} LF_{-1} + i_T TB_{B-1} + FEE - i_D D_{IH-1} - i_A A_{-1} \tag{41}$$

$$i_{LH} = i_A + x_1 \tag{42}$$

$$i_{LC} = i_A + x_2 \tag{43}$$

$$i_{LF} = i_A + x_3 \tag{44}$$

$$i_D = i_A - x_4 \tag{45}$$

$$K_B = K_{B-1} + PB_{BU} - DL_{NS} \tag{46}$$

$$DL_{NS} = \varphi LH_{NS-1} \tag{47}$$

$$PB_{BU} = s_B PB_{B-1} \tag{48}$$

$$PB_{BD} = PB_B - PB_{BU} \tag{49}$$

$$NLH = k_H NLH^D \tag{50}$$

$$k_H = k_{H0} - k_{H1} LEV_{W1-1} + k_{H2}\left(CAR_{-1} - CAR^T\right) - k_{H3} BUR_{W1-1} - k_{H4}\phi \tag{51}$$

$$NLC = k_C NLC^D \tag{52}$$

$$k_C = k_{C0} + k_{C1}\left(CAR_{-1} - CAR^T\right) - k_{C2} BUR_{W2-1} \tag{53}$$

$$CAR = \frac{K_B}{LH_{NS} + LC + LF} \tag{54}$$

$$HPM_B = h_B D_{IH} \tag{55}$$

$$TB_{BN} = K_B + D_{IH} - LH_{NS} - LC - LF - HPM_B \tag{56}$$

$$A_N = LH_{NS} + LC + LF + HPM_B - K_B - D_{IH} \tag{57}$$

$$A = A_N \text{, iff } A_N > 0 \text{; otherwise } A = 0 \tag{58}$$

$$TB_B = TB_{BN} \text{, iff } TB_{BN} > 0 \text{; otherwise } TB_B = 0 \tag{59}$$

Equation (38) defines the proportion (s) of loans that are securitised. The first term (s_0) captures some exogenous factors related with the institutional structure in the economy and the regulation with regard to the financial activities. The second term reflects the fact that there is a target yield on MBSs and that the supply of MBSs partially adjusts to their demand so as for the actual yield to remain close to the target one.[18] In particular, when the actual yield (y_M), which is inversely linked with the price of MBSs (see equation (79)), is lower (higher) than the target yield (y_M^T), the level of securitisation increases (decreases) and so does the supply of MBSs. This places downward (upward) pressures on the price of MBSs, increasing (decreasing) the actual yield. Equation (39) gives the amount of securitised loans, which are transferred to the balance sheet of SPVs-underwriters (LH_S). Equation (40) shows the amount of non securitised loans, which are retained in the balance sheet of commercial banks (LH_{NS}).

The profits of commercial banks (PB_B) are equal to the sum of the interest on non securitised loans, the interest on consumer loans, the interest on firms' loans, the interest on treasury bills (TB_B) and the administrative fees (FEE) due to securitised loans, minus the interest on deposits and on the advances from the central bank (A) (see equation (41)); i_T is the interest on treasury bills, D_{IH} are the deposits of investor households and i_D is the interest on deposits. The interest rates on loans and deposits are set with reference to the interest rate of the central bank (i_A). Note that, for simplicity, x_1, x_2, x_3, x_4 are deemed exogenous. According to equation (46), the change in the capital of commercial banks (K_B) equals their undistributed profits minus the amount of defaulted loans (see also Godley and Lavoie, 2007, ch. 11; Charpe *et al*. 2011, ch. 9). The amount of defaulted loans (DL_{NS}) is a proportion (φ) of LH_{NS} (equation (47)). Equation (48) and (49) show that commercial banks retain a proportion (s_B) of their profits (PB_{BU}) while the rest profits are distributed (PB_{BD}) to the investor households who are the owners of the commercial banks (for a similar assumption see Godley and Lavoie, 2007, ch.11).

Commercial banks apply credit rationing when they grant loans to worker households-type I and to worker households-type II. This is captured in our model by making a

[18] This mechanism draws on Lysandrou (2014).

distinction between the desired amount of new loans demanded by worker households and the effective amount of new loans; the latter represents the amount of new loans that are ultimately provided after imposing the credit rationing procedure. Equation (50) gives the effective amount of new housing loans as a proportion of the desired amount of new housing loans.[19] The variable k_H captures the degree of credit availability for housing loans $(0 \leq k_H \leq 1)$. According to equation (51), this depends negatively on the lagged leverage ratio of worker households-type I, positively on the lagged actual capital adequacy ratio (CAR) of commercial banks relative to the target capital adequacy ratio (CAR^T), negatively on the burden of debt of worker households of type I and negatively on the default rate. The target capital adequacy ratio is determined by the regulatory authority and the actual capital adequacy ratio is defined as the ratio of banks' capital to the sum of non-securitised loans, consumer loans and firms' loans (equation (54)).[20]

Equation (52) defines the effective amount of consumer loans as a proportion (k_C) of the desired amount of consumer loans $(0 \leq k_C \leq 1)$. According to equation (53), the degree of credit availability for consumer loans depends positively on the difference between the lagged capital adequacy ratio and the target capital adequacy ratio and negatively on the burden of debt of type II worker households. Importantly, our formulation implies that the higher the proportion of securitised loans the higher, *ceteris paribus*, the actual capital adequacy ratio and the lower, thereby, the credit rationing. In this way, securitisation can be conducive to higher investment in housing market and larger consumption expenditures by type II worker households.

Equation (55) shows that the commercial banks hold a proportion of deposits in the form of cash (HPM_B), based on the reserve requirement ratio (h_B) determined by the central bank. Banks hold treasury bills when the sum of capital and deposits is higher than the sum of loans and cash. Otherwise, the commercial banks take advances from the central bank and hold no treasury bills. This fact is captured by equations (56)-(59).

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[19] See Le Heron and Mouakil (2008) and Dafermos (2012) for similar formulations.

[20] Following Godley and Lavoie (2007, ch. 11), housing and consumption loans are assigned a 100% risky weight, while cash and treasury bills are assumed to carry a 0% weight.

4.3.5 SPVs-underwriters

$$COUPON = coupM_{-1} \tag{60}$$

$$coup = i_{LH} - x_5 \tag{61}$$

$$FEE = feLH_{S-1} \tag{62}$$

$$ES = i_{LH}LH_{S-1} - COUPON - FEE \tag{63}$$

$$PU = i_{LH}LH_{S-1} + i_T TB_{U-1} - FEE \tag{64}$$

$$PU_U = i_{TB}TB_{U-1} + ES \tag{65}$$

$$M = M_{-1} + \Delta LH_S + DL_{SU} \tag{66}$$

$$DL_S = \varphi LH_{S-1} \tag{67}$$

$$DL_{SU} = DL_S \text{, iff } \varphi < \varphi^g \text{; otherwise } DL_{SU} = \varphi^g LH_{S-1} \tag{68}$$

$$TB_U = TB_{U-1} + PU_U + \Delta M p_M - \Delta M \tag{69}$$

$$K_U = K_{U-1} + PU_U - DL_{SU} - CG_M \tag{70}$$

$$CG_M = \Delta p_M M_{-1} \tag{71}$$

Equation (60) defines the coupon payment, $COUPON$, provided by SPVs-underwriters to institutional investors; M is the amount of MBSs. The coupon rate $(coup)$ is defined according to the interest rate on loans minus a specific spread (x_5), which is deemed to be high enough to cover the guaranteed loan losses and the administrative fees (equation (61)). Equation (62) determines the amount of administrative fees that the SPVs-underwriters provide to the commercial banks. Administrative fees are a proportion (fe) of the loans that are securitised. The excess spread (ES) is determined by subtracting administrative fees and coupon payments from interest payments (see equation (63)). Equation (64) gives the total profits of SPVs-underwriters PU and equation (65) defines the profits that are retained (PU_U); TB_U denotes the amount of treasury bills held by SPVs-underwriters.

Equation (66) indicates that the change in the amount of MBSs equals the change in securitised loans plus the amount of defaulted securitised loans (DL_{SU}) that are covered by SPVs-underwriters. Two points are in order. First, it is postulated that the commercial banks sell mortgage loans to the SPVs-underwriters at a price equal to \$1 while the face value of an MBS is also \$1. However, the SPVs-underwriters may sell the mortgages at price different than \$1 (this is the price of the MBSs, p_M, which can only accidentally be equal to 1). Second, equations (67)-(68) suggest that the principal repayments are distributed to institutional investors without being affected by defaults on securitised loans (DL_S) in so far as the latter are lower than those guaranteed by the SPVs-underwriters. If $DL_S > DL_{SU}$ the principal repayments to MBSs holders decline by $(\varphi - \varphi^g)LH_{S-1}$; φ^g is the guaranteed rate of default by SPVs-underwriters.[21] Note that in this case there is also a reduction in the coupon payments.

Equation (69) indicates that treasury bills act as a residual in the portfolio choice of SPVs-underwriters. The change in the capital of SPVs-underwriters (K_U) is defined in equation (70). Equation (71) specifies the capital gains on MBSs (CG_M).

4.3.6 Institutional investors

$$PI = COUPON + i_T TB_{II-1} \tag{72}$$

$$PI_U = s_I PI_{-1} \tag{73}$$

$$PI_D = PI - PI_U \tag{74}$$

$$K_{II} = K_{II-1} + PI_U + CG_M - DL_{SII} \tag{75}$$

$$DL_{SII} = (\varphi - \varphi^g)LH_{S-1}, \text{ iff } \varphi > \varphi^g\text{; otherwise } DL_{SII} = 0 \tag{76}$$

$$p_M M = (\gamma_{10} + \gamma_{11} r_{M-1} + \gamma_{12} i_T)(K_{II-1} + SH_{-1}) \tag{77}$$

$$TB_{II} = (\gamma_{20} + \gamma_{121} r_{M-1} + \gamma_{22} i_T)(K_{II-1} + SH_{-1}) \tag{78a}$$

$$TB_{II} = K_{II} + SH - p_M M \tag{78}$$

$$y_M = \frac{COUPON}{p_{M-1} M_{-1}} \tag{79}$$

$$r_M = y_M + \frac{CG_M}{p_{M-1} M_{-1}} \tag{80}$$

[21] This can be shown by combining equations (7), (39), (66), (67) and (68), which yields: $\Delta M = sNLH - rep_L LH_{S-1} - (\varphi - \varphi^g)LH_{S-1}$.

The institutional investors get revenues from holding MBSs and treasury bills. Their profits (PI) are given by equation (72); TB_{II} is the amount of treasury bills held by institutional investors. A small part of their profits are retained (PI_U); s_I denotes the retention ratio (see equation (73)). The rest profits (PI_D) are distributed to investor households who hold the shares issued by institutional investors (equation (74)). The shares bought by investor households constitute the main source of fund of institutional investors' investments. For simplicity, it is assumed that the shares issued by institutional investors have a stable price equal to \$1 per share.[22]

Equation (75) defines the change in the capital of institutional investors (K_{II}); DL_{SII} denotes the amount of defaulted loans that are not guaranteed by SPVs-institutional investors (see equation (76)). The portfolio choice of institutional investors is captured by equations (77) and (78a). In our formulation, Godley's (1999) imperfect asset substitutability framework has been adopted. Therefore, the expected gross wealth of institutional investors (which is equal to $K_{II-1} + SH_{-1}$) is imperfectly allocated between treasury bills and MBS according to the respective rates of return; SH are the shares of institutional investors.[23] Note that equation (78a) is replaced in the computer model by equation (78), with treasury bills acting as a buffer. The yield on MBSs is given by the ratio of the coupon payments to the lagged value of MBSs (equation (79)). The total rate of return of MBSs (r_M), defined in equation (80), consists of two components: the yield and the capital gain on MBSs.

4.3.7 Investor households

$$YT_I = i_T TB_{IH-1} + i_D D_{IH-1} + PI_D + PF_D + PB_{BD} \tag{81}$$

$$YD_I = YT_I - T_{IH} \tag{82}$$

$$V_I = V_{I-1} + YD_I - C_{IH} + CG_e + CG_{HI} \tag{83}$$

[22] Unlike our abstraction, in practice the price of institutional investors' shares can be different than unity due to significant changes in institutional investors' net asset value or due to adverse expectations on the part of borrowers regarding the safety of their investment (see e.g. Macey, 2011; Duygan-Bumb *et al.*, 2013). However, in normal times this price is close to unity.

[23] The parameters in the portfolio choice equations satisfy the horizontal, vertical and symmetry adding-up conditions. Thus, some of them are negative.

$$V_{IF} = V_I - HPM_{IH} \tag{84}$$

$$HPM_{IH} = h_I C_{IH} \tag{85}$$

$$C_{IH} = c_{31} YD_{I-1} + c_{32} V_{I-1} \tag{86}$$

$$CG_e = \Delta p_e e_{-1} \tag{87}$$

$$CG_{HI} = \Delta p_H H_{DI-1} \tag{88}$$

$$\frac{SH}{V_{IF-1}} = \lambda_{10} + \lambda_{11} r_{S-1} + \lambda_{12} i_T + \lambda_{13} r_{e-1} + \lambda_{14} r_{H-1} + \lambda_{15} i_D + \lambda_{16} \frac{YD_{I-1}}{V_{IF-1}} \tag{89}$$

$$\frac{TB_{IH}}{V_{IF-1}} = \lambda_{20} + \lambda_{21} r_{S-1} + \lambda_{22} i_T + \lambda_{23} r_{e-1} + \lambda_{24} r_{H-1} + \lambda_{25} i_D + \lambda_{26} \frac{YD_{I-1}}{V_{IF-1}} \tag{90}$$

$$\frac{p_e e}{V_{IF-1}} = \lambda_{30} + \lambda_{31} r_{S-1} + \lambda_{32} i_T + \lambda_{33} r_{e-1} + \lambda_{34} r_{H-1} + \lambda_{35} i_D + \lambda_{36} \frac{YD_{I-1}}{V_{IF-1}} \tag{91}$$

$$\frac{p_H H_{DI}}{V_{IF-1}} = \lambda_{40} + \lambda_{41} r_{S-1} + \lambda_{42} i_T + \lambda_{43} r_{e-1} + \lambda_{44} r_{H-1} + \lambda_{45} i_D + \lambda_{46} \frac{YD_{I-1}}{V_{IF-1}} \tag{92}$$

$$\frac{D_{IH}}{V_{IF-1}} = \lambda_{50} + \lambda_{51} r_{S-1} + \lambda_{52} i_T + \lambda_{53} r_{e-1} + \lambda_{54} r_{H-1} + \lambda_{55} i_D + \lambda_{56} \frac{YD_{I-1}}{V_{IF-1}} \tag{93a}$$

$$D_{IH} = V_{IF} - SH - TB_{IH} - p_e e - p_H H_{DI} \tag{93}$$

$$r_S = \frac{PI_D}{SH_{-1}} \tag{94}$$

$$r_e = \frac{PF_D + CG_e}{p_{e-1} e_{-1}} \tag{95}$$

$$r_H = \frac{CG_{HI}}{p_{H-1} H_{DI-1}} \tag{96}$$

Equation (81) defines the before taxes income of investor households (YT_I). The disposable income of investor households (YD_I) is given by equation (82). Note that TB_{IH} denotes the treasury bills held by investor households and T_{IH} stands for their income taxes. Equations (83) and (84) describe, respectively, the wealth of investor households (V_I) and their financial market asset wealth (V_{IF}). The high-powered money (HPM_{IH}) is, according to equation (85) a proportion (h_I) of their consumption. Equation (86) gives the consumption of investor households, which depends on their expected disposable income and expected wealth. Equations (87) and (88) define, respectively, the capital gains on firms' equity (CG_e) and houses (CG_{HI}).

Investor households allocate their expected financial market asset wealth between deposits, treasury bills, houses, firms' equities and institutional investors' equities. As in the portfolio choice of institutional investors, Godley's (1999) imperfect asset substitutability framework is adopted (see equations (89-93a)).[24] Note that equation (93a) is replaced in the computer model by equation (93), with deposits acting as a buffer. Equations (94), (95) and (96) define, respectively, the rate of return on institutional investors' equity (r_S), the rate of return on firms' equity (r_e) and the rate of return on houses (r_H).

For the purposes of our analysis, two points are worth highlighting. First, a decline in the distributed profits of institutional investors (e.g. due to excessive mortgage defaults) reduces investor households' willingness to invest in institutional investors' shares with adverse effects on the MBSs market. Second, a fall in the wage income share exerts, *ceteris paribus*, a positive impact on the income of investor households and thereby on their wealth. Hence, since a proportion of investor households' wealth is held in the form of institutional investors' equities, wage stagnation can enhance investment in MBS, fostering mortgage securitisation.

4.3.8 Government

$$TB = TB_{-1} + GOV - T_{W1} - T_{W2} - T_{IH} + i_T TB_{-1} - PB_{CB} \tag{97}$$

$$GOV = GOV_{-1}(1+g) \tag{98}$$

$$T_{W1} = \tau_W W_{W1-1} \tag{99}$$

$$T_{W2} = \tau_W W_{W2-1} \tag{100}$$

$$T_{IH} = \tau_{IH} YT_{I-1} \tag{101}$$

$$i_T = i_A \tag{102}$$

[24] Again the parameters in the portfolio choice equations satisfy the horizontal, vertical and symmetry adding-up constraints.

Equation (97) gives the amount of treasury bills issued by the government (TB). As equation (98) shows, the government expenditures are increasing with a constant rate g. Equations (99)-(101) define income taxes. Equation (102) states that the interest rate on treasury bills equals the interest rate on the central bank. The latter is set exogenously.

4.3.9 Central bank

$$PB_{CB} = i_T TB_{CB-1} + i_A A_{-1} \tag{103}$$

$$HPM = HPM_{IH} + HPM_B \tag{104}$$

$$TB_{CB} = HPM - A \tag{105}$$

$$TB_{CB} = TB - TB_{IH} - TB_B - TB_{II} - TB_U \tag{106}$$

Equation (103) describes the profits of the central bank (PB_{CB}). The high-powered money provided by the central bank (HPM) is depicted by equation (104). Equation (105) gives the amount of treasury bills held by the central bank (TB_{CB}). The redundant equation of the model (equation (106)) indicates that the central bank is the residual purchaser of treasury bills.

4.4 Simulation experiments

The complexity of the model presented in section 4.3 precludes analytical solutions. Hence, the model was solved numerically using reasonable values for its parameters. Steady-state solutions were then found that served as a basis for our simulation experiments in which exogenous shocks were imposed on the model.[25]

[25] The Eviews programme utilised in the simulation analysis is available in the appendix. Note that the methodology used here (and is widely adopted in the related literature) has the drawback that it explores the behaviour of the model only close to specific plausible steady states. Therefore, the behaviour of the model around other possible steady states is not analysed. This is the cost of developing a model that is complex enough to capture the joint macroeconomic effects of securitisation and wage stagnation. It should, however, be pointed out that an advantage of the employed methodology is that it isolates the effects that stem from the exogenous changes under investigation.

The first experiment simulates the effects of some exogenous developments that increase the degree of securitisation in the economy. In particular, we consider a rise in the exogenous component that determines the proportion of mortgages securitised by banks (s_0). This rise is postulated to stem from changes in the institutional structure of the banking sector that prompt banks to engage more intensively in securitisation activities. An additional development is the reallocation of investor households' wealth from bank deposits to institutional investors' shares (i.e. λ_{10} increases). This reallocation reflects investor households' willingness to increase the yield of their portfolio taking advantage of the higher return provided by institutional investors. It may also be prompted by a more favourable evaluation of the quality of MBSs by the credit rating agencies. Note that the reallocation enhances the demand for MBSs, putting downward pressures on their yield. This, in turn, increases the proportion of the mortgages that are securitised.

Figure 1 shows the main effects of these shocks.[26] The increase in the proportion of mortgages that are securitised brings about a rise in the capital adequacy ratio of commercial banks, inducing them to decrease their credit rationing (Figure 1a). Accordingly, the amount of new mortgages and consumer loans becomes higher. The rise in mortgages causes an increase in the demand for houses from worker households that leads to: (i) a housing price appreciation (Figure 1b) that has feedback enhancing effects on credit availability since it tends to reduce the leverage of households;[27] and (ii) an increase in the supply of houses. The rise in consumer loans boosts consumer spending. These developments increase the output of the economy (Figure 1d). Remarkably, the output is also positively affected by the rise in the consumption of investor households, as a result of the income and wealth effects that stem from the expansion of the MBSs market: Figure 1b indicates that there is a rise in the price of MBSs after a passing initial decline.

[26] In Figure 1 (and in Figure 2 below) the series are expressed as a ratio of their values in the steady-state baseline solution.

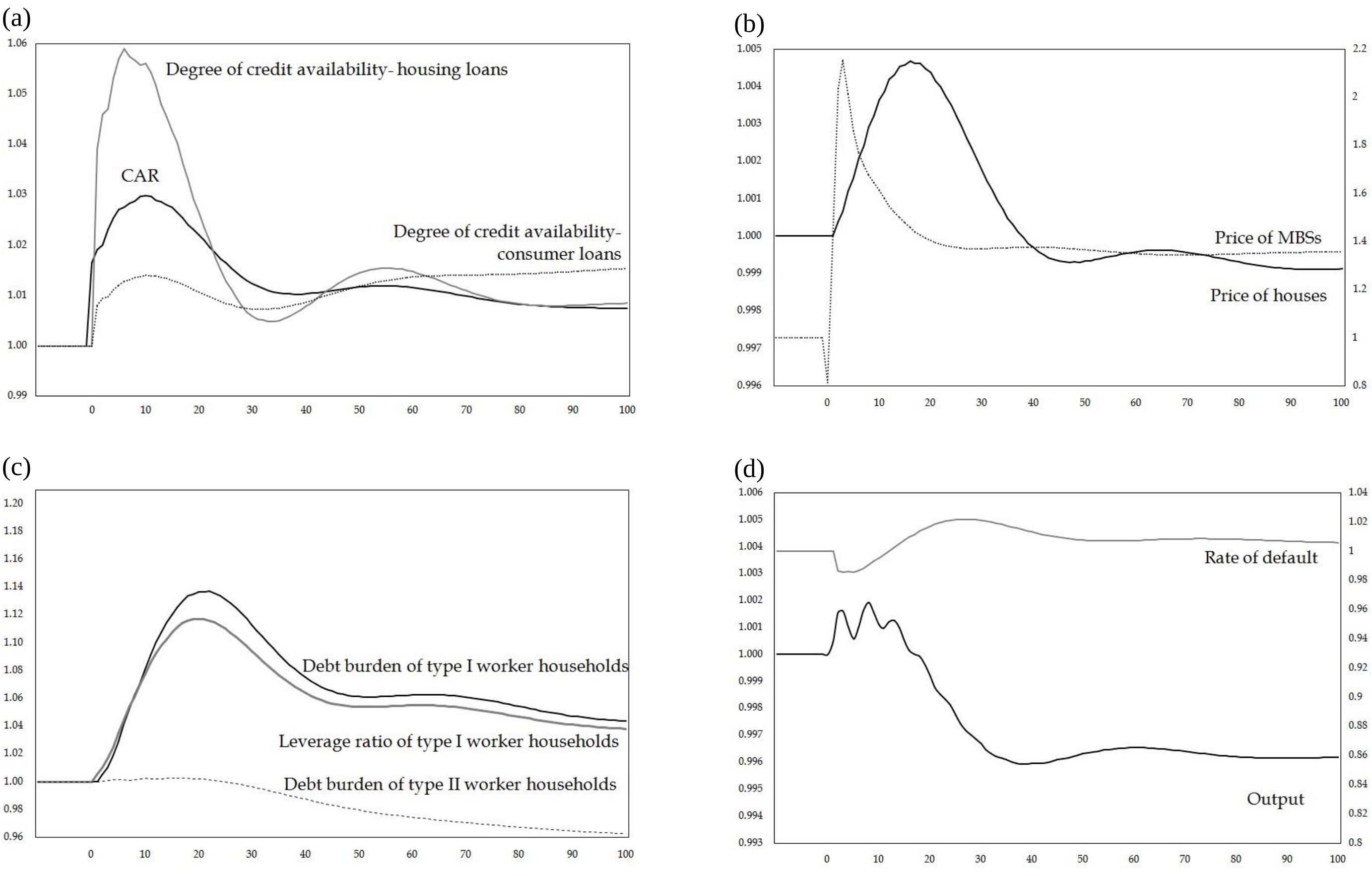
[27] Note that, as indicated in Figure 1c, the leverage ratio of type I households increases relative to the baseline solution. The reason is that in our simulations the increase in loans outweights the rise in the the value of houses, making the leverage ratio higher. However, without the increase in the price of houses the leverage would be higher.

Furthermore, credit expansion increases the debt commitments of worker households. The result is a gradual rise in the burden of debt of worker households, which is more important in the case of type I households. This increase tends to make higher the rate of default. However, the significant rise in credit availability overpowers the adverse effects of the higher burden of debt, leading to a lower rate of default in the first periods after the shocks (see Figure 1d).

Overall, in the first periods the economy experiences an economic, housing and financial boom that coexists with a rise in the burden of debt of households and a fall in the rate of default. It is also noteworthy that higher credit provision and increasing housing and MBSs prices reinforce the one the other. Following Tymoigne's (2010, 2011) conceptualisation of financial fragility, it can be argued that these developments correspond to an economy characterised by increasing financial fragility.

This growing financial fragility has long-run adverse effects. The gradual increase in the burden of debt of type I workers households, in conjuction with the loan expansion that places donward pressures on the capital adequacy ratio, reduces banks' credit availability and increases the rate of default on mortgages (Figure 1d). Moreover, the higher burden of debt negatively affects worker households' demand for houses leading to a decline in the price of houses (Figure 1b). Hence, housing investment and consumption start falling, reducing the level of output in the economy. Importantly, this reduction in the output has detrimental feedback effects on households' burden of debt, further reducing credit availability and further increasing the rate of default (see Figures 1a and 1d). The increasing rate of default has adverse effects on the MBSs market since the capital of institutional investors declines, putting downward pressures on the price of the MBSs. This tends to increase the yield on MBSs and, therefore, the proportion of mortgages that are securitised declines, further slowing down credit expansion. As a result of these developments, output ends up lower than its baseline solution. Overall, after a period of economic and financial prosperity, the initial rise in the degree of securitisation brings eventually the economy into a period of financial instability, which is characterised by a lower output, a higher rate of loan defaults and a declining price of houses.

Fig. 1. *Effects of an increase in the degree of securitisation*



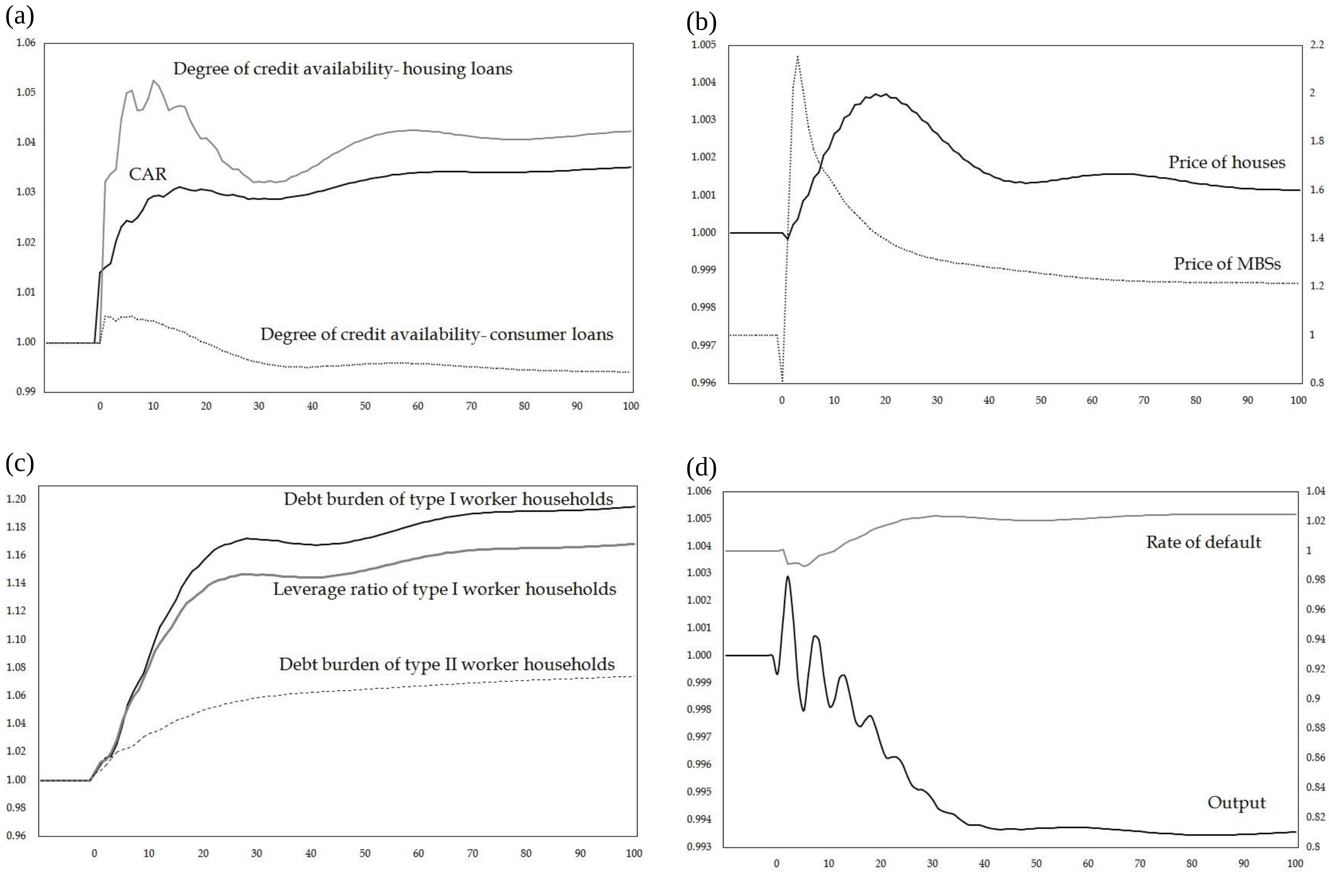
The second simulation experiment is identical to the first one with the only difference being that the rise in the degree of securitisation is accompanied by a decline in the wage income share (s_W). Figure 2 presents the results. Initially, the economy experiences a passing decline in the level of economic activity (Figure 2d). This decline is basically due to the adverse impact of the wage shock on consumption. In our simulations this adverse impact outweighs the favourable effects on the profits of firms that push upwards the investment in productive capital and the consumption of investor households. In other words, with our choice of parameters, aggregate demand is wage-led.

However, after the initial reduction the economy enters a borrowing-induced expansion as in the first simulation. There are, though, various noteworthy differences. To begin with, the decline in the wage income share induces type II worker households to demand more loans to attain their consumption norms. This produces a more vigorous rise in their debt commitments, compared with the first simulation. In conjunction with the direct negative effect of the wage shock on households' gross disposable income, this higher increase in debt commitments leads to a more rapid rise in their burden of debt (Figure 2c). At the same time, worker households of type I also experience a higher rise in their burden of debt, due to the adverse effect of the wage shock on the their gross income. This more rapid rise in the burden of debt of households is the main driving force behind the lower price increase in houses (see Figure 1b) and lower duration of the economic boom in the second simulation, in comparison with the first simulation (see Figure 2d). The shorter economic boom is also explained by the lower initial rise in the proportion of mortgages that are securitised. Notice that wage stagnation affects favourably the income of investor households and, thus, their wealth. As a result, it provides an additional boost in the shares of institutional investors and, hence, in the demand for MBSs. This higher demand for MBSs ultimately leads to a higher degree of securitisation.

Another important implication of the wage shock is that the negative longer-run effects of the initial credit expansion on the macroeconomy are more intense. The higher debt expansion in the initial periods combined with the direct detrimental effects of wage stagnation on worker households' consumption leads eventually to a lower level of output and a higher rate of default compared to the first simulation (Figure 2d). Moreover, the leverage and the burden of debt of households keep rising in the long run (in the first experiment there was a decline after the initial periods) and the credit availability for consumer loans becomes lower than in the baseline solution.[28] Consequently, it can be overall argued that wage stagnation reinforces in our model the long-run adverse effects of securitisation on macroeconomic stability.

[28] Interestingly, the degree of credit availability for housing loans remains higher than in the baseline solution. The reason for this is that the wage shock reduces the loans of firms placing upward pressures on the capital adequacy ratio. The firm loans decline because the wage shock affects prositively the internal funds of firms and negatively the desired investment (due to the wage-led structure of aggregate demand).

Fig. 2. *Effects of an increase in the degree of securitisation combined with a decline in the wage income share*



4.5 Conclusion

This chapter explored the macroeconomic effects of securitisation and wage stagnation within a SFC model, paying particular attention to their role in the emergence of financial fragility. The simulation experiments indicated that a rise in securitisation practices is likely to bring about, at a first stage, a borrowing-induced expansion, a housing boom, an appreciation in MBSs prices and a decline in the rate of default. However, this prosperity is accompanied by a rise in the burdens of debt of households, indicating a situation of increasing financial fragility. The rising burdens of debt gradually set the stage for the reversal of the initial expansionary effects of securitisation. Ultimately, the economy is led to a lower level of output, a higher rate of default on mortgages and a declining level of house and MBSs prices.

When the securitisation shock is accompanied by an exogenous decline in the wage income share the period of prosperity is shorter, basically because the burden of debt of households increases much more rapidly. Furthermore, the long-run adverse effects on macroeconomic performance are enhanced. Overall, these results provide support to the view that the combination of risky financial practices and higher inequality can, under certain circumstances, render a macro system more prone to instability.

Appendix

The Eviews programme of the simulation analysis is as follows:

'Creation of a work file called 'SEC'

wfcreate(wf=SEC) a 2500 3100
smpl 2500 3100
genr year=@trend

'Values for parameters and exogenous variables

genr n1=50
genr n2=50
genr n3=4

'Worker households – type I

genr c11=0.6
genr c12=0.05

genr phi0=0.025
genr phi1=0.05
genr phi2=0.01

genr h10=0.0357
genr h11=0.001
genr h12=0.9

'Worker households – type II

genr xi=0.28

'Firms

genr a0=0.0125
genr a1=0.02
genr a2=0.13

genr v=0.19

genr sF=0.6

genr x=0.05

genr h21=0.052
genr h22=0.5

genr h3=0.7

```
'Commercial banks

genr kH0=0.35
genr kH1=0.05
genr kH2=15
genr kH3=1.7
genr kH4=1

genr kC0=0.661
genr kC1=2.4
genr kC2=0.75

genr repL=0.1

genr hB=0.02
genr CART=0.08

genr sB=0.4

'Institutional investors

genr gamma10=0.46
genr gamma11=0.1
genr gamma12=-0.1

genr gamma20=1-gamma10
genr gamma21=-0.1
genr gamma22=0.1

genr sI=0.2

'Investor households

genr hI=0.1

genr c31=0.4
genr c32=0.02

genr lambda11=0.04
genr lambda12=-0.01
genr lambda13=-0.01
genr lambda14=-0.01
genr lambda15=-0.01
genr lambda16=-0.0012

genr lambda20=0.01
genr lambda21=-0.01
genr lambda22=0.04
genr lambda23=-0.01
```

```
genr lambda24=-0.01
genr lambda25=-0.01
genr lambda26=-0.001

genr lambda30=0.25
genr lambda31=-0.01
genr lambda32=-0.01
genr lambda33=0.04
genr lambda34=-0.01
genr lambda35=-0.01
genr lambda36=-0.001

genr lambda40=0.1
genr lambda41=-0.01
genr lambda42=-0.01
genr lambda43=-0.01
genr lambda44=0.04
genr lambda45=-0.01
genr lambda46=-0.001

genr lambda51=-0.01
genr lambda52=-0.01
genr lambda53=-0.01
genr lambda54=-0.01
genr lambda55=0.04
genr lambda56=0.004

'Government

genr g=0.03
genr tauW=0.15
genr tauIH=0.25

'Interest rates

genr iA=0.02
genr iT=iA
genr x1=0.02
genr x2=0.021
genr x3=0.001
genr x4=0.001
genr x5=0.022
genr iLH=iA+x1
genr iLC=iA+x2
genr iLF=iA+x3
genr iD=iA-x4
genr coup=iLH-x5
genr yMT=0.021

genr fe=0.006
```

```
genr phig=0.0221

'Exogenous changes

genr lambda10=0.1 '*(year<500)+0.2*(year>=500)
genr lambda50=1- lambda10- lambda20- lambda30- lambda40

genr s0=0.2 '*(year<500) + 0.28*(year>=500)
genr s1=0.5

genr sw=0.65 '*(year<500)+0.647*(year>=500)
```

'INITIAL VALUES FOR ENDOGENOUS VARIABLES

```
genr p_H=1.478748
genr H_DW= 1.448573e+24
genr H_DI=1.467045e+23
genr H=2.765149e+24
genr HU=H-H_DW-H_DI
genr dH=8.053828e+22
genr gPH=0
genr gH_DW=0.03
genr gH_DI=0.03
genr gH_D=0.03
genr gH=0.03
genr ratH=(H_DW+H_DI)/H

genr C_IH=1.155634e+23
genr C_W1=2.934382e+23
genr C_W2=3.466398e+23
genr INV=2.895654e+23
genr GOV=1.842925e+23
genr Y=C_IH+C_W1+C_W2+GOV+INV+dH
genr W=8.267227e+23
genr W_W1=(n1/(n1+n2))*W
genr W_W2=(n2/(n1+n2))*W
genr YD_W1=3.442835e+23
genr YD_WG1=YD_W1
genr YD_W2=3.288496e+23
genr YD_I=1.804773e+23
genr YT_I=2.383226e+23

genr LH=2.286495e+23
genr LH_NS=1.820366e+23
genr LH_S=4.661294e+22
genr LC= 6.108027e+23
genr NLH= 3.374419e+22
genr NLH_DN=4.539041e+22
genr NLC= 7.709145000000001e+22
genr NLC_DN=1.349234e+23
```

```
genr BUR_W1=0.0880007
genr LEV_W1=LH/(P_H*H_DW)
genr BUR_W2=0.2367596
genr k_H=0.7429375

genr K_F=9.941745e+24
genr PF=4.764651e+23
genr PF_U=2.775525e+23
genr PF_D=PF-PF_U
genr p_e=1069019
genr e=5.573908e+17
genr CG_e= 3.2986e+21
genr r_F=PF_U/K_F
genr u=Y/(v*K_F)
genr LF=3.3596e+23
genr BUR_LF=0.0816592

genr D_IH=1.283391e+24

genr p_M=1.355815
genr M=8.080898000000001e+22
genr PU=3.466306e+21
genr COUPON=1.412196e+21
genr PU_U=2.05411e+21

genr HPM_IH=hI*C_IH
genr HPM_B=hB*D_IH
genr HPM=HPM_IH+HPM_B
genr A=0
genr TB_IH=1.55735e+22
genr TB_B=2.605763e+23
genr TB_II=1.361207e+23
genr TB_U=9.927287e+22
genr TB=5.4876753E+23
genr TB_CB=HPM-A
genr K_B=HPM_B+LH_NS+LC+LF+TB_B-D_IH-A
genr PB_B=1.988963e+22
genr TB_CBred=TB-TB_IH-TB_B-TB_II-TB_U

genr SH=2.186456e+23
genr PI=4.055317e+21
genr PI_U=7.874403e+20
genr PI_D=PI-PI_U
genr CG_M=3.27855e+16
genr V_W1=p_H*H_DW-LH
genr V_I=HPM_IH+TB_IH+D_IH+SH+p_e*e+p_H*H_DI
genr V_IF=V_I-HPM_IH
genr K_II=TB_II+p_M*M-SH
genr K_U=LH_S+TB_U-p_M*M
genr CAR=K_B/(LH_NS+LC+LF)
```

genr MP=M*p_M

genr r_SH=0.0153944
genr r_e=0.3495401
genr r_H=0
genr y_M=0.0132762
genr r_M=0.0132765

'MODEL SPECIFICATION

delete *_model
model SEC_model

'Worker households type I

SEC_model.append YD_W1=W_W1-iLH*LH(-1)-T_W1 'equation (1)
SEC_model.append YD_WG1=YD_W1+iLH*LH(-1) 'equation (2)
SEC_model.append W_W1=(n1/(n1+n2))*W 'equation (3)
SEC_model.append C_W1=c11*YD_W1(-1)+c12*V_W1(-1) 'equation (4)
SEC_model.append CG_HW=(p_H-p_H(-1))*H_DW(-1) 'equation (5)
SEC_model.append NLH_DN=p_H(-1)*(H_DDW-H_DW(-1))+repL*LH(-1)+C_W1-YD_W1 'equation (6)
SEC_model.append NLH_D=(NLH_DN>0)*NLH_DN+0
SEC_model.append LH=LH(-1)+NLH-repL*LH(-1)-DL 'equation (7)
SEC_model.append DL=phi*LH(-1) 'equation (8)
SEC_model.append phi=phi0+phi1*BUR_W1(-1)-phi2*k_H(-1) 'equation (9)
SEC_model.append BUR_W1=((iLH+repL)*LH(-1))/YD_WG1 'equation (10)
SEC_model.append V_W1=V_W1(-1)+YD_W1-C_W1+CG_HW+DL 'equation (11)
SEC_model.append LEV_W1=LH/(p_H*H_DW) 'equation (12)
SEC_model.append H_DDW=H_DW(-1)+(h10-h11*BUR_W1(-1)+h12*gPH(-1))*H_DW(-1) 'equation (13)
SEC_model.append H_DW=H_DW(-1)+(YD_W1+(LH-LH(-1))-C_W1+DL)/p_H 'equation (14)
SEC_model.append gH_DDW=(H_DDW-H_DW(-1))/H_DW(-1)
SEC_model.append gH_DW=(H_DW-H_DW(-1))/H_DW(-1)
SEC_model.append gH_DI=(H_DI-H_DI(-1))/H_DI(-1)

'Worker households type II

SEC_model.append YD_W2=W_W2-iLC*LC(-1)-T_W2 'equation (15)
SEC_model.append YD_WG2=YD_W2+iLC*LC(-1) 'equation (16)
SEC_model.append W_W2=(n2/(n1+n2))*W 'equation (17)
SEC_model.append C_W2=YD_W2+LC-LC(-1) 'equation (18)
SEC_model.append CA_W2D=(xi/n3)*C_IH 'equation (19)
SEC_model.append C_W2D=n2*CA_W2D 'equation (20)
SEC_model.append NLC_DN=C_W2D-YD_W2+ repL*LC(-1) 'equation (21)
SEC_model.append NLC_D=(NLC_DN>0)*NLC_DN+0
SEC_model.append LC=LC(-1)+NLC-repL*LC(-1) 'equation (22)
SEC_model.append BUR_W2=((iLC+repL)*LC(-1))/YD_WG2 'equation (23)

'Firms

```
SEC_model.append Y=C_W1+C_W2+C_IH+INV+GOV+dH 'equation (24)
SEC_model.append INV=(a0+a1*u(-1)+a2*r_F(-1))*K_F(-1) 'equation (25)
SEC_model.append u=Y/(v*K_F) 'equation (26)
SEC_model.append r_F=PF_U/K_F 'equation (27)
SEC_model.append K_F=K_F(-1)+INV 'equation (28)
SEC_model.append PF=Y-W-iLF*LF(-1) 'equation (29)
SEC_model.append W=sw*Y(-1) 'equation (30)
SEC_model.append PF_U=sF*PF(-1) 'equation (31)
SEC_model.append PF_D=PF-PF_U 'equation (32)
SEC_model.append e=e(-1)+(x*INV(-1))/p_e 'equation (33)
SEC_model.append LF=LF(-1)+INV+dH-PF_U-(H_DW-H_DW(-1))*p_H-(H_DI-
H_DI(-1))*p_H -(e-e(-1))*p_e 'equation (34)
SEC_model.append BUR_LF=((iLF+repL)*LF(-1))/(Y-W)
SEC_model.append H=H(-1)+(h21*ratH+h22*gPH)*H(-1) 'equation (35)
SEC_model.append HU=HU(-1)+(H-H(-1))-(H_DW-H_DW(-1))-(H_DI-H_DI(-1))
'equation (36)
SEC_model.append p_H=p_H(-1)+h3*(gH_D(-1)-gH(-1))*p_H(-1) 'equation (37)
SEC_model.append dH=H-H(-1)
SEC_model.append gPH=(P_H-P_H(-1))/P_H(-1)
SEC_model.append gH=(H-H(-1))/H(-1)
SEC_model.append ratH=(H_DW+H_DI)/H
SEC_model.append gH_D=(H_DW+H_DI-H_DW(-1)-H_DI(-1))/(H_DW(-
1)+H_DI(-1))
```

'Commercial banks

```
SEC_model.append s=s0-s1*(y_M(-1)-yMT) 'equation (38)
SEC_model.append LH_S=s*LH 'equation (39)
SEC_model.append LH_NS=(1-s)*LH 'equation (40)
SEC_model.append PB_B=iLH*LH_NS(-1)+iLC*LC(-1)+iLF*LF(-1)+iT*TB_B(-
1)+FEE-iD*D_IH(-1)-iA*A(-1) 'equation (41)
SEC_model.append iLH=iA+x1 'equation (42)
SEC_model.append iLC=iA+x2 'equation (43)
SEC_model.append iLF=iA+x3 'equation (44)
SEC_model.append iD=iA-x4 'equation (45)
SEC_model.append K_B=K_B(-1)+PB_BU-DL_NS 'equation (46)
SEC_model.append DL_NS= phi*LH_NS(-1) 'equation (47)
SEC_model.append PB_BU=sB*PB_B(-1)  'equation (48)
SEC_model.append PB_BD=PB_B-PB_BU  'equation (49)
SEC_model.append NLH=k_H*NLH_D 'equation (50)
SEC_model.append k_H=kH0-kH1*LEV_W1(-1)+kH2*(CAR(-1)-CART)-
kH3*BUR_W1(-1)-kH4* phi 'equation (51)
SEC_model.append NLC=k_C*NLC_D 'equation (52)
SEC_model.append k_C=kC0+kC1*(CAR(-1)-CART)- kC2*BUR_W2(-1) 'equation
(53)
SEC_model.append CAR=K_B/(LH_NS+LC+LF) 'equation (54)
SEC_model.append HPM_B=hB*D_IH 'equation (55)
SEC_model.append TB_BN=K_B+D_IH-LH_NS-LC-LF-HPM_B 'equation (56)
```

```
SEC_model.append A_N=LH_NS+LC+LF+HPM_B-K_B-D_IH 'equation (57)
SEC_model.append A=(A_N>0)*A_N+0 'equation (58)
SEC_model.append TB_B=(TB_BN>0)*TB_BN+0 'equation (59)

'SPVs-underwriters

SEC_model.append COUPON=coup*M(-1) 'equation (60)
SEC_model.append coup=iLH-x5 'equation (61)
SEC_model.append FEE=fe*LH_S(-1) 'equation (62)
SEC_model.append ES=iLH*LH_S(-1)-COUPON-FEE 'equation (63)
SEC_model.append PU= iLH*LH_S(-1)+iT*TB_U(-1)-FEE 'equation (64)
SEC_model.append PU_U=iT*TB_U(-1)+ES 'equation (65)
SEC_model.append M=M(-1)+LH_S-LH_S(-1)+DL_SU 'equation (66)
SEC_model.append DL_S= phi *LH_S(-1) 'equation (67)
SEC_model.append DL_SU=DL_S*( phi <= phig)+(phig*LH_S(-1))*(phi>phig)
'equation (68)
SEC_model.append TB_U=TB_U(-1)+ PU_U+(M-M(-1))*p_M - (M-M(-1)) 'equation
(69)
SEC_model.append K_U=K_U(-1)+PU_U-CG_M-DL_SU 'equation (70)
SEC_model.append CG_M=(p_M-p_M(-1))*M(-1) 'equation (71)

'Institutional investors

SEC_model.append PI= iT*TB_II(-1)+COUPON 'equation (72)
SEC_model.append PI_U=sI*PI(-1) 'equation (73)
SEC_model.append PI_D=PI-PI_U 'equation (74)
SEC_model.append K_II=K_II(-1)+PI_U+CG_M-DL_SII 'equation (75)
SEC_model.append DL_SII=(( phi - phig)*LH_S(-1))*(phi>phig)+0*(phi<=phig)
'equation (76)
SEC_model.append P_M=(coef_M*(K_II(-1)+SH(-1)))/M 'equation (77)
SEC_model.append TB_II=K_II+SH-M*p_M 'equation (78)
SEC_model.append y_M=COUPON/(p_M(-1)*M(-1)) 'equation (79)
SEC_model.append r_M=y_M + CG_M/(p_M(-1)*M(-1)) 'equation (80)
SEC_model.append coef_M=gamma10+gamma11*r_M(-1)+gamma12*iT
SEC_model.append coef_TBII=gamma20+gamma21*r_M(-1)+gamma22*iT

'Investor households

SEC_model.append YT_I= iD*D_IH(-1)+iT*TB_IH(-1)+PI_D+PF_D+PB_BD
'equation (81)
SEC_model.append YD_I= YT_I-T_IH 'equation (82)
SEC_model.append V_I=V_I(-1)+YD_I-C_IH+CG_e+CG_HI 'equation (83)
SEC_model.append V_IF=V_I-HPM_IH 'equation (84)
SEC_model.append HPM_IH=hI*C_IH 'equation (85)
SEC_model.append C_IH=c31*YD_I(-1)+c32*V_I(-1)'equation (86)
SEC_model.append CG_e=(p_e-p_e(-1))*e(-1)'equation (87)
SEC_model.append CG_HI=(p_H-p_H(-1))*H_DI(-1)'equation (88)
SEC_model.append SH=(lambda10+lambda11*r_SH(-
1)+lambda12*iT+lambda13*r_e(-1)+ lambda14*r_H(-
1)+lambda15*iD+lambda16*(YD_I(-1)/V_IF(-1)))*V_IF(-1) 'equation (89)
```

SEC_model.append TB_IH=(lambda20+lambda21*r_SH(-1)+lambda22*iT+lambda23*r_e(-1)+ lambda24*r_H(-1)+lambda25*iD+lambda26*(YD_I(-1)/V_IF(-1)))*V_IF(-1) 'equation (90)
SEC_model.append p_e=((lambda30+lambda31*r_SH(-1)+lambda32*iT+lambda33*r_e(-1)+lambda34*r_H(-1)+lambda35*iD+lambda36*(YD_I(-1)/V_IF(-1)))*V_IF(-1))/e(-1)-(x*INV(-1))/e(-1) 'equation (91)
SEC_model.append H_DI =((lambda40+lambda41*r_SH(-1)+lambda42*iT+lambda43*r_e(-1)+ lambda44*r_H(-1)+lambda45*iD+lambda46*(YD_I(-1)/V_IF(-1)))*V_IF(-1))/P_H 'equation (92)
SEC_model.append D_IH=V_IF-SH-p_e*e-TB_IH-H_DI*p_H 'equation (93)
SEC_model.append r_SH =PI_D/SH(-1) 'equation (94)
SEC_model.append y_E=PF_D/(p_e(-1)*e(-1))
SEC_model.append r_e =(PF_D+CG_e)/(p_e(-1)*e(-1)) 'equation (95)
SEC_model.append r_H =CG_HI/(p_H(-1)*H_DI(-1)) 'equation (96)

'Government

SEC_model.append TB=TB(-1)+GOV-T_W1-T_W2-T_IH+iT*TB(-1)-PB_CB'equation (97)
SEC_model.append GOV=GOV(-1)*(1+g) 'equation (98)
SEC_model.append T_W1=tauW*W_W1(-1) 'equation (99)
SEC_model.append T_W2=tauW*W_W2(-1) 'equation (100)
SEC_model.append T_IH=tauIH*YT_I(-1) 'equation (101)
SEC_model.append iT=iA 'equation (102)

'Central bank

SEC_model.append PB_CB=iT*TB_CB(-1)+iA*A(-1) 'equation (103)
SEC_model.append HPM=HPM_IH+HPM_B 'equation (104)
SEC_model.append TB_CB=HPM-A 'equation (105)
SEC_model.append TB_CBred=TB-TB_IH-TB_B-TB_II-TB_U 'equation (106)

'additional helpful parameters and variables

SEC_model.append g_Y=(Y-Y(-1))/Y(-1)
SEC_model.append g_CIH=(C_IH-C_IH(-1))/C_IH(-1)
SEC_model.append g_CW1=(C_W1-C_W1(-1))/C_W1(-1)
SEC_model.append g_CW2=(C_W2-C_W2(-1))/C_W2(-1)
SEC_model.append g_INV=(INV-INV(-1))/INV(-1)
SEC_model.append g_dH=(dH-dH(-1))/dH(-1)
SEC_model.append g_W=(W-W(-1))/W(-1)

SEC_model.append g_NLDH=(NLH_DN-NLH_DN(-1))/NLH_DN(-1)
SEC_model.append g_NLDC=(NLC_DN-NLC_DN(-1))/NLC_DN(-1)

SEC_model.append g_YDW1=(YD_W1-YD_W1(-1))/YD_W1(-1)
SEC_model.append g_BUR1=(BUR_W1-BUR_W1(-1))/BUR_W1(-1)
SEC_model.append g_LH=(LH-LH(-1))/LH(-1)

```
SEC_model.append g_YDW2=(YD_W2-YD_W2(-1))/YD_W2(-1)
SEC_model.append g_BUR2=(BUR_W2-BUR_W2(-1))/BUR_W2(-1)
SEC_model.append g_LC=(LC-LC(-1))/LC(-1)

SEC_model.append g_PFU=(PF_U-PF_U(-1))/PF_U(-1)

SEC_model.append g_e=(e-e(-1))/e(-1)
SEC_model.append g_pe=(p_e-p_e(-1))/p_e(-1)
SEC_model.append g_DIH=(D_IH-D_IH(-1))/D_IH(-1)
SEC_model.append g_TBIH=(TB_IH-TB_IH(-1))/TB_IH(-1)

SEC_model.append MP=M*P_M
SEC_model.append g_MP=(MP-MP(-1))/MP(-1)
SEC_model.append g_M=(M-M(-1))/M(-1)
SEC_model.append g_PM=(P_M-P_M(-1))/P_M(-1)
SEC_model.append g_SH=(SH-SH(-1))/SH(-1)
SEC_model.append g_TBII=(TB_II-TB_II(-1))/TB_II(-1)
SEC_model.append g_KII=(K_II-K_II(-1))/K_II(-1)

SEC_model.append rat_SH=SH/V_IF
SEC_model.append rat_TBIH=TB_IH/V_IF
SEC_model.append rat_e=(p_e*e)/V_IF
SEC_model.append rat_PDIH=(P_H*H_DI)/V_IF
SEC_model.append rat_DIH=D_IH/V_IF

SEC_model.append rat_CW1Y=C_W1/Y
SEC_model.append rat_CW2Y=C_W2/Y
SEC_model.append rat_CIHY=C_IH/Y
SEC_model.append rat_INVY=INV/Y
SEC_model.append rat_dHY=dH/Y
SEC_model.append rat_GOVY=GOV/Y

SEC_model.append ratHDW_H=H_DW/H
SEC_model.append ratHDI_H=H_DI/H

SEC_model.append ratCW2D_YD=C_W2D/YD_W2
SEC_model.append ratCW2_YD=C_W2/YD_W2

SEC_model.append ratYD_CW2=YD_W2/C_W2
SEC_model.append ratLC_CW2=(LC-LC(-1))/C_W2
SEC_model.append ratYD_HDW=(YD_W1-C_W1)/((H_DW-H_DW(-1))*P_H)
SEC_model.append ratLH_HDW=(LH-LH(-1))/((H_DW-H_DW(-1))*P_H)
SEC_model.append ratDL_HDW=(DL)/((H_DW-H_DW(-1))*P_H)

SEC_model.append coef_SH=lambda10+lambda11*r_SH(-
1)+lambda12*iT+lambda13*r_e(-1)+ lambda14*r_H(-
1)+lambda15*iD+lambda16*(YD_I(-1)/V_IF(-1))
SEC_model.append coef_TBIH=lambda20+lambda21*r_SH(-
1)+lambda22*iT+lambda23*r_e(-1)+ lambda24*r_H(-
1)+lambda25*iD+lambda26*(YD_I(-1)/V_IF(-1))
```

SEC_model.append coef_pe=lambda30+lambda31*r_SH(-1)+lambda32*iT+lambda33*r_e(-1)+lambda34*r_H(-1)+lambda35*iD+lambda36*(YD_I(-1)/V_IF(-1))
SEC_model.append coef_PHDI =lambda40+lambda41*r_SH(-1)+lambda42*iT+lambda43*r_e(-1)+ lambda44*r_H(-1)+lambda45*iD+lambda46*(YD_I(-1)/V_IF(-1))
SEC_model.append coef_DIH= lambda50+lambda51*r_SH(-1)+lambda52*iT+lambda53*r_e(-1)+ lambda54*r_H(-1)+lambda55*iD+lambda56*(YD_I(-1)/V_IF(-1))

'SIMULATION

SEC_model.scenario "Baseline"
SEC_model.solve

'main economic variables

group data0 (TB_CB_0)(TB_CBred_0)(g_Y_0)(g_CW1_0)(g_CW2_0)(g_CIH_0)(g_INV_0)(g_dH_0)(rat_CW1Y_0)(rat_CW2Y_0)(rat_CIHY_0)(rat_INVY_0)(rat_dHY_0)(rat_GOVY_0)(NLH_DN_0)(NLH_D_0)(NLH_0)(g_LH_0)(gH_DDW_0)(gH_DW_0)(gH_DI_0)(gH_D_0)(gH_0)(gPH_0)(H_DDW_0)(H_DW_0)(H_DI_0)(H_0)(dH_0)(ratH_0)(ratHDW_H_0)(ratHDI_H_0)(HU_0)(p_H_0)(ratYD_CW2_0)(ratLC_CW2_0)(ratYD_HDW_0)(ratLH_HDW_0)(ratDL_HDW_0)(k_H_0)(LEV_W1_0)(CAR_0)(BUR_W1_0)(LH_0)(phi_0)(DL_0)(W_W1_0)(YD_W1_0)(YD_WG1_0)(C_W1_0)(T_W1_0)(V_W1_0)(CG_HW_0)(g_LC_0)(NLC_DN_0)(NLC_D_0)(NLC_0)(k_C_0)(BUR_W2_0)(LC_0)(W_W2_0)(YD_W2_0)(YD_WG2_0)(C_W2_0)(C_W2D_0)(ratCW2D_YD_0)(ratCW2_YD_0)(T_W2_0)(YT_I_0)(YD_I_0)(C_IH_0)(T_IH_0)(PI_D_0)(PF_D_0)(PB_BD_0)(V_I_0)(HPM_IH_0)(V_IF_0)(SH_0)(TB_IH_0)(e_0)(p_e_0)(D_IH_0)(rat_SH_0)(rat_TBIH_0)(rat_e_0)(rat_PDIH_0)(rat_DIH_0)(coef_SH_0)(coef_TBIH_0)(coef_PE_0)(coef_PHDI_0)(coef_DIH_0)(r_SH_0)(y_e_0)(r_e_0)(CG_E_0)(r_H_0)(CG_HI_0)(s_0)(y_M_0)(r_M_0)(M_0)(P_M_0)(MP_0)(LH_S_0)(DL_S_0)(DL_SU_0)(DL_SII_0)(K_U_0)(CG_M_0)(PU_0)(PU_U_0)(COUPON_0)(ES_0)(FEE_0)(TB_U_0)(coef_M_0)(coef_TBII_0)(K_II_0)(TB_II_0)(PI_0)(PI_U_0)(LH_NS_0)(PB_B_0)(PB_BU_0)(DL_NS_0)(K_B_0)(TB_B_0)(TB_BN_0)(A_0)(A_N_0)(HPM_B_0)(LF_0)(BUR_LF_0)(K_F_0)(INV_0)(u_0)(r_F_0)(PF_0)(PF_U_0)(W_0)(Y_0)(GOV_0)(HPM_0)(TB_0)(PB_CB_0)

show data0

5. Bank liquidity and macroeconomic fragility: Empirical evidence for the EMU

5.1 Introduction

The imprudent management of bank liquidity has been one of the core factors that contributed to the 2007-8 financial distress. When the crisis unfolded, various banks exhibited a fragile liquidity position by having a high exposure to short-term funding, even though their capital buffers were at a sufficient level (see e.g. BCBS, 2010A; Ayadi *et al*., 2012; Bonfim and Kim, 2012). The reversal in the liquidity of the interbank market induced them to resort to the fire-sale of assets, transforming their illiquidity problems into insolvency ones. The overall result was the destabilisation of the financial system and the macroeconomy.

These crisis developments have induced important changes in the regulatory framework of banks. Basel III has introduced two liquidity indices, with the aim to better supervise the liquidity of the financial system (see BCBS, 2010A). By imposing certain minimum limits in these indices, the new regulatory framework intends to contribute to the monitoring of both the short-term and the medium- to long-term liquidity of banks.

Even though the explicit consideration of liquidity measures in Basel III is an important step towards a more effective supervision of the banking sector, there are still many issues that remain to be addressed in the field of liquidity regulation. This chapter focuses on two of them. The first is the need for a more dynamic definition of liquidity. In the current regulatory framework the weights assigned to banks' assets and liabilities are predetermined and do not adjust according to the conditions in the related financial markets. This is quite problematic since the liquidity and the stability of a balance sheet item is likely to be time-varying as a result of changes in risk perceptions and financial conditions (see e.g. Ayadi *et al*., 2012). A characteristic example is the liquidity of the government bonds. In Basel III government bonds are assigned a static weight equal to 0.05. This implies that in the aftermath of the EMU sovereign crisis all government bonds continue to be treated as highly liquid, despite the substantial deterioration in their liquidity profile. To address the issue of time-varying liquidity this chapter puts forward a dynamic liquidity ratio in which the weights of the balance sheet items adjust to their time specific liquidity and stability properties. The suggested ratio is applied to EMU-12 economies and is compared with the static ratio introduced by Basel III.

The second issue refers to the link between bank liquidity and macroeconomic risk. In Basel III, the minimum liquidity requirements are invariant to the fragility of the macro system. From the macroprudential point of view this is problematic: higher (lower) perceived macro risk should be accompanied by a higher (lower) bank liquidity. The reason is twofold. First, higher liquidity requirements in periods of increasing macro fragility restrict banks' liquidity creation; the latter tends to rise in periods of financial euphoria amplifying instability trends.[1] Second, a more liquid banking sector can more adequately absorb the shocks that may stem from a more fragile macroeconomy. In this chapter we provide econometric evidence which shows that in most EMU countries the bank liquidity does not increase when the macroeconomic fragility becomes higher. This calls for the imposition of macro fragility-related minimum liquidity requirements.

The chapter is organised as follows. Section 5.2 develops our dynamic liquidity ratio and applies it to EMU-12 countries. Section 5.3 presents the econometric evidence for the link between bank liquidity and macroeconomic risk. Section 5.4 concludes and sets out the policy implications of the analysis.

[1] There is evidence that bank liquidity follows a countercyclical pattern, being excessively low when the economy expands and excessively high when the economy shrinks (see Aspachs *et al.*, 2004; Acharya *et al.*, 2011).

5.2 The Dynamic Net Stable Funding Ratio: Definition and application

5.2.1 Definition

The liquidity of a bank expresses its ability to meet contractual liability obligations and to fund asset positions without significant cost.[2] This ability depends positively on (a) the degree of liquidity of its assets and (b) the proportion of stable liabilities in total liabilities. An asset is perceived to be more liquid when it has a low credit and market risk. The credit risk is related with the possibility of borrower's default; a default can lead to the loss of expected inflows that come from loan repayments and interest income. The market risk is associated with the possibility that an asset will be liquidated at an unfavourable price in the related market. A liability is conceived to be stable when it provides a long-term funding and it is not expected to be liquidated by banks' lenders in financial distress conditions. Overall, the higher the amount of stable liabilities relative to the amount of less liquid assets the better the liquidity position of a bank.

In line with this general framework, in Basel III the liquidity position of banks in the medium to long term is captured by the Net Stable Funding Ratio (*NSFR*), which is given by the ratio of the Available amount of Stable Funding (*ASF*) to the Required amount of Stable Funding (*RSF*). The ratio is written as:

$$NSFR_t = \frac{ASF_t}{RSF_t} = \frac{\sum sw_j SL_{jt}}{\sum sw_i SA_{it}} \qquad (1)$$

where sw_j is the static weight of liability *j*, sw_i is the static weight of asset i, SL_{jt} is the stock of liability *j* in time *t* and SA_{it} is the stock of asset *i* in time *t*. According to formula (1), the *ASF* is defined as the weighted sum of the stock of liabilities that are deemed stable. The greater the weight assigned to a liability the more stable this liability is conceived. The *RSF* is calculated as the weighted sum of the stock of assets that are less liquid and must be supported with stable funding. The greater the weight

[2] For a detailed definition of the concept of liquidity and its macroeconomic implications see e.g. Minsky (2008), Davidson (2002), BCBS (2008, 2010A) and Nikolaou (2009).

applied to an asset the more this asset needs to be supported with stable funding. Given that holding more stable liabilities relative to illiquid assets improves the medium- to long-term liquidity of banks, a higher *NSFR* is desirable.

Table 1 shows how *NSFR* is estimated in this chapter. The static weight of each asset and liability is calculated following broadly the approach of BCBS (2010A). Since this ratio is going to be applied to EMU countries, the assets and the liabilities have been categorised according to the classification of balance sheet data provided by the European Central Bank (ECB); see Appendix A for the detailed aggregated balance sheet of euro area monetary financial institutions (MFIs).

On the liability side, capital and reserves are deemed more stable and thereby a weight equal to 1 is assumed. Moreover, deposits with agreed maturity and debt securities issued for longer than one year are classified as equally stable. Deposits of monetary financial institutions, deposits of the central government, external liabilities and overnight deposits are regarded less stable than the other deposits. Hence, the former are assigned a weight of 0.8 while the latter are assigned a weight of 0.9. All the other liabilities are given a zero weight. On the asset side, securities other than shares issued by the government in the euro area constitute the most liquid asset, after cash and loans to monetary financial institutions, with a weight equal to 0.05. Loans are classified according to their maturity and type. We consider loans to non-financial corporations up to one year and loans for house purchase as more liquid than the rest long term loans, assigning a weight of 0.5 and 0.65 respectively. For other loans to households, for loans to non-financial corporations greater than one year and for external assets, which tend to be less liquid, a higher weight equal to 0.85 is assigned. The rest of the assets have a weight equal to 1.

Table 1. *Balance sheets weighting used to calculate the Net Stable Funding Ratio* (*NSFR*)

Available amount of Stable Funding (*ASF*)		
Corresponding Basel III category	**Liability**	**Weight**
Tier 1 and 2 capital instruments	Capital and reserves	1
Other liabilities with an effective maturity of one year or greater	Deposits with agreed maturity greater than 1 year	1
	Debt securities issued for longer than 1 year	1
Stable deposits with residual maturity less than a year	Deposits with agreed maturity up to 1 year	0.9
	Deposits redeemable at notice	0.9
	Repurchase agreements	0.9
Less stable deposits with residual maturity less than a year	Overnight deposits	0.8
	Deposits of monetary financial institutions	0.8
	Deposits of the central government	0.8
	External liabilities	0.8
All other liabilities	All other liabilities	0
Required amount of Stable Funding (*RSF*)		
Corresponding Basel III category	**Asset**	**Weight**
Cash	-	0
Loans to banks (e.g. interbank)	Loans to monetary financial institutions (MFIs)	0
Sovereign securities	Holdings of securities other than shares issued by general government in the euro area	0.05
Retail loans up to 1 year	Loans to non-financial corporations up to 1 year	0.5
Mortgages	Loans for house purchase	0.65
Retail loans	Loans to non-financial corporations greater than 1 year	0.85
	Loans to households *excluding* lending for house purchase	0.85
	External assets	0.85
All other assets	All other assets	1

Note: The selection of the weights is based on BCBS (2010A)

One important feature of *NSFR* is that the weights of balance sheet items are static. This is quite problematic since in the real world financial system the liquidity of assets and the stability of liabilities change continuously due to time-varying market conditions, financial perceptions and perceived risks. For example, as Minsky (2008) has pointed out, in tranquil years economic agents' required margins of safety become lower due to the widespread euphoria; hence, the credit and the market risk are perceived to be low (see also Kregel, 1997). The opposite holds in a period that follows a financial episode in which the perceived risks are high and the stability of banks' liabilities declines, due to the generalised increase in economic agents' liquidity preference. Attention should also be drawn to the fact that a market can rapidly turn from a liquid into an illiquid one if, for some reason, many investors try to liquidate their assets at the same time. This is a common feature of financial distress situations.

This dynamic nature of financial markets and financial behaviours brings forward the need for a more dynamic definition of liquidity. In this chapter this is done by allowing the balance sheet weights in *NSFR* to be a function of the interest rates that correspond to the assets and liabilities under investigation. On the asset side, the interest rates can be used as proxies for the perceived credit and market risk. A higher interest rate is broadly associated with a higher risk premium and, thus, with less liquid assets. On the liability side, a high interest rate implies that banks' lenders are not very willing to provide the required funding. Hence, they are more prone to withdraw their liabilities in a stress event.

In the estimation of the dynamic balance sheet weights the interest rates are compared to a benchmark interest rate. The benchmark interest rate expresses the interest rate that corresponds to the safest and most liquid lending for banks, as this is determined by the monetary policy. The higher the spread between the interest rate of an asset and the benchmark interest rate the less liquid this asset is considered. Furthermore, a high spread between the interest rate of a liability and the benchmark interest rate implies that banks are willing to foregone their profitability in order to obtain funding from this type of liability. Thus, the higher this spread the more banks need to compensate the potential borrowers in order to convince them to become less liquid. This corresponds to cases of less stable funding.

However, many empirical studies[3] have shown that the interest rate spreads on loans and deposits provided to or held by households and non-financial corporations are significantly affected by the degree of competition in the banking sector. In particular, high competition reduces banks' ability to set high loan rates and low deposit rates, relative to the benchmark interest rate. Consequently, the fluctuations and the cross-country differences of the interest rate spreads on loans and deposits may not only reflect changes/differences in the perceived credit and market risks, but they may also partly capture changes/differences in the oligopoly structure of the banking sector. To account for this fact, in the procedure of estimating the time-varying weights the interest rate spreads on loans and deposits are suitably adjusted to consider the impact of the oligopoly structure.

[3] See e.g. Corvoisier and Gropp (2002), van Leuvensteijn *et al.* (2013) and the references therein.

We have chosen not to make other adjustments in the interest rate spreads. Obviously, these spreads may also be affected by various other factors, such as the rate of non-performing loans (that affects the perceived credit risk), the banks' operating costs, the quality of management or the degree of financial innovation (see e.g. Maudos and Fernandez de Guevara, 2004; Gropp *et al*., 2007). Nonetheless, the impact of these factors is less clear-cut and cannot be easily captured quantitatively, as in the case of the oligopoly structure. Thus, to avoid unnecessary complications we have abstracted from considering their potential role in the determination of the interest rate spreads.

Moreover, it should be pointed out that the actual financial risk of banks' assets and liabilities is not completely reflected on interest rate spreads. This risk also depends on various macroeconomic factors, such as the unemployment rate of banks' borrowers, the growth rate of the economy, the developments in the housing market etc. The advantage, though, of the use of interest rates is that they are available for each balance sheet category and can be easily employed to provide an overall picture of the time-varying liquidity of banks, which is the purpose of our analysis. A more detailed and integrated analysis of bank liquidity can well be the subject of future extensions of the present approach.

We proceed to describe the procedure through which the time-varying weights of assets and liabilities are calculated in this chapter. The calculation requires a panel data sample. The time-varying weights are estimated for each country separately taking into account the properties of the whole sample.

The actual interest rate spread of asset i in period t (spr_{it}) is defined as the difference between the interest rate of this asset in period t (r_{it}) and the benchmark interest rate (rb_t):

$$spr_{it} = r_{it} - rb_t \qquad (2)$$

The adjusted interest rate spread of asset i $(aspr_{it})$, which is used for the calculation of the time-varying weight in our analysis, is given by the following formula:

$$aspr_{it} = \begin{cases} spr_{it} - \min(spr_i), & \text{if the asset's spread is invariant to the degree of oligopoly} \\ \dfrac{spr_{it} - \min(spr_i)}{\left|\ln CI_t\right|}, & \text{if the asset's spread is affected by the degree of oligopoly} \end{cases} \tag{3}$$

where $\min(spr_i)$ is the minimum value of the interest rate spread of asset *i* calculated across time and countries, and CI_t is a concentration index that takes values between 0 and 1.

According to formula (3), the adjusted interest rate spread is always non-negative and its minimum value over the sample is equal to zero; this is ensured by subtracting the minimum value of the spread (over the whole sample) from the interest rate spread. Moreover, in the case of loans provided to households and non-financial corporations, whose spread is considered to positively depend on the degree of oligopoly, it is postulated that the credit risk increases when the spread becomes higher relative to the degree of oligopoly. Therefore, by adopting a simplifying formulation, it is assumed that the adjusted spread for loans equals the ratio of the actual spread (after the subtraction of the minimum value over the sample) to the concentration index. Note that the absolute value of the natural logarithm of the concentration index is used to smooth the values of the index and avoid an unnecessarily high impact of very low or very high figures.

Applying a simple normalisation method,[4] the adjusted interest rate spread is transformed into the normalised spread $(nspr_{it})$, which lies between 0 and 1:

$$nspr_{it} = \frac{aspr_{it} - \min(aspr_i)}{\max(aspr_i) - \min(aspr_i)} \tag{4}$$

[4] For a brief description of the various methods of normalisation used for the construction of composite indices see Giovannini *et al*. (2008).

where $\min(aspr_i)$ and $\max(aspr_i)$ is the minimum and maximum value of adjusted interest rate spread of asset *i* calculated across time and countries; recall that $\min(aspr_i) = 0$.

The time-varying weight of asset *i* in time *t* (tw_{it}) is estimated via the following formula:[5]

$$tw_{it} = sw_i + a_i(nspr_{it} - median(nspr_i)) \qquad (5)$$

where $a_i > 0$ is the responsiveness of the time-varying weight of asset *i* to the divergence between the normalised spread of this asset and the median value of the normalised spread across time and countries $(median(nspr_i))$. Note that when $nspr_{it} = median(nspr_i)$, the dynamic weight is the same with the static one. This implies that the static weight of each asset corresponds to the median financial risk in our sample.

For each asset we define a minimum value for its time-varying weight which is equal to a proportion, $q < 1$, of the static weight (i.e. $\min(tw_i) = qsw_i$). Since the time-varying weight should take its minimum value when the normalised spread is at its minimum level, we have that:

$$\min(tw_i) = qsw_i = sw_i + a_i(\min(nspr_i) - median(nspr_i)) \qquad (6)$$

Since by definition $\min(nspr_i) = 0$, from (6) it can be easily derived that:

$$a_i = \frac{(1-q)sw_i}{median(nspr_i)} \qquad (7)$$

Note that in the case of the loans to monetary financial institutions, in which the static weight equals 0 (see Table 1), the following formula is used instead of (5).

[5] For simplicity, a linear function has been assumed.

$$tw_{it} = sw_i + a_i(nspr_{it} - 0) \tag{5'}$$

Formula (5') implies that for the loans to monetary financial institutions the minimum dynamic weight is equal to the static weight. Moreover, for this type of asset we define that $a_i = 0.05$ in order for the maximum dynamic weight not to exceed the next most liquid asset according the static approach, namely the sovereign securities (see Table 1).

A similar procedure is followed for the estimation of the time-varying weights of liabilities. The actual interest rate spread of liability *j* in period *t* (spr_{jt}) is defined as:

$$spr_{jt} = r_{jt} - rb_t \tag{8}$$

where r_{jt} is the interest rate of this liability *j* in period *t*.

The adjusted interest rate spread of liability *j* in period *t* $(aspr_{jt})$ is given by the following formula:

$$aspr_{jt} = \begin{cases} spr_{jt} - \min(spr_j)\text{, if the liability's spread is invariant to the degree of oligopoly} \\ \\ \dfrac{spr_{jt} - \min(spr_j)}{\left|\ln(1 - CI_t)\right|}\text{, if the liability's spread is affected by the degree of oligopoly} \end{cases} \tag{9}$$

In the case of deposits held by households and non-financial corporations, whose spread is considered to inversely rely on the degree of competition, it is postulated that their financial risk increases when the spread becomes higher relative to the degree of competition in the banking sector. Therefore, the adjusted spread for these deposits equals the ratio of the actual spread (after the subtraction of the minimum value over the sample) to the absolute logarithm of 1 minus the concentration index; $1 - CI_t$ is used to capture the degree of competition. Again the absolute value of the natural logarithm is employed to smooth the values of the concentration index.

The normalised spread of liability j $\left(nspr_{jt}\right)$ in period t is computed as:

$$nspr_{jt} = \frac{aspr_{jt} - \min\left(aspr_j\right)}{\max\left(aspr_j\right) - \min\left(aspr_j\right)} \tag{10}$$

The time-varying weight of liability j in time t $\left(tw_{jt}\right)$ is estimated as:

$$tw_{jt} = sw_j + b_j\left(nspr_{jt} - median(nspr_j)\right) \tag{11}$$

where $b_j < 0$ is the responsiveness of the time-varying weight of liability j to the divergence between the normalised spread of this asset and the median value of the normalised spread. The parameter b_j is negative because a higher spread implies a less stable liability. Again, the static weight of each liability refers to the median financial risk in our sample.

For each liability we define a maximum value for its time-varying weight which equals to p times the static weight, where $p > 1$ (i.e. $\max\left(tw_j\right) = psw_j$). Since the time-varying weight should take its maximum value when the normalised spread is at its minimum level, we have that:

$$\max\left(tw_j\right) = sw_j + b_j\left(\min\left(nspr_j\right) - median(nspr_j)\right) \tag{12}$$

Since by definition $\min\left(nspr_j\right) = 0$ from (12) it can be easily derived that:

$$b_j = \frac{(p-1)sw_j}{median\left(nspr_j\right)} \tag{13}$$

The ratio that is based on time-varying balance sheet weights is called Dynamic Net Stable Funding Ratio (*DNSFR*) and is defined as follows:

$$DNSFR_t = \frac{ASF_t}{RSF_t} = \frac{\sum tw_{jt} SL_{jt}}{\sum tw_{it} SA_{it}} \quad (14)$$

Table 2 reports the interest rates that have been used for each balance sheet item in the construction of the above ratio. Note that in the case of capital and reserves, debt securities issued for longer than 1 year, deposits of the central government, all other liabilities and all other assets the dynamic weight is assumed to be invariably equal to the static weight.

Table 2. *Interest rates used to calculate the balance sheet weighting in Dynamic Net Stable Funding Ratio (DNSFR)*

Available amount of Stable Funding (*ASF*)	
Liability	**Interest rate**
Capital and reserves	-
Deposits with agreed maturity greater than 1 year	Interest rate on deposits with agreed maturity greater than 1 year (to non-financial corporations and households)
Debt securities issued for longer than 1 year	-
Deposits with agreed maturity up to 1 year	Interest rate on deposits with agreed maturity up to 1 year (to non-financial corporations and households)
Deposits redeemable at notice	Interest rate on deposits redeemable at notice (to households)
Repurchase agreements	Interest rate on repurchase agreements (to non-financial corporations and households)
Overnight deposits	Interest rate on overnight deposits (to non-financial corporations and households)
Deposits of monetary financial institutions	Euribor 3 months rate
Deposits of the central government	-
External liabilities	Interest rate on deposits with agreed maturity greater than 1 year (to non-financial corporations and households)
All other liabilities	-
Required amount of Stable Funding (*RSF*)	
Asset	**Interest rate**
Loans to monetary financial institutions (MFIs)	Euribor 3 months rate
Holdings of securities other than shares issued by general government in the euro area	Domestic securities: Long-term interest rate for convergence purposes, debt security issued (10 years)
	Other than domestic securities: Euro area 10-year government benchmark bond yield
Loans to non-financial corporations up to 1 year	Interest rate on loans for non-financial corporations up to 1 year
Loans for house purchase	Interest rate on loans on house purchases (to households)
Loans to non-financial corporations greater than 1 year	Interest rate on loans for non-financial corporations over 1 year
Loans to households *excluding* lending for house purchase	Interest on consumer credit and other loans (to households)
External assets	Interest on consumer credit and other loans (to households)
All other assets	-

Notes:

1/ Households include also non-profit institutions serving households (NPISH).
2/ Interest rates on loans and deposits are either annualised agreed rates (AAR) or narrowly defined effective rates (NDER) (see ECB, 2003 for definitions). These interest rates refer to new business indicators.

5.2.2 Application to EMU-12 countries

In our estimations, aggregated data from the ECB database over the period 2003:01 to 2012:07 have been utilised. The analysis refers to the EMU-12 countries (Belgium, Germany, Ireland, Greece, Spain, France, Italy, Portugal, Finland, the Netherlands, Austria and Luxemburg) for which data are available for a sufficiently long period of time. In the case of government securities on the asset side of banks' balance sheets, we have opted to make a distinction according to the nationality of their issuer: the credit and market risk of these securities is significantly affected by the fiscal position of the country that issues them. For this purpose, the Bruegel database on sovereign bond holding has been employed. This database provides data on the amount of each country's government securities held by the domestic banking sector, allowing us to estimate securities' 'home bias'.[6] Although these data do not allow us to fully consider the impact of government securities' nationality on the liquidity position of banks, the consideration of the 'home bias' permits us to capture, at least partially, some important aspects of this impact. In the baseline calculations the ECB policy rate has been used as the benchmark interest rate. However, to check for the robustness of the results, the EONIA (Euro Overnight Index Average) interest rate has also been used as a benchmark interest rate; the related results are presented in Appendix C. The EONIA interest rate refers to the interbank overnight lending and gives information about the gains and the costs of short-tem lending/borrowing for banks, especially in periods of financial distress. It is also the rate that the ECB attempts to control via its operations and facilities (see e.g. de Bondt, 2005).

Moreover, the Herfindahl index has been used to account for the impact of the oligopoly structure on the interest rate spreads of loans and deposits. The Herfindahl index is equal to the sum of the squares of the market shares to total assets of all the credit institutions in the banking sector. The index ranges from 0 to 1. A higher value of the index indicates more concentration in the market. The available data are annually and have been transformed to monthly ones using the cubic-spline function. To verify the robustness of our results the baseline ratio has also been calculated

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[6] For the countries or the time points for which Bruegel does not provide data for the government securities held by the domestic banking sector, the 'home bias' is proxied by the figures reported by Acharya *et al*. (2012, p. 54, Chart 3) based on the European Bank stress tests on March 31st, 2010.

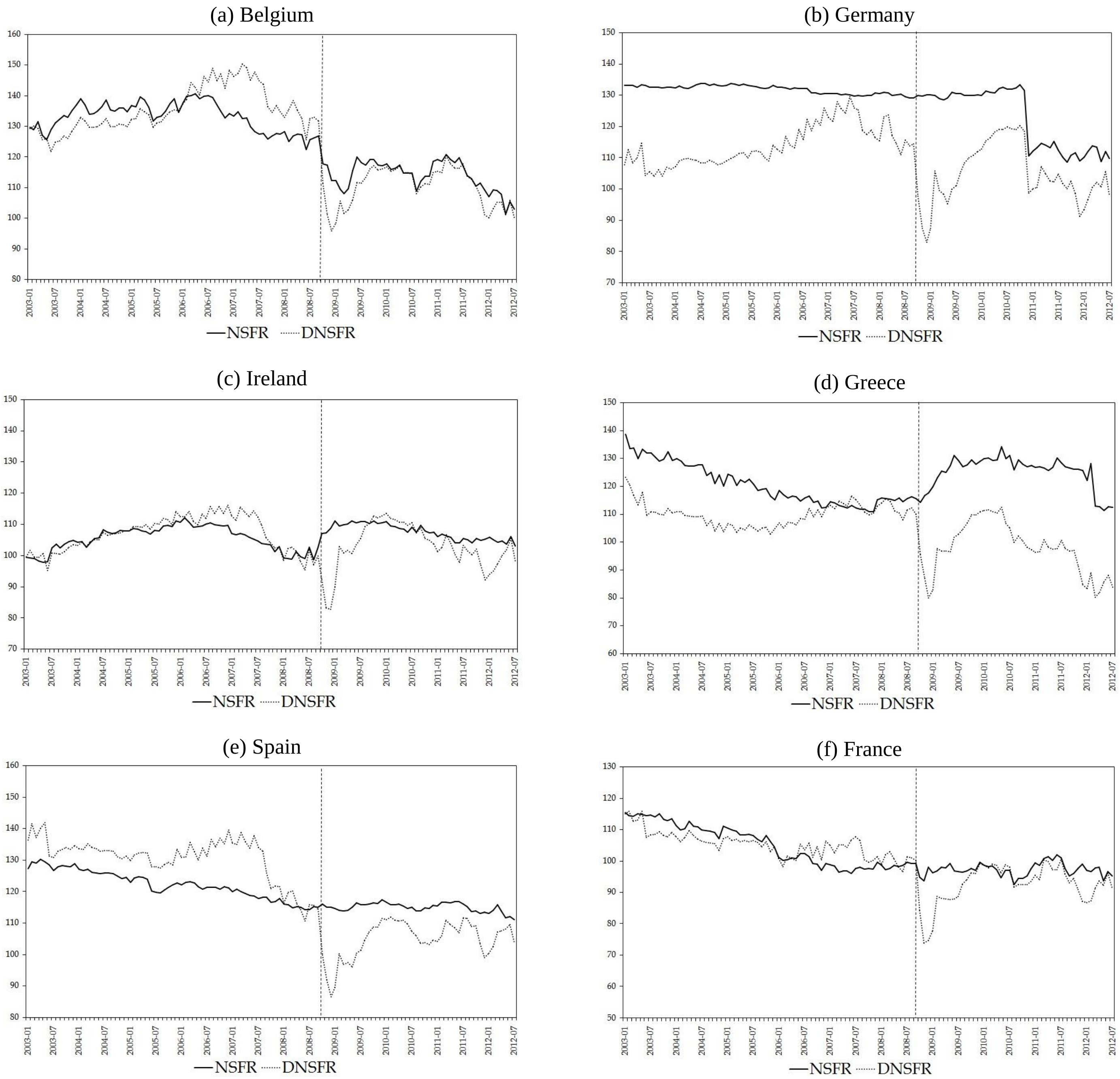
without adjusting for the concentration index, i.e. without dividing the interest rate spreads in formulas (5) and (9) by the term that refers to the concentration index. The related results are reported in Appendix D.[7]

In the baseline calculations it holds that $q = 0.8$ and $p = 1.2$. For robustness, we have also considered the case in which $q = 0.9$ and $p = 1.1$; the related results are reported in Appendix E. Note that the loans and deposits in which the spread is considered to depend on the concentration index are the loans for house purchase, the loans to non-financial corporations up to 1 year, the loans to non-financial corporations greater than 1 year, the loans to households excluding lending for house purchase, the deposits with agreed maturity greater than 1 year, the deposits with agreed maturity up to 1 year, the overnight deposits, repurchase agreements and the deposits redeemable at notice.

Figure 1 displays the evolution of *NSFR* and *DNSFR* over the period under examination, according to our baseline calculations. The vertical dotted line marks the time point in which the collapse of the Lehman Brothers occurred (2008:08). We observe the following: First, in almost all countries *DNSFR* was higher than *NSFR* for almost all time points before the collapse of the Lehman Brothers and lower thereafter.[8] This suggests that the liquidity ratio adopted by Basel III potentially underestimates the liquidity position of banks before the crisis and overestimates it in the after-crisis period. Second, in 8 out of 12 countries (Germany, Ireland, Greece, Spain, France, Italy, Portugal and Austria) the evolution of liquidity over the last decade seems to be quite different according to the ratio utilised. In particular, while *NSFR* suggests that the bank liquidity in these countries has either remained approximately the same or even improved after the collapse of the Lehman Brothers, *DNSFR* shows a substantial deterioration in liquidity.

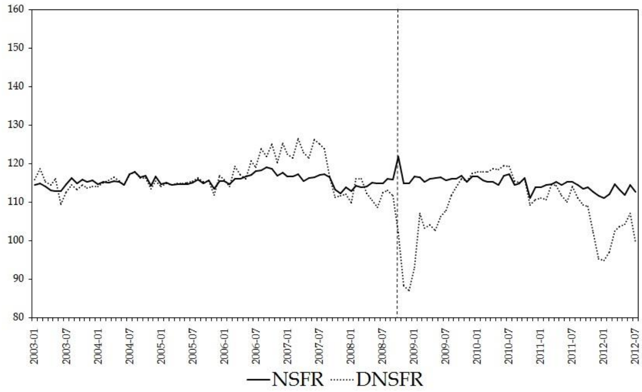
[7] All the data sources of our analysis are reported in Appendix B.
[8] The only exceptions are Germany and Greece.

Fig. 1. *Net Stable Funding Ratio (NSFR) and Dynamic Net Stable Funding Ratio (DNSFR) in percentage points, EMU-12 countries, 2003:01 to 2012:07; baseline calculations*

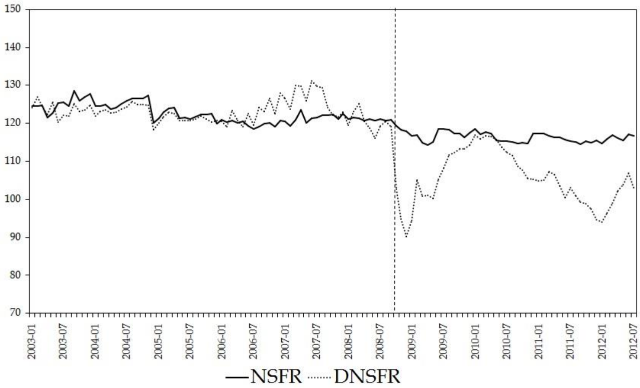


(continued from the previous page)

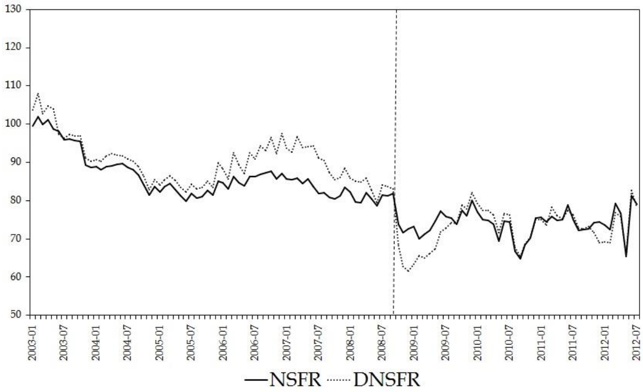
(g) Italy



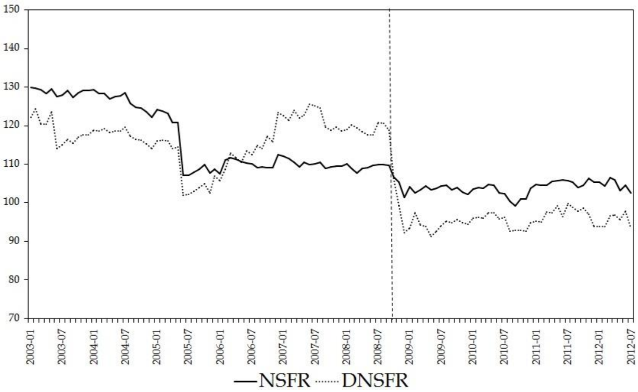
(h) Portugal



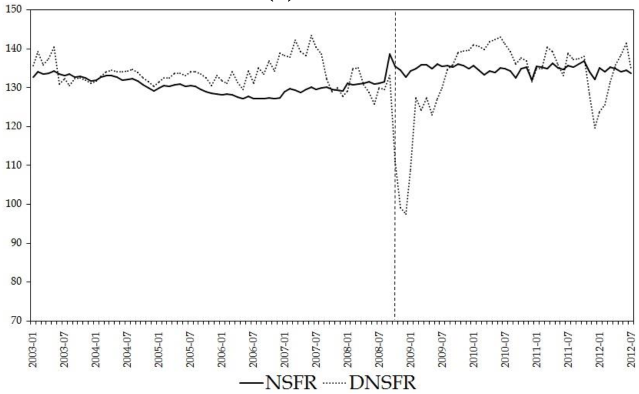
(i) Finland



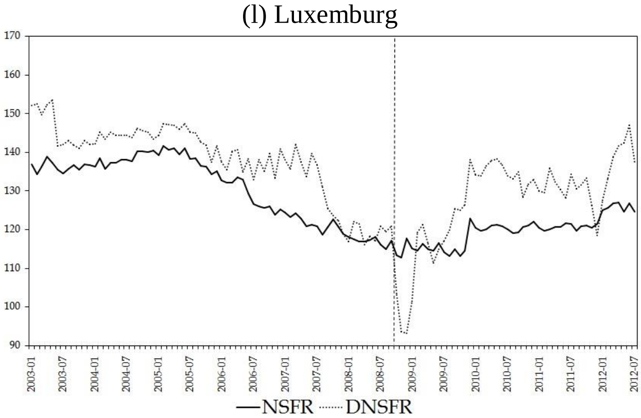
(j) Netherlands



(k) Austria



(l) Luxemburg



The difference between the two indices has basically to do with the adverse after-crisis developments in various markets. In particular, after the collapse of the Lehman Brothers there was a brisk rise in the 3-month Euribor interest rate as a result of the distress in the interbank market. This rise explains the deterioration in the liquidity index in all countries of our sample in the first months after the crisis. Moreover, many countries, most notably Spain, France, Italy and Portugal, saw a decline in the lending interest rates spread in 2007 and a substantial increase thereafter. This explains to a great extent why in these countries the dynamic liquidity index improved slightly in 2007 and declined significantly after the crisis. In Greece of particular importance for the evolution of the dynamic liquidity index was the existence of low deposit interest rates before the crisis and their significant rise after 2008 due to the adverse impact of the crisis on the behaviour of depositors and thereby on the stability of deposits. Lastly, the crisis has substantially modified the liquidity of bonds that have been issued by countries with fiscal problems. Hence, banks that hold government bonds of these countries have seen a deterioration in their liquidity position. Due to the 'home bias' in the holding of government bonds, this implies that the banking sector in Greece, Ireland, Portugal, Italy and Spain has most greatly been affected by the distress in the sovereign bond market.

The main conclusions inferred from our baseline calculations do not change when the EONIA rate is employed as a benchmark interest rate instead of the ECB policy rate, when the baseline calculations are made without adjusting for the concentration index, or when higher values for *p* and *q* are utilised; see Appendix C, Appendix D and Appendix E respectively. There are, however, some slight differences that need to be pointed out. In particular, when the EONIA rate is used in the calculations, the *DNSFR* is lower in the after-crisis period relative to the baseline estimations. This is due to the fact that the EONIA rate was lower than the ECB policy rate in this period as a result of the distress in the interbank market. According to our formulas, the lower the benchmark interest rate the lower, *ceteris paribus*, the liquidity of assets and the stability of liabilities. As a result, in Appendix C we can see that in some countries (most notably Austria and Luxembourg) the *DNSFR* is lower than the *NSFR* in some time points after the crisis. Moreover, when the baseline ratio is calculated without adjusting for the concentration index, there is noteworthy difference in the case of

Germany. In this country the concentration index is much smaller than in the other EMU-12 countries. Consequently, when we make no adjustment for the concentration index the relative dynamic liquidity of the banks of this country appears to improve.[9] Lastly, higher values for *q* and lower values for *p* imply that the differences between the static and the dynamic weights are lower. This explains why *DNSFR* and *NSFR* are closer the one to the other in Appendix E. This, though, does not affect the qualitative implications of our analysis.

On the basis of the above estimates, it can be overall argued that the *NSFR* does not successfully gauge the decline in the liquidity of banks that seems to have occurred in various EMU countries as a result of the recent financial distress. By assigning static weights in banks' balance sheet items, this ratio ignores the changing nature of liquidity, which is particularly important in periods of financial distress. On the contrary, the dynamic liquidity ratio suggested in this chapter reflects the effects of financial distress on the liquidity of assets and the stability of liabilities, depicting more accurately the fragility of banks over periods of high volatility and uncertainty, as the current one.

5.3 The link between bank liquidity and macroeconomic fragility in the EMU: An econometric analysis

In Basel III, the imposed minimum liquidity requirements are invariant to macroeconomic conditions. For example, the minimum *NSFR* is equal to 100% irrespective of the degree of financial fragility in the macroeconomy (see, BCBS, 2010A). However, from a macroprudential point of view the bank liquidity should, arguably, increase when the macro system seems to be more prone to financial instability. The rational is twofold. First, excessive financial expansion is commonly one of the underlying reasons behind the build-up of financial fragility structures. A rise in bank liquidity (which, practically, implies lower debt expansion for both financial and non-financial corporations) can slow down the financial instability trends of the macro system. Second, a more liquid financial system can more successfully absorb the shocks that stem from the real economy. For instance, a stronger liquidity

[9] Note that, according to our formulas, the adjustment for the concentration index improves the *DNSFR* in countries with high concentration and does the opposite in countries with low concentration.

position allows banks to more successfully face the problems arising from an unexpected rise in the loan default rate of households and firms.

In this section we explore whether the banking sector in EMU countries increases its liquidity when the macro system becomes more fragile. Failure to find a positive link between bank liquidity and macro fragility implies that banks do not self-impose macro fragility-related liquidity requirements. This would suggest the need for the regulatory agents in the EMU to impose such requirements in order to decrease the system-wide risk. Note that since the responsiveness of bank liquidity to macroeconomic fragility over a sufficiently long horizon is of interest, our analysis focuses on the long-run relationship between the two variables. The absence of a short-term responsiveness would not necessarily be problematic since this might be due to the sluggish reaction of banks to macroeconomic factors. However, the non-existence of such a responsiveness in the long run would imply that banks systematically fail to take into account macro fragility in the determination of their liquidity.

In our empirical investigation bank liquidity is captured both by the static and the dynamic liquidity ratio developed in the previous section. Following Tymoigne (2011), the macroeconomic fragility is viewed 'as the propensity of financial problems to generate financial instability'. In this chapter, the macroeconomic fragility is proxied by the credit-to-GDP ratio. Although this measure cannot provide a detailed view of the macroeconomic fragility (see Tymoigne, 2011 for sector-specific indices), it can be used to give an overall picture of some financial instability trends. Empirical evidence has shown that the credit-to-GDP ratio can quite successfully signal periods of financial distress (see Drehmann *et al*., 2010). It has also been used by Basel III as the main guide for determining the appropriate amount of countercyclical capital buffer (see BCBS, 2010B). An additional advantage is that this index is available for most of the countries under investigation.

However, it must be noted that an increase in the credit-to-GDP ratio does not necessarily reflect only higher financial risk. It may also capture procedures like the financial deepening and the institutional penetration of financial intermediation. It is, though, important to point out that in our sample the credit-to-GDP ratio is in most cases higher than 100%, which implies that it is more likely to capture higher risk rather than the aforementioned procedures.

5.3.1 Econometric methodology

The econometric exploration of the link between bank liquidity and macro fragility is conducted by utilising time-series techniques and making the analysis distinctively for each country with the use of aggregated data for the banking sector.[10] Time-series techniques have been chosen instead of panel data ones for two reasons. First, we wish to avoid the heterogeneity bias which basically stems from the diversification of macroeconomic fragility within the EMU. Second, the purpose of the econometric investigation is to examine how each national banking sector responds to the macroeconomic fragility of its country. Thus, a panel investigation of this issue would not be illuminating for our purposes.

The econometric analysis is conducted by utilising the ARDL (Auroregressive Distributed lag)-bounds testing procedure, developed by Pesaran and Shin (1999) and Pesaran *et al*. (2001). The main advantage of this approach, in comparison with the more traditional Johansen (1988) maximum likelihood method, is twofold. First, it allows us to check for cointegration when the variables of the econometric analysis are either I(0) or I(1). On the contrary, Johansen's cointegration technique prerequisites the existence of only I(1) series. As will be shown below, in our sample the possibility of I(0) series cannot be excluded, implying that the ARDL-bounds testing approach is more appropriate. Second, the ARDL-bounds testing procedure is more suitable for small sample data sizes, as our own one. The Johansen method relies on a VAR system of equations and, thus, the degrees of freedom may decline significantly when the size of the sample is small.[11]

The following econometric specification is used:

[10] Recent empirical literature has investigated the relationship between banks' liquidity and micro characteristics using micro panel datasets (see e.g. Berger and Bouwman, 2009; Fungacova *et al*., 2010; Horvath *et al*., 2012; Distinguin *et al*., 2013).
[11] Note also that in the ARDL-bounds testing approach the potential endogeneity problems are mitigated due to the use of lagged values of the explanatory variables.

$$LIQ_t = \theta_0 + \theta_1 t + \theta_2 CREDIT_t + u_t \quad (15)$$

where *LIQ* is the liquidity ratio (either the *NSFR* or the *DNSFR*, see section 5.2) and *CREDIT* is the credit-to-GDP ratio obtained from the ECB database. The credit-to-GDP ratio is available on a quarterly basis. For the purposes of our analysis the quarterly data have been transformed to monthly ones, using the cubic-spline function. All variables in the econometric analysis are expressed in percentage points. The analysis refers to the period 2003:01 to 2012:07.[12]

Following Pesaran *et al*. (2001), the econometric analysis is conducted in four steps. First, we conduct unit root tests. At this stage it is important to rule out the possibility of I(2) series. To test for the order of integration we apply the Phillips-Perron unit root test. Having excluded the possibility of I(2) series, we then conduct the Zivot and Andrews (1992) test with one structural break. Since the financial crisis has potentially caused a structural break in our series, the Zivot and Andrews test is appropriate to identify if the series are I(0) or I(1). In the test the break point is endogenously determined by the data using as a criterion the minimisation of the ADF *t*-test statistic. We estimate two models of the Zivot and Andrews test: model A with a change in intercept and model C with a change in both intercept and slope. The null hypothesis is that the time series have a unit root without a structural break; the alternative hypothesis suggests that there is a trend stationary series with a structural break.[13] Note that although the result of Zivot and Andrews test cannot affect our inference for the appropriateness or not of the ARDL-bounds testing approach, it is necessary in our case in order to properly identify the order of integration of our series.

The second step involves the estimation of the unrestricted error correction model of function (15) using the OLS estimation technique:

$$\Delta LIQ_t = \delta_0 + \delta_1 t + \delta_2 LIQ_{t-1} + \delta_3 CREDIT_{t-1} + \sum_{i=1}^{r} \delta_{4i} \Delta LIQ_{t-i} + \sum_{i=0}^{r} \delta_{5i} \Delta CREDIT_{t-i} + \delta_6 D_t + e_t \quad (16)$$

[12] For the Netherlands and Luxemburg the data begin from 2005:01 while for Austria they start from 2006:01. Notice that the first four observations in each country are reserved to construct the necessary lagged variables.

[13] For a description of the Phillips-Perron and the Zivot and Andrews unit root tests see Appendix F.

where Δ is the first difference operator, *r* is the lag order for the error correction model and D_t is a dummy variable associated with the outbreak of the crisis $\hat{\delta}_2 = 0$. The ARDL-bounds testing procedure requires the estimation of specific *F*-test and *t*-test statistics. Using (16) as a general formula, we consider the following four cases that have been analysed by Pesaran *et al.* (2001): Case II (restricted intercept and no trend), in which the *F*-test statistic checks the null hypothesis that $\hat{\delta}_0 = \hat{\delta}_2 = \hat{\delta}_3 = 0$; Case III (unrestricted intercept and no trend) in which the *F*-test statistic checks the null hypothesis that $\hat{\delta}_2 = \hat{\delta}_3 = 0$; Case IV (unrestricted intercept and restricted trend) in which the *F*-test statistic checks the null hypothesis that $\hat{\delta}_1 = \hat{\delta}_2 = \hat{\delta}_3 = 0$; Case V (unrestricted intercept and unrestricted trend) in which the *F*-test statistic checks the null hypothesis that $\hat{\delta}_2 = \hat{\delta}_3 = 0$. In all cases the *t*-test statistic is employed to check the null hypothesis that $\hat{\delta}_2 = 0$. These statistics are then compared with the critical values provided by Pesaran *et al*. (2001). The existence of a long-run relationship between *LIQ* and *CREDIT* requires that the null hypothesis is rejected. If the *t*-test and *F*-test statistics are higher than the upper bound of the respective critical values then the null hypothesis is rejected. If the *t*-test and *F*-test statistics are below the lower bound of the respective critical values then the null hypothesis cannot be rejected and no long-run relationship exists. When the computed *t*-test and *F*-test statistics fall within the bounds of the critical values, it is not possible to arrive at a conclusive decision.

Before estimating equation (16) we need to control for the existence of a possible structural breakpoint. In particular, we test whether such a break exists in September 2008, when Lehman Brothers collapsed.[14] To this end, the Chow test is conducted. The *t*-test statistic checks if $\hat{\delta}_6 = 0$. The null hypothesis suggests that no break exists. The rejection of the null hypothesis implies that a dummy variable must be included in equation (16). Additionally, it is essential to choose the optimal lag structure (*r*) of equation (16). In this procedure, our criterion is the minimisation of the Akaike (AIC) and Schwartz (SBC) Bayesian Information Criteria as well as the existence of no autocorrelation.

[14] ECB (2012B) has reported a break in bank financing patterns in the third quarter of 2008.

Third, if cointegration has been found, we proceed to estimate the optimal ARDL specification. Note, though, that in our analysis we have chosen the ARDL model to be estimated even if no cointegration is found. This allows us to further check that the result of the cointegration analysis is valid. Moreover, to explore whether the financial crisis has prompted a change in the relationship between *CREDIT* and *LIQ* we also conduct estimations for the sub-periods 2003:01 to 2008:08 and 2008:09 to 2012:07. The ARDL(p, q) model for *LIQ* is computed based on the following equation:

$$LIQ_t = \kappa_0 + \kappa_1 t + \sum_{i=1}^{p} \kappa_{2i} LIQ_{t-i} + \sum_{j=0}^{q} \kappa_{3j} CREDIT_{t-j} + \kappa_4 D_t + uu_t \tag{17}$$

where p, q are the orders of the ARDL(p, q) model specified using the AIC criterion. From the estimation of the optimal ARDL(p, q) model we obtain the following long-run parameters for equation (15):

$$\theta_2 = \frac{\sum_{j=0}^{q} \kappa_{3j}}{1 - \sum_{i=1}^{p} \kappa_{2i}}, \; \theta_1 = \frac{\kappa_1}{1 - \sum_{i=1}^{p} \kappa_{2i}} \text{ and } \theta_0 = \frac{\kappa_0}{1 - \sum_{i=1}^{p} \kappa_{2i}}.$$

In order for a positive long-run relationship to exist between the liquidity ratios and the credit-to-GDP a statistically significant long-run coefficient for *CREDIT*, θ_2, is required. When θ_2 is statistically significant a 1 percentage point rise in *CREDIT* causes θ_2 percentage points rise in *LIQ*.

Fourth, suitable transformation of ARDL(p, q) equation (17) can give us its error correction form:

$$\Delta LIQ_t = \lambda_0 + \lambda_1 \Delta t_t + \sum_{i=1}^{p} \lambda_{2i} \Delta LIQ_{t-i} + \sum_{j=0}^{q} \lambda_{3j} \Delta CREDIT_{t-j} + \lambda_4 \Delta D_t + \lambda_5 EC_{t-1} + ee_t \tag{18}$$

In equation (18) the coefficient of the error correction term (λ_5) stands for the speed of adjustment towards the equilibrium. For instance, if $\lambda_5 = -0.5$ and the data are monthly, the adjustment back to equilibrium takes place at a rate of 50% per month. The coefficient of the error correction term is given by the following formula:

$$\lambda_5 = -\left(1 - \sum_{i=1}^{p} \kappa_{2i}\right).$$

A negative and statistically significant λ_5 suggests that the long-run equilibrium is stable. The rationale is that when EC_{t-1} is positive (negative) and, thus, LIQ_{t-1} is above (below) its equilibrium value, a negative λ_5 implies that there is a downward (upward) pressure on LIQ_t, or equivalently, that there is a tendency for ΔLIQ_t to be negative (positive). This ensures the adjustment towards the equilibrium. On the contrary, a positive and statistically significant λ_5 term implies that the equilibrium is not restored.

Overall, the existence of a positive and stable long-run relationship between the liquidity ratios and the credit-to-GDP in the long run requires that: (i) the *F* and *t* statistics indicate cointegration; (ii) there is a positive statistically significant long-run coefficient for *CREDIT* and (iii) the (lagged) error correction term coefficient is negative and statistically significant. If any of these conditions is not satisfied for a specific country, then it can be argued that the liquidity of this country's banking sector does not react positively to a rise in the credit-to-GDP ratio, supporting the view for the imposition of macro fragility-related liquidity requirements.

5.3.2 Results

In Appendix G the results from the Phillips-Perron unit root test are reported. It turns out that the variables are a mixture of I(0) and I(1). When the Zivot and Andrews test is used to control for the existence of a structural break (see Appendix H), some of the series being I(1) according to the Phillips-Perron test turn out to be I(0) with one structural break. The existence of stationary series in our sample indicates the need for the use of the ARDL-bounds testing approach to cointegration, which is valid for both I(0) and I(1) variables.

Table 3 and Table 4 display the various *F* and *t* statistics that have been computed for the examination of cointegration over the whole period of the analysis. The Chow test, presented in Appendix I, indicates the existence of a structural break in most EMU countries. AIC and SBC criteria have been used to determine the appropriate lag order *r* for each country with or without deterministic trend (see Appendix I). In Table 5 and Table 6 the estimation results for the optimal ARDL specification over the whole period and the two sub-periods are presented.

Table 3. *F and t statistics for testing the existence of long-run relationship of equation (16) when the Net Stable Funding Ratio (NSFR) is used as a dependent variable, EMU-12 countries, 2003:01 to 2012:07*

		Without trends			With trends		
	r	t_{III}	F_{II}	F_{III}	t_V	F_{IV}	F_V
BE	2	-3.42[c]	4.57[c]	6.49[c]	-3.00[a]	4.41[a]	5.36[a]
GE	1	-0.60[a]	1.36[a]	2.01[a]	-1.04[a]	1.67[a]	0.78[a]
IR	3	-2.53[a]	10.2[c]	14.22[c]	- 2.03[a]	9.62[c]	6.79[b]
GR	3	-0.80[a]	0.72[a]	0.50[a]	-0.94[a]	7.43[c]	11.14[c]
SP	3	-2.07[a]	2.93[a]	3.23[a]	-2.53[a]	2.96[a]	3.88[a]
FR	3	-2.13[a]	2.18[a]	2.97[a]	-2.18[a]	2.16[a]	2.66[a]
IT	3	-2.83[a]	2.97[a]	4.46[a]	-3.42[b]	4.25[a]	5.86[a]
PT	3	-3.24[c]	3.67[b]	5.25[b]	-3.60[b]	4.35[a]	6.52[a]
FI	1	-2.9[b]	5.85[c]	8.62[c]	-3.84[c]	5.78[c]	7.64[c]
NL	3	-6.06[c]	14.75[c]	21.89[c]	-6.17[c]	15.02[c]	21.21[c]
AT	2	-4.11[c]	6.49[c]	8.85[c]	-3.95[c]	6.37[c]	8.00[c]
LU	1	-1.29[a]	3.66[b]	4.67[a]	-1.25[a]	3.23[a]	1.05[a]

Note: [a] indicates that the statistic lies below the 0.05 lower bound, [b] that it falls within the 0.05 bounds and [c] that the statistic lies above the 0.05 upper value; t_{III} and t_V are the *t*-test statistics which check the null hypothesis that $\hat{\delta}_2 = 0$ in equation (16) with no trend and with a trend respectively; F_{II}, F_{III}, F_{IV} and F_V are respectively the *F*-test statistics for the Case II (restricted intercept and no trend) in which the null hypothesis that $\hat{\delta}_0 = \hat{\delta}_2 = \hat{\delta}_3 = 0$ is checked, Case III (unrestricted intercept and no trend) in which the null hypothesis that $\hat{\delta}_2 = \hat{\delta}_3 = 0$ is checked, Case IV (unrestricted intercept and restricted trend) in which the null hypothesis that $\hat{\delta}_1 = \hat{\delta}_2 = \hat{\delta}_3 = 0$ is checked and Case V (unrestricted intercept and unrestricted trend) the null hypothesis that $\hat{\delta}_2 = \hat{\delta}_3 = 0$ is checked; *r* is the selected lag order for equation (16). The critical values of the *t*-tests and *F*-tests have been obtained from Pesaran *et al*. (2001).

The results presented in Tables 3 and 4 show that when *NSFR* is used as a dependent variable there is evidence in favour of a long-run relationship for Belgium, Finland, the Netherlands and Austria. When *DNSFR* is used as a liquidity ratio, cointegration exists for Belgium, Portugal, Finland, the Netherlands, Spain and France. However, for these cases Tables 5 and 6 show that there are signs for a positive statistically significant relationship between the liquidity ratios and the credit-to-GDP ratio only for Austria, when the liquidity is captured by the *NSFR*, and for Portugal, Greece and the Netherlands, when the *DNSFR* is the dependent variable. It is also worth noting that in the latter countries the statistically significant relationship is not retained in all sub-periods.

In the other cases in which cointegration turns out to exist, there is either no statistically important relationship or the impact of *CREDIT* on the liquidity ratios is negative and statistically significant. The latter holds for Belgium and Finland when the liquidity is captured by the *NSFR*, and for Spain when the *DNSFR* is the dependent variable. This relationship is not, though, robust for the two sub-periods. For instance, in Belgium the statistical significant coefficient of *CREDIT* is negative for the period 2003:01 to 2008:08, but it turns positive for the period 2008:09 to 2012:07. Overall, these results show very little evidence in favour of a long-run positive relationship between bank liquidity and macroeconomic fragility in the EMU.

Table 4. *F and t statistics for testing the existence of long-run relationship of equation (16) when the Dynamic Net Stable Funding Ratio (DNSFR) is used as a dependent variable, EMU-12 countries, 2003:01 to 2012:07*

		Without trends			With trends		
	r	t_{III}	F_{II}	F_{III}	t_v	F_{IV}	F_V
BE	3	-3.58[c]	4.60[c]	6.53[c]	-3.49[b]	4.49[a]	6.71[c]
GE	1	-2.07[a]	2.23[a]	3.34[a]	-2.19[a]	5.25[c]	7.87[c]
IR	3	-2.10[a]	1.59[a]	2.29[a]	-2.13[a]	2.48[a]	3.46[a]
GR	3	-2.05[a]	1.96[a]	2.16[a]	-3.44[b]	4.23[a]	6.33[a]
SP	3	-1.37[a]	4.78[c]	5.91[c]	-3.74[c]	5.58[c]	7.97[c]
FR	3	-4.16[c]	6.29[c]	8.76[c]	-4.13[c]	5.89[c]	8.80[c]
IT	3	-2.33[a]	2.14[a]	2.72[a]	-2.50[a]	2.12[a]	3.16[a]
PT	3	-3.81[c]	4.93[c]	7.38[c]	-4.40[c]	6.60[c]	9.89[c]
FI	2	-3.53[c]	5.55[c]	8.21[c]	-3.54[b]	5.94[c]	7.99[c]
NL	3	-3.40[c]	11.24[c]	16.79[c]	-3.34[a]	11.13[c]	13.90[c]
AT	2	-2.97[b]	2.97[a]	4.42[a]	-2.94[a]	2.90[a]	4.36[a]
LU	2	-1.47[a]	1.95[a]	2.85[a]	-1.36[a]	1.95[a]	2.08[a]

Note: [a] indicates that the statistic lies below the 0.05 lower bound, [b] that it falls within the 0.05 bounds and [c] that the statistic lies above the 0.05 upper value; t_{III} and t_V are the *t*-test statistics which check the null hypothesis that $\hat{\delta}_2 = 0$ in equation (16) with no trend and with a trend respectively; F_{II}, F_{III}, F_{IV} and F_V are respectively the *F*-test statistics for the Case II (restricted intercept and no trend) in which the null hypothesis that $\hat{\delta}_0 = \hat{\delta}_2 = \hat{\delta}_3 = 0$ is checked, Case III (unrestricted intercept and no trend) in which the null hypothesis that $\hat{\delta}_2 = \hat{\delta}_3 = 0$ is checked, Case IV (unrestricted intercept and restricted trend) in which the null hypothesis that $\hat{\delta}_1 = \hat{\delta}_2 = \hat{\delta}_3 = 0$ is checked and Case V (unrestricted intercept and unrestricted trend) the null hypothesis that $\hat{\delta}_2 = \hat{\delta}_3 = 0$ is checked; *r* is the selected lag order for equation (16). The critical values of the *t*-tests and *F*-tests have been obtained from Pesaran *et al*. (2001).

In the countries in which no cointegration is found, the results from the estimation of the ARDL models (see Tables 5 and 6) show that only in three of them (Greece, Italy and Luxemburg) there may be a possibility for a positive relationship between *CREDIT* and the *NSFR*. In addition, in only two countries (Germany and Luxemburg) there is a chance for a positive relationship between *NSFR* and the credit-to-GDP ratio. For the other countries the coefficient of *CREDIT* is either insignificant or negative. Therefore, even if someone doubts the inference of the Pesaran *et al.* (2001) test, the overall conclusion for little evidence of a positive link between macroeconomic fragility and bank liquidity in the EMU does not alter.

Table 5. *Estimation results for the ARDL model, dependent variable: Net Stable Funding Ratio (NSFR), EMU-12 countries*

(a) Period: 2003:01 to 2012:07

	CREDIT	EC_{-1}	R^2-Adjusted	$x^2_{SC}(12)$	x^2_{FF}	x^2_{H}	Trend	Dummy	ARDL
BE	-0.54 (0.06)***	-0.18 (0.05)***	0.95	13.81 [0.31]	0.07 [0.78]	3.96 [0.004]	No	No	ARDL(1,0)
GE	-0.62 (1.53)	-0.04 (0.03)	0.94	31.92 [0.001]	0.31 [0.57]	2.87 [0.09]	Yes	No	ARDL(4,4)
IR	-0.35 (0.15)**	-0.08 (0.03)**	0.87	8.54 [0.74]	0.03 [0.85]	17.40 [0.00]	No	Yes	ARDL(3,3)
GR	7.06 (7.31)	-0.03 (0.03)	0.90	28.70 [0.004]	0.03 [0.84]	0.20 [0.65]	Yes	No	ARDL(2,1)
SP	-0.06 (0.03)*	-0.17 (0.05)***	0.96	6.41 [0.89]	0.004 [0.98]	0.02 [0.88]	Yes	No	ARDL(1,0)
FR	-0.24 (0.15)	-0.07 (0.04)*	0.93	11.46 [0.49]	8.39 [0.004]	2.47 [0.11]	No	No	ARDL(3,0)
IT	0.13 (0.07)*	-0.41 (0.09)***	0.38	12.38 [0.41]	0.18 [0.67]	0.52 [0.46]	Yes	No	ARDL(2,0)
PT	-0.01 (0.05)	-0.35 (0.07)***	0.88	6.69 [0.87]	0.001 [0.97]	7.00 [0.008]	Yes	No	ARDL(1,0)
FI	-0.26 (0.05)***	-0.25 (0.07)***	0.86	7.73 [0.80]	3.10 [0.07]	8.65 [0.003]	No	No	ARDL(3,0)
NL	0.01 (0.10)	-0.48 (0.07)***	0.79	8.85 [0.71]	3.09 [0.07]	10.09 [0.001]	No	Yes	ARDL(1,0)
AT	0.13 (0.06)**	-0.71 (0.10)***	0.86	16.96 [0.15]	7.01 [0.008]	0.92 [0.33]	No	Yes	ARDL(1,2)
LU	0.27 (0.41)	-0.02 (0.03)	0.93	13.89 [0.30]	0.05 [0.82]	0.74 [0.39]	No	No	ARDL(3,0)

(continued from the previous page)

(b) Period: 2003:01 to 2008:08

	CREDIT	EC_{-1}	R^2-Adjusted	$x^2_{SC}(12)$	x^2_{FF}	x^2_H	Trend	ARDL
BE	-0.58 (0.15)***	-0.26 (0.07)***	0.85	7.47 [0.82]	0.46 [0.49]	0.29 [0.58]	No	ARDL(1,4)
GE	-1.09 (1.17)	-0.12 (0.07)*	0.92	13.86 [0.31]	0.99 [0.31]	0.15 [0.69]	Yes	ARDL(1,2)
IR	-0.24 (0.16)	-0.07 (0.04)*	0.87	14.29 [0.28]	3.65 [0.05]	12.00 [0.001]	No	ARDL(2,0)
GR	1.81 (0.31)***	-0.46 (0.13)***	0.94	9.74 [0.63]	0.0009 [0.99]	0.57 [0.44]	Yes	ARDL(2,2)
SP	0.12 (0.07)*	-0.42 (0.10)***	0.96	9.36 [0.67]	2.30 [0.12]	0.02 [0.86]	Yes	ARDL(1,1)
FR	0.73 (0.75)	-0.16 (0.07)**	0.96	9.83 [0.63]	0.07 [0.78]	0.05 [0.81]	Yes	ARDL(1,0)
IT	-0.68 (0.22)***	-0.45 (0.10)***	0.51	15.95 [0.19]	2.74 [0.09]	0.25 [0.61]	Yes	ARDL(1,0)
PT	0.26 (0.06)***	-0.57 (0.10)***	0.71	5.73 [0.92]	0.13 [0.71]	4.69 [0.03]	Yes	ARDL(1,0)
FI	-0.14 (0.18)	-0.14 (0.05)***	0.88	9.79 [0.63]	1.14 [0.28]	0.01 [0.90]	No	ARDL(1,0)
NL	0.26 (0.25)	-0.56 (0.10)***	0.27	15.42 [0.21]	0.02 [0.86]	24.10 [0.00]	No	ARDL(1,0)
AT	-	-	-	-	-	-	-	-
LU	0.09 (0.01)***	-0.72 (0.15)***	0.97	17.15 [0.14]	0.04 [0.83]	0.62 [0.42]	Yes	ARDL(1,0)

(continued from the previous page)

(c) Period: 2008:09 to 2012:07

	CREDIT	EC_{-1}	R^2-Adjusted	$x^2_{SC}(12)$	x^2_{FF}	x^2_H	Trend	ARDL
BE	1.86 (1.08)*	-0.21 (0.08)**	0.73	8.93 [0.70]	0.006 [0.93]	0.01 [0.89]	Yes	ARDL(1,0)
GE	1.61 (0.60)**	-0.36 (0.12)***	0.92	20.31 [0.06]	10.55 [0.001]	0.63 [0.42]	Yes	ARDL(1,4)
IR	-0.04 (0.09)	-0.35 (0.07)***	0.85	14.11 [0.29]	0.54 [0.46]	3.56 [0.05]	Yes	ARDL(3,0)
GR	4.17 (3.50)	-0.10 (0.08)	0.78	21.06 [0.04]	1.41 [0.23]	0.45 [0.49]	Yes	ARDL(2,1)
SP	0.24 (0.09)***	-0.39 (0.11)***	0.69	14.05 [0.29]	-	1.74 [0.18]	Yes	ARDL(1,4)
FR	-0.001 (0.14)	-0.45 (0.12)***	0.26	8.31 [0.76]	1.65 [0.19]	0.34 [0.55]	No	ARDL(1,0)
IT	0.02 (0.10)	-1	0.47	16.98 [0.15]	0.21 [0.64]	0.71 [0.39]	Yes	ARDL(0,1)
PT	-0.04 (0.15)	-0.29 (0.10)***	0.58	6.49 [0.88]	1.58 [0.20]	0.72 [0.39]	No	ARDL(1,0)
FI	-0.02 (0.16)	-0.63 (0.13)***	0.10	15.79 [0.20]	0.88 [0.34]	2.64 [0.10]	No	ARDL(1,0)
NL	0.006 (0.13)	-0.33 (0.10)***	0.50	4.41 [0.97]	0.12 [0.72]	0.08 [0.76]	No	ARDL(1,0)
AT	-	-	-	-	-	-	-	-
LU	-0.008 (0.01)	-0.55 (0.17)***	0.81	19.64 [0.07]	0.17 [0.67]	0.65 [0.41]	Yes	ARDL(4,0)

Note: The table reports the coefficients of the credit-to-GDP ratio (*CREDIT*) and of the lagged error correction term (EC_{-1}); standard errors are reported in brackets.. R^2 - *Adjusted* is the adjusted squared multiple correlation coefficient. $x^2_{SC}(12)$, $x^2_{FF}(12)$, and $x^2_H(12)$, denote chi-squared statistics to test for the null hypothesis of no serial correlation of order 12, no functional form mis-specification and homoskedasticity, respectively; *p*-values are reported in brackets. Symbols ***, **, and * denote statistical significance at 0.01, 0.05 and 0.10 levels, respectively.

Table 6. *Estimation results for the ARDL model, dependent variable: Dynamic Net Stable Funding Ratio (DNSFR), EMU-12 countries*

(a) Period: 2003:01 to 2012:07

	CREDIT	EC_{-1}	R^2-Adjusted	$x^2_{SC}(12)$	x^2_{FF}	x^2_{H}	Trend	Dummy	ARDL
BE	0.24 (0.24)	-0.18 (0.04)***	0.94	28.62 [0.004]	1.73 [0.18]	0.12 [0.72]	No	Yes	ARDL(4,0)
GE	1.38 (1.26)	-0.21 (0.06)***	0.81	14.77 [0.25]	4.62 [0.03]	4.14 [0.04]	Yes	Yes	ARDL(1,4)
IR	-0.05 (0.04)	-0.11 (0.04)**	0.80	10.08 [0.60]	2.44 [0.11]	16.33 [0.00]	No	No	ARDL(1,0)
GR	1.00 (0.45)**	-0.17 (0.05)***	0.85	23.96 [0.02]	0.005 [0.93]	6.09 [0.01]	Yes	Yes	ARDL(1,0)
SP	-0.34 (0.14)**	-0.18 (0.05)***	0.94	14.52 [0.26]	0.14 [0.70]	2.03 [0.15]	Yes	Yes	ARDL(1,1)
FR	-0.09 (0.16)	-0.28 (0.06)***	0.84	35.37 [0.00]	4.68 [0.03]	2.43 [0.11]	No	Yes	ARDL(2,0)
IT	-0.24 (0.19)	-0.12 (0.04)**	0.77	12.01 [0.44]	0.49 [0.48]	8.00 [0.005]	No	No	ARDL(1,0)
PT	0.48 (0.21)**	-0.27 (0.06)***	0.91	21.03 [0.05]	4.20 [0.04]	0.01 [0.90]	Yes	Yes	ARDL(3,2)
FI	0.06 (0.17)	-0.27 (0.06)***	0.87	20.79 [0.05]	2.34 [0.12]	3.78 [0.05]	No	Yes	ARDL(1,0)
NL	1.95 (0.85)**	-0.15 (0.04)***	0.94	11.07 [0.52]	3.39 [0.06]	0.83 [0.36]	No	Yes	ARDL(1,1)
AT	-0.003 (0.59)	-0.15 (0.06)**	0.72	13.56 [0.32]	2.08 [0.14]	3.63 [0.05]	No	No	ARDL(1,4)
LU	0.03 (0.05)	-0.13 (0.05)**	0.81	10.23 [0.59]	0.58 [0.44]	5.34 [0.02]	No	No	ARDL(1,4)

(continued from the previous page)

(b) Period: 2003:01 to 2008:08

	CREDIT	EC_{-1}	R^2-Adjusted	$x^2_{SC}(12)$	x^2_{FF}	x^2_H	Trend	ARDL
BE	-1.38 (1.13)	-0.08 (0.05)	0.86	11.37 [0.49]	0.48 [0.48]	1.01 [0.31]	No	ARDL(2,4)
GE	-0.93 (0.28)*	-0.26 (0.12)**	0.80	6.64 [0.88]	0.08 [0.77]	5.27 [0.02]	No	ARDL(3,3)
IR	-1.84 (1.22)	0.08 (0.07)	0.85	17.68 [0.12]	1.07 [0.30]	2.24 [0.13]	Yes	ARDL(3,0)
GR	0.17 (0.10)	-0.17 (0.07)**	0.70	17.83 [0.12]	4.03 [0.04]	9.15 [0.002]	No	ARDL(2,0)
SP	0.79 (0.18)***	-0.61 (0.11)***	0.86	22.22 [0.03]	0.02 [0.88]	0.24 [0.61]	Yes	ARDL(1,4)
FR	-0.31 (0.06)***	-0.54 (0.10)***	0.60	15.19 [0.23]	0.27 [0.59]	0.13 [0.71]	No	ARDL(1,0)
IT	-2.28 (1.14)*	-0.24 (0.09)**	0.62	12.43 [0.41]	4.13 [0.04]	1.34 [0.24]	Yes	ARDL(2,0)
PT	-0.03 (0.08)	-0.27 (0.11)**	0.39	13.71 [0.31]	0.37 [0.53]	3.49 [0.06]	No	ARDL(2,0)
FI	0.11 (0.24)	-0.19 (0.06)***	0.78	13.58 [0.32]	0.26 [0.60]	0.17 [0.67]	No	ARDL(4,4)
NL	1.99 (0.53)***	-0.42 (0.10)***	0.87	13.89 [0.30]	1.21 [0.27]	1.67 [0.19]	No	ARDL(1,0)
AT	-	-	-	-	-	-	-	-
LU	-0.38 (0.05)***	-0.44 (0.14)***	0.88	16.05 [0.18]	1.42 [0.23]	0.25 [0.61]	No	ARDL(2,2)

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(c) Period: 2008:09 to 2012:07

	CREDIT	EC_{-1}	R^2-Adjusted	$x^2_{SC}(12)$	x^2_{FF}	x^2_H	Trend	ARDL
BE	2.74 (1.20)**	-0.26 (0.07)***	0.73	22.63 [0.03]	0.21 [0.64]	2.51 [0.11]	Yes	ARDL(2,0)
GE	2.35 (0.64)***	-0.46 (0.10)***	0.76	15.67 [0.20]	1.04 [0.30]	4.86 [0.02]	No	ARDL(1,3)
IR	0.82 (0.20)***	-0.38 (0.09)***	0.78	16.54 [0.16]	0.91 [0.34]	7.82 [0.005]	Yes	ARDL(2,2)
GR	4.28 (2.56)	-0.19 (0.07)**	0.79	9.09 [0.69]	4.47 [0.03]	0.52 [0.46]	Yes	ARDL(2,0)
SP	1.01 (0.34)***	-0.42 (0.08)***	0.77	12.64 [0.39]	0.03 [0.84]	0.05 [0.81]	Yes	ARDL(3,2)
FR	0.73 (0.39)**	-0.34 (0.09)***	0.67	21.05 [0.05]	1.25 [0.26]	0.05 [0.82]	No	ARDL(2,0)
IT	4.40 (0.93)***	-0.43 (0.09)***	0.82	9.05 [0.69]	0.02 [0.86]	4.73 [0.03]	Yes	ARDL(2,4)
PT	2.20 (0.72)***	-0.28 (0.06)***	0.84	18.34 [0.10]	0.34 [0.55]	0.06 [0.79]	Yes	ARDL(2,2)
FI	0.56 (0.30)*	-0.42 (0.11)***	0.41	19.11 [0.08]	3.00 [0.08]	0.18 [0.67]	No	ARDL(1,0)
NL	-0.12 (0.28)	-0.37 (0.07)***	0.74	22.50 [0.03]	7.90 [0.005]	22.03 [0.00]	No	ARDL(3,0)
AT	-	-	-	-	-	-	-	-
LU	0.29 (0.12)**	-0.33 (0.10)***	0.83	13.71 [0.31]	1.15 [0.28]	0.85 [0.35]	Yes	ARDL(1,4)

Note: The table reports the coefficients of the credit-to-GDP ratio (*CREDIT*) and of the lagged error correction term (EC_{-1}); standard errors are reported in brackets.. R^2 - *Adjusted* is the adjusted squared multiple correlation coefficient. $x^2_{SC}(12)$, $x^2_{FF}(12)$, and $x^2_H(12)$, denote chi-squared statistics to test for the null hypothesis of no serial correlation of order 12, no functional form mis-specification and homoskedasticity, respectively*;* *p*-values are reported in brackets. Symbols ***, **, and * denote statistical significance at 0.01, 0.05 and 0.10 levels, respectively.

5.4 Conclusion

This chapter has centered on the issue of liquidity regulation. This issue has been at the core of the innovations of Basel III. The chapter has put forward a dynamic liquidity ratio that, contrary to the ratios used in Basel III, allows for a time-varying definition of bank balance sheet items' liquidity and stability. The implementation of this ratio in the EMU-12 countries has shown that it can more successfully portray the actual liquidity problems of banks, especially in the aftermath of the crisis. This implies that a more dynamic view of liquidity needs to be adopted in the current regulatory framework.

Using the ARDL bounds-testing approach, the chapter has also indicated that in most EMU countries bank liquidity is not positively related with macroeconomic fragility. Based on this evidence, it has been argued that bank liquidity requirements should increase when the macroeconomic risk becomes higher. This will allow liquidity regulation to play a more substantial role in preventing financial instability in the macroeconomy.

Appendices

Appendix A. Aggregated balance sheet of euro area monetary financial institutions (MFIs) excluding European System of Central Banks (ESCB)

1. Assets	2. Liabilities
1.1. Loans to euro area residents	2.1. Currency in circulation (Not available)
1.1.1. Monetary financial institutions	2.2. Deposits of euro area residents
1.1.2. General government	2.2.1. Monetary financial institutions
1.1.3. Other euro area residents	2.2.2. Central government
1.1.3.1. Non-financial corporations	2.2.3. Other general government/other euro area residents
1.1.3.2. Households	2.2.3.1. Overnight
1.1.3.2.1. Consumer credit	2.2.3.2. With agreed maturity
1.1.3.2.2. Lending for house purchase	*2.2.3.2.1. Up to 1 year*
1.1.3.2.3. Other lending	*2.2.3.2.2. Over 1 year and up to 2 years*
1.1.3.3. Non-monetary financial intermediaries other than insurance corporations and pension funds	*2.2.3.2.3. Over 2 years*
1.1.3.4. Insurance corporations and pension funds	2.2.3.3. Redeemable at notice
1.2. Holdings of securities other than shares issued by euro area residents	*2.2.3.3.1. Up to 3 months*
1.2.1. Monetary financial institutions	*2.2.3.3.2. Over 3 months*
1.2.1.1. Up to 1 year	2.2.3.4. Repurchase agreements
1.2.1.2. Over 1 year and up to 2 years	2.3. Money market fund shares/units
1.2.1.3. Over 2 years	2.4. Debt securities issued
1.2.2. General government	2.4.1. Up to 1 year
1.2.3. Other euro area residents	2.4.2. Over 1 year and up to 2 years
1.3. Money market fund shares/units	2.4.3. Over 2 years
1.4. Holdings of shares/other equity issued by euro area residents	2.5. Capital and reserves
1.4.1. Monetary financial institutions	2.6. External liabilities
1.4.2. Other euro area residents	2.7. Remaining liabilities
1.5. External assets	
1.6. Fixed assets	
1.7. Remaining assets	

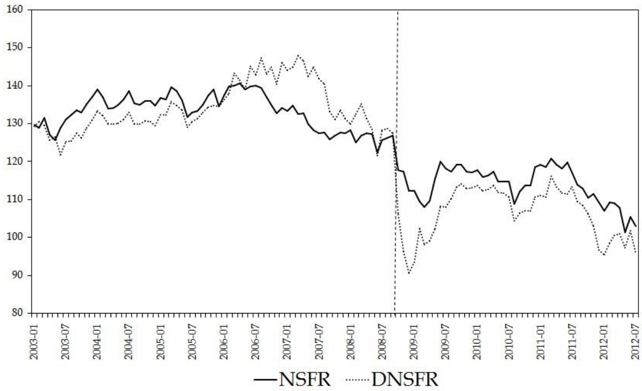
Note: See Colangelo and Lenza (2012) and ECB (2012A) for the definitions of the data.

Appendix B. Description of the data sources

Variable name	Data sources
Net Stable Funding Ratio (*NSFR*)	ECB, monetary statistics, MFI balance sheets
Credit-to-GDP ratio (*CREDIT*)	ECB, Euro area accounts, main indicators
Herfindahl index for credit institutions (*CI*)	ECB, monetary and financial statistics, structural finance indicators
Sovereign bond holding by resident banks	Bruegel (see Merler and Pisani-Ferry, 2012; Acharya *et al*., 2012, p. 54, Chart 3)
Long-term interest rate for convergence purposes, debt security issued (10 years)	ECB, monetary statistics, long term interest rates
Euro area 10-year government benchmark bond yield for other than domestic securities	ECB, monetary statistics, market indices
ECB policy rate (*rb*)	ECB, money banking and financial markets, market indices
EONIA interest rate (*rb*)	ECB, money banking and financial markets, market indices
Euribor 3 months rate	European Bank Federation
Interest rate on deposits	ECB, money banking and financial markets, market interest rates, deposits
Interest rate on loans	ECB, money banking and financial markets, market interest rates, loans

Appendix C. Net Stable Funding Ratio (*NSFR*) and Dynamic Net Stable Funding Ratio (*DNSFR*) in percentage points, EMU-12 countries, 2003:01 to 2012:07, *DNSFR* has been calculated by setting *p=0.8*, *q=1.2*, adjusting for the concentration index and using the EONIA policy rate as a benchmark interest rate

(a) Belgium



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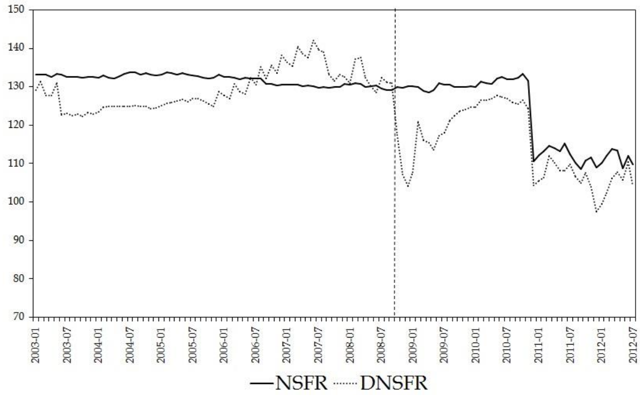
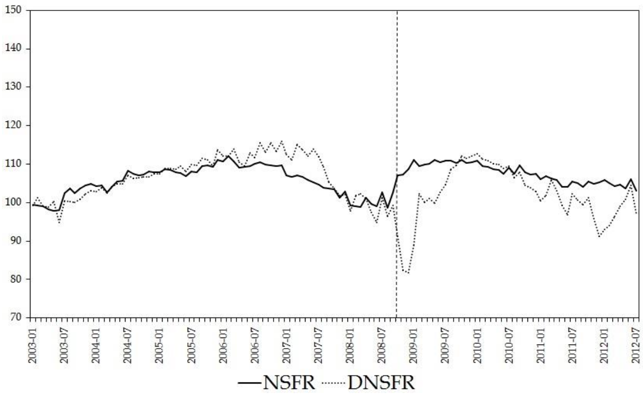
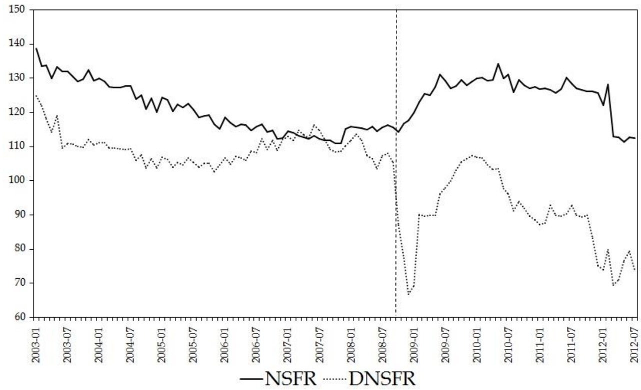


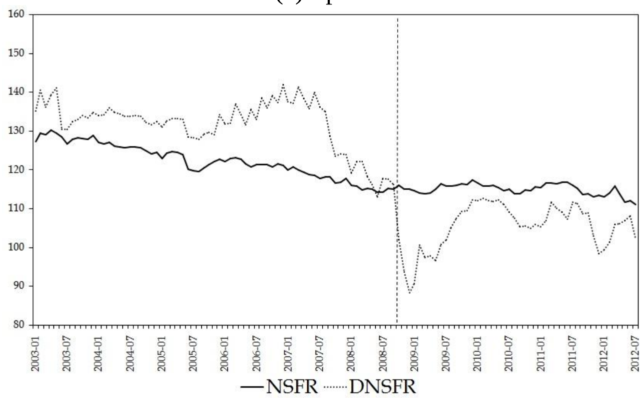
(c) Ireland



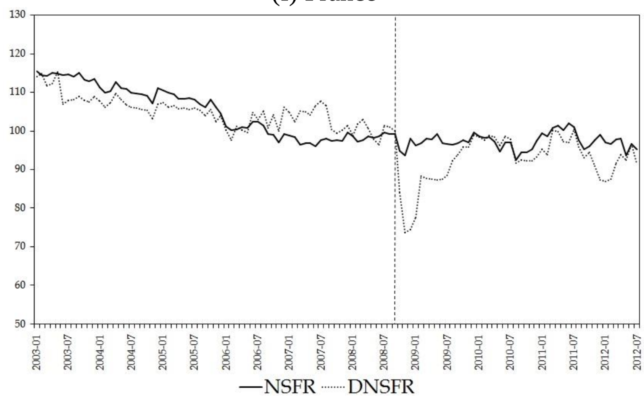
(d) Greece



(e) Spain



(f) France



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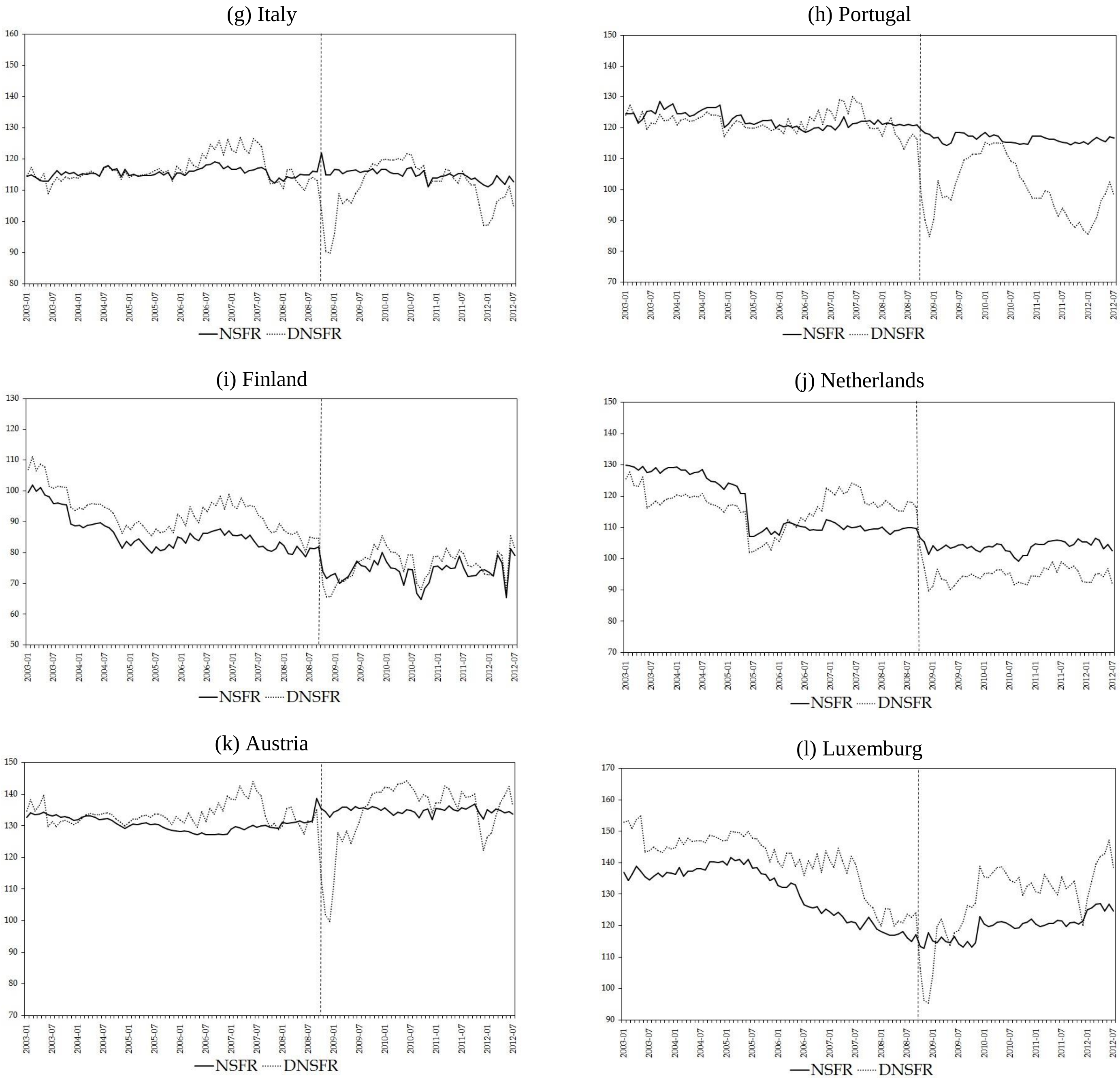
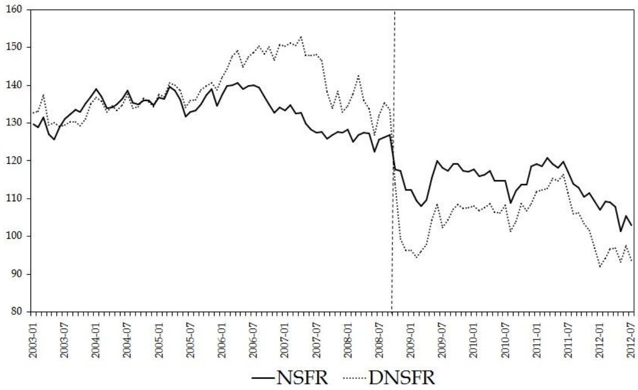
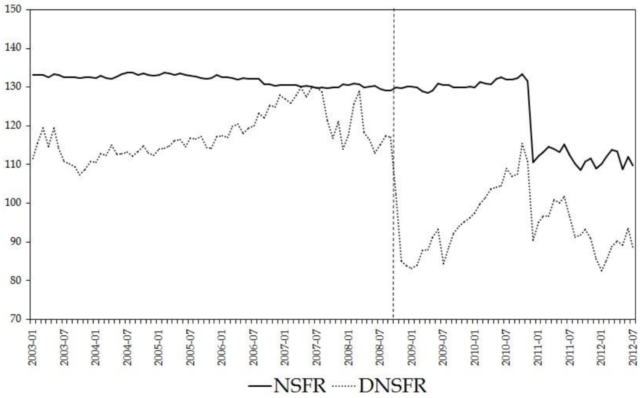


Appendix D. Net Stable Funding Ratio *(NSFR*) and Dynamic Net Stable Funding Ratio (*DNSFR*) in percentage points, EMU-12 countries, 2003:01 to 2012:07; *DNSFR* has been calculated by setting *p=0.8*, *q=1.2*, without adjusting for the concentration index and using the ECB policy rate as a benchmark interest rate

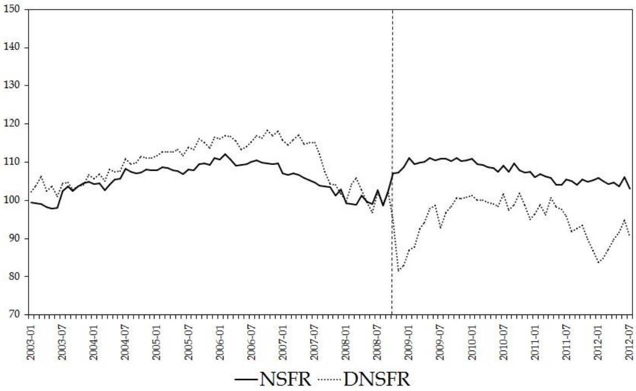
(a) Belgium



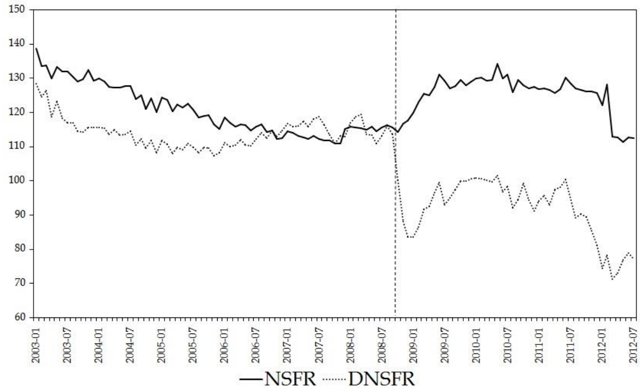
(b) Germany



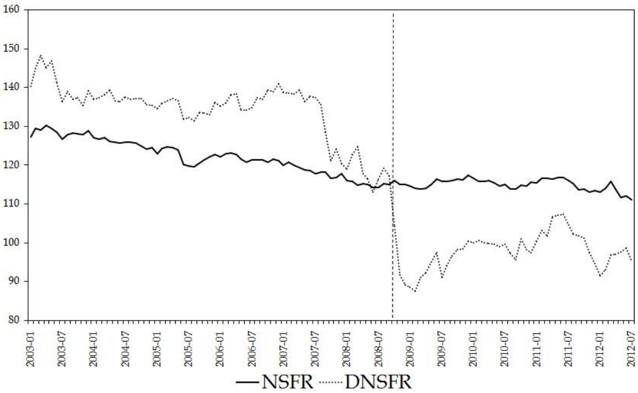
(c) Ireland



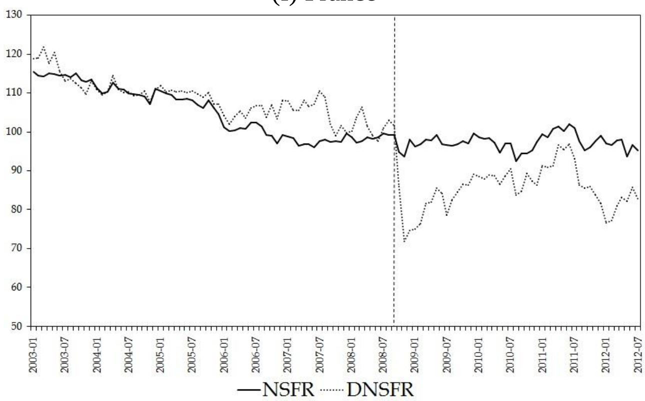
(d) Greece



(e) Spain



(f) France



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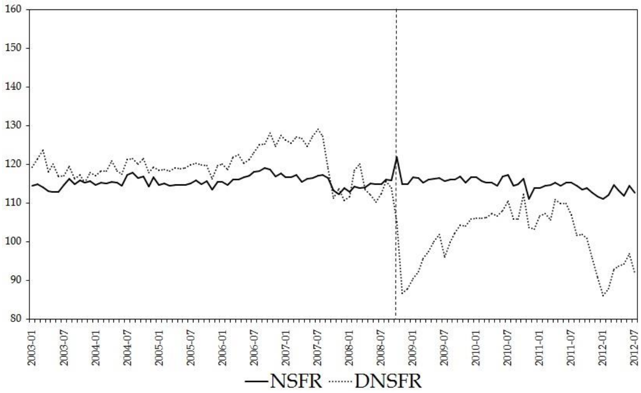
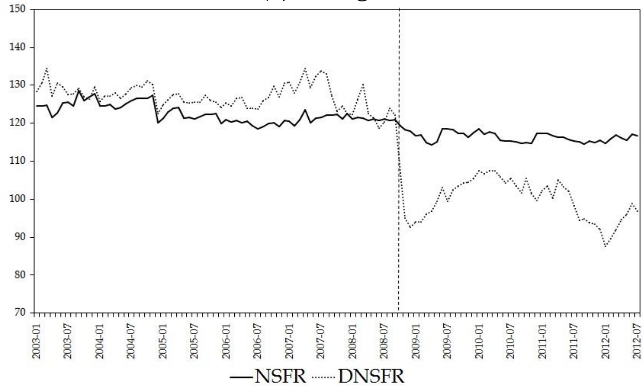
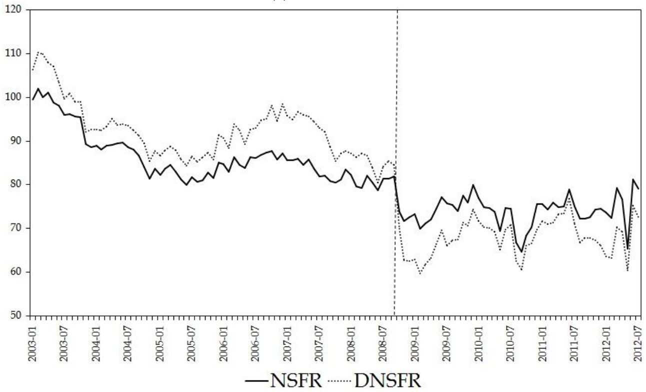
(g) Italy



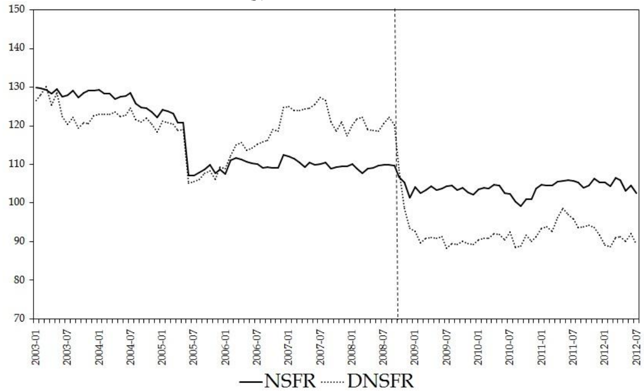
(h) Portugal



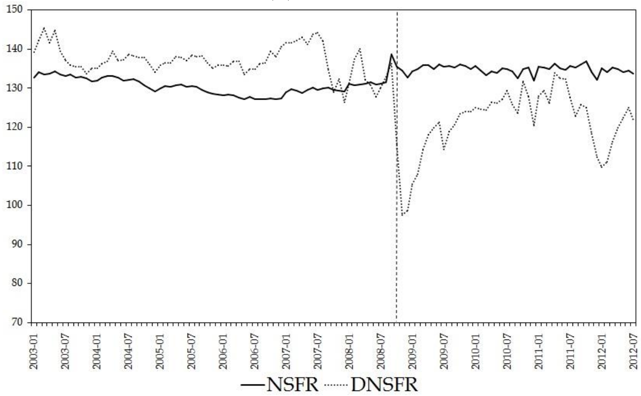
(i) Finland



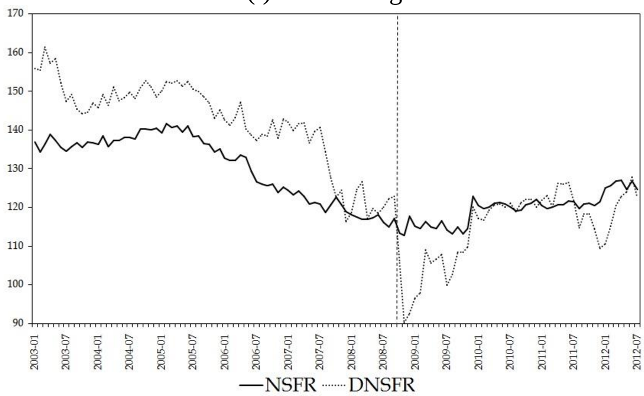
(j) Netherlands



(k) Austria

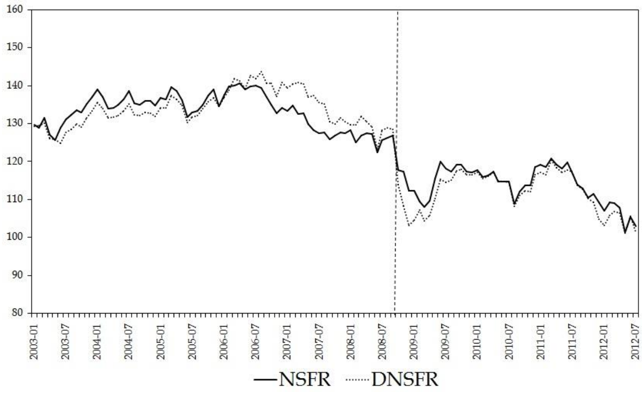


(l) Luxemburg

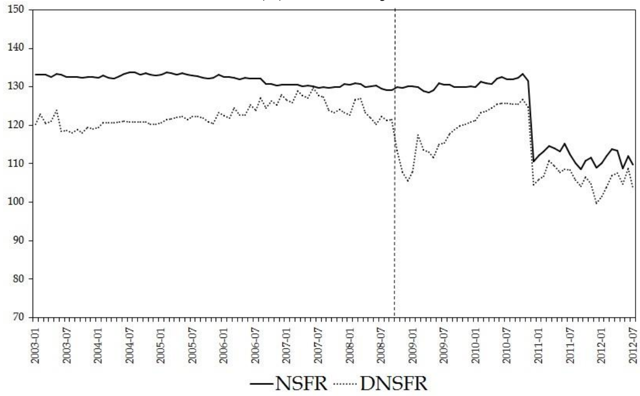


Appendix E. Net Stable Funding Ratio *(NSFR)* and Dynamic Net Stable Funding Ratio (*DNSFR*), EMU-12 countries, 2003:01 to 2012:07; *DNSFR* has been calculated by setting *p=0.9*, *q=1.1* , adjusting for the concentration index and using the ECB policy interest rate as a benchmark interest rate

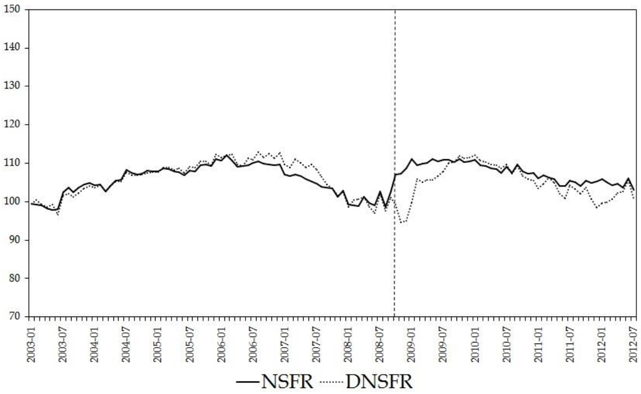
(a) Belgium



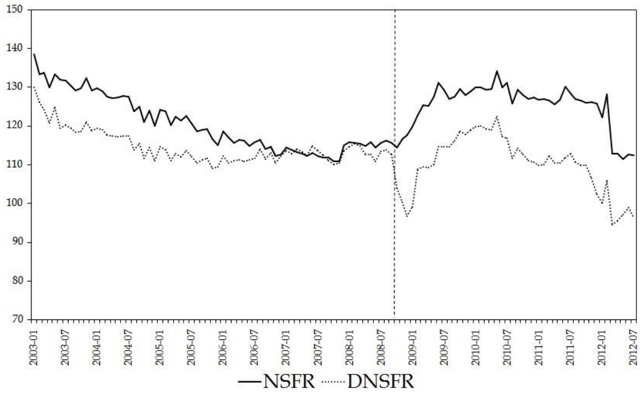
(b) Germany



(c) Ireland



(d) Greece



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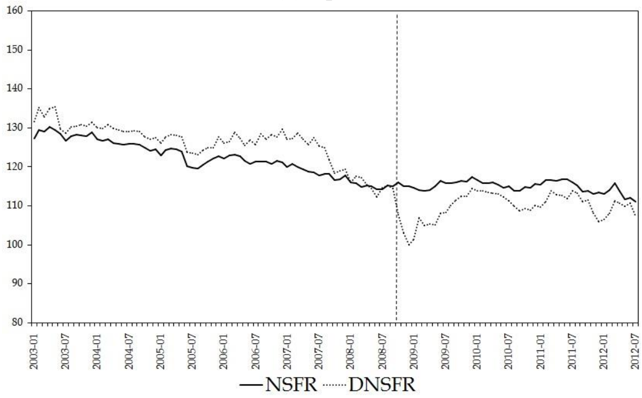
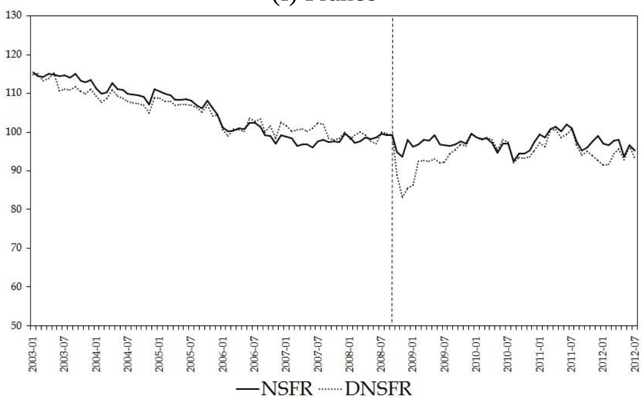


(f) France



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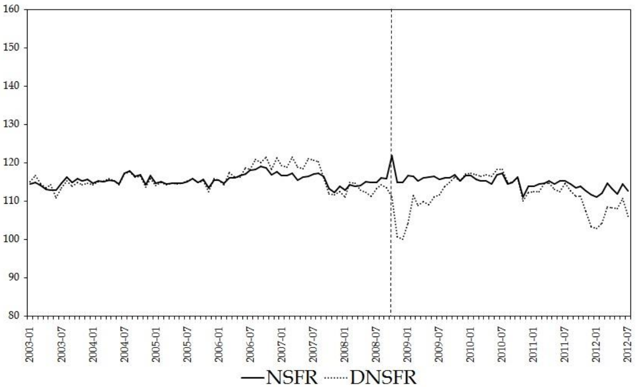
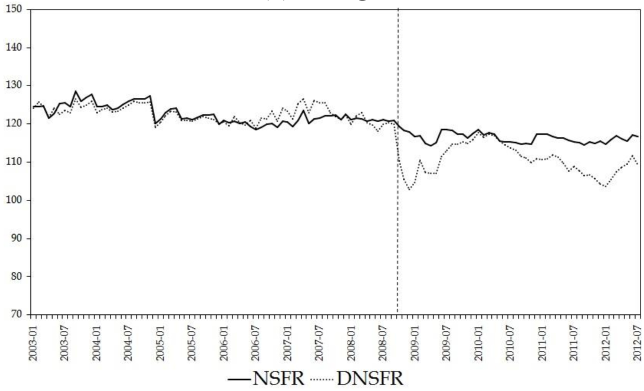
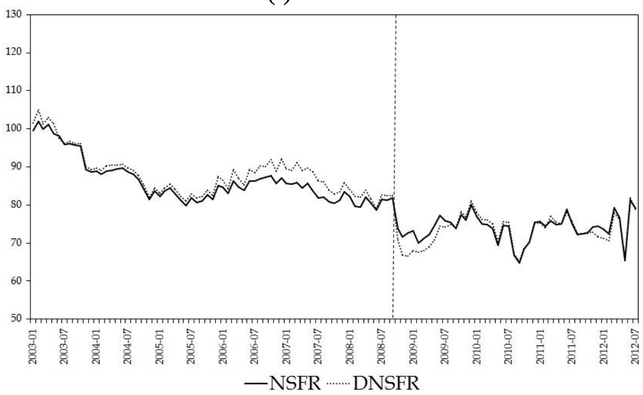
(g) Italy



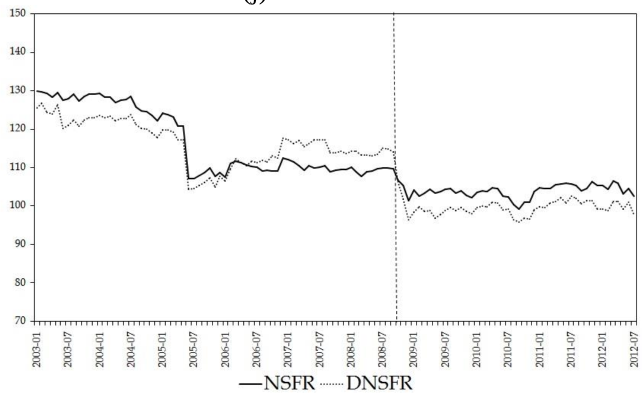
(h) Portugal



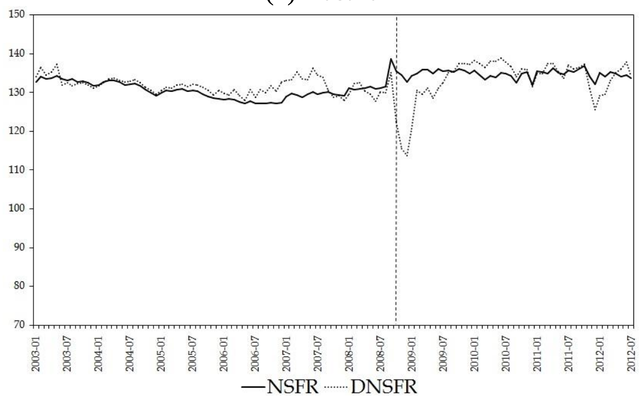
(i) Finland



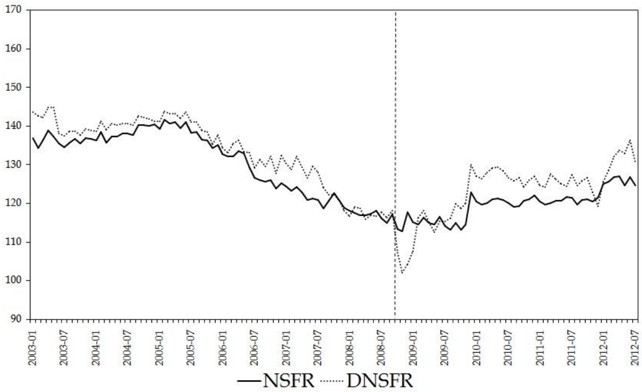
(j) Netherlands



(k) Austria



(l) Luxemburg



Appendix F. Description of the Phillips-Perron and Zivot and Andrews unit root tests

The Phillips-Perron unit root test (see Phillips and Perron, 1988) requires the estimation of the following regression equation using OLS (Ordinary Least Squares):

$$\Delta y_t = \beta_0 + \beta_1 t + \beta y_{t-1} + \varepsilon_t \qquad \text{(F.1)}$$

where y_t is the variable under investigation (*LIQ* or *CREDIT*), $t = 1,...,T$ is an index of time and ε_t is I(0) and may be heteroskedastic. The Phillips-Perron test calculates the Z_t statistic that corrects for any serial correlation and heteroskedasticity in the errors ε_t of the test regression.[15] The Z_t statistic is given by:

$$Z_t = \sqrt{\frac{c_0}{\alpha}} \frac{\widehat{\beta} - 1}{\upsilon} - \frac{1}{2}(a - c_0)\frac{T\upsilon}{\sqrt{\alpha s^2}}$$

where: $c_0 = \frac{T-k}{T} s^2$, $\alpha = c_0 + 2\sum_{j=1}^{L}\left(1 - \frac{j}{L+1}\right)c_j$, $c_j = \frac{1}{T}\sum_{s=j+1}^{T}\varepsilon_t \varepsilon_{t-s}$,

$s^2 = \frac{1}{T-k}\sum_{i=1}^{T}\varepsilon_t^2$.

In the above expressions *T* is the number of observations, *k* is the number of covariates in the regression (1 for random walk, 2 for random walk with drift and 3 for trend stationary), *L* is the number of Newey-West lags to use in calculating α, and υ^2 is the asymptotic variance of $\widehat{\beta}$. We test the null hypothesis that $\beta = 0$ to examine whether a unit root is present. If the null hypothesis is rejected, we conclude that there are no unit roots in y_t. For all variables for which the null hypothesis cannot be rejected, there is strong evidence of non-stationarity. We then proceed to explore whether the unit root is removed by taking first differences.

[15] The Phillips-Perron test corrects serial correlation and heteroskedasticity by using the Newey-West covariance matrix estimator.

Regarding the Zivot and Andrews (1992) unit root test, its Model A has the following regression form:

$$\Delta y_t = \gamma_0 + \gamma_1 t + \gamma_2 y_{t-1} + \gamma_3 DU_t + \sum_{j=1}^{k} \gamma_{5j} \Delta y_{t-j} + \varepsilon_t \qquad \text{(F.2)}$$

The regression form of model C is as follows:

$$\Delta y_t = \gamma_0 + \gamma_1 t + \gamma_2 y_{t-1} + \gamma_3 DU_t + \gamma_4 DT_t + \sum_{j=1}^{k} \gamma_{5j} \Delta y_{t-j} + \varepsilon_t \qquad \text{(F.3)}$$

In equations (F.2) and (F.3) DU_t is a dummy variable that is equal to one for $t > BP$ and zero otherwise; DT_t is the corresponding trend shift variable, where $DT_t = t - BP$ if $t > BP$ and zero otherwise, and BP is the break point. The Δy_{t-j} terms allow for serial correlation. The *t*-test statistic that $\gamma_2 = 0$ is calculated for recursive regressions where DU_t or DT_t change each time for the 'trimming region' [0.15-0.85]. The break point, BP, is endogenously determined by the data using as a criterion the minimisation of the ADF *t*-test statistic. This statistic is then compared with the critical values provided by Zivot and Andrews (1992). The null hypothesis is that the time series has a unit root without a structural break; the alternative hypothesis suggests that there is a trend stationary series with a structural break.

Appendix G. Philips-Perron unit root tests

		Levels		First differences	
		Without trends	**With trends**	**Without trends**	**With trends**
BE	*NSFR*	-0.229	-2.604	-11.078***	-11.221***
	DNSFR	-0.924	-1.934	-9.654***	-9.672***
	CREDIT	0.066	-1.433	-4.626***	-4.699***
GE	*NSFR*	-0.386	-1.850	-10.913***	-10.998***
	DNSFR	-2.403	-2.617	-11.075***	-11.038***
	CREDIT	-1.701	-1.390	-3.118**	-3.212*
IR	*NSFR*	-2.419	-2.183	-12.973***	-13.124***
	DNSFR	-2.312	-2.482	-10.927***	-10.914***
	CREDIT	-1.029	-0.820	-3.399**	-3.469**
GR	*NSFR*	-2.225	-2.183	-15.275***	-15.210***
	DNSFR	-1.998	-2.737	-10.006***	-9.961***
	CREDIT	-1.888	0.918	-3.097**	-3.506**
SP	*NSFR*	-0.806	-2.580	-11.668***	-11.637***
	DNSFR	-1.211	-2.371	-10.389***	-10.346***
	CREDIT	-3.510***	2.348	-1.268	-2.686
FR	*NSFR*	-1.858	-2.261	-12.914***	-12.976***
	DNSFR	-2.392	-3.563**	-10.283***	-10.242***
	CREDIT	0.343	-2.261	-3.727***	-3.727**
IT	*NSFR*	-5.414***	-5.622***	-18.249***	-18.262***
	DNSFR	-2.292	-2.789	-9.987***	-9.951***
	CREDIT	-2.074	0.476	-3.867***	-3.904**
PT	*NSFR*	-1.768	-4.721***	-14.168***	-14.097***
	DNSFR	-1.512	-2.827	-10.251***	-10.202***
	CREDIT	-0.895	-0.508	-3.319**	-3.382*
FI	*NSFR*	-2.504	-3.570**	-14.720***	-15.097**
	DNSFR	-2.257	-2.932	-13.300***	-13.402***
	CREDIT	-0.620	-1.711	-3.971***	-3.953**
NL	*NSFR*	-3.583***	-3.984**	-10.022***	-10.128***
	DNSFR	-1.340	-1.895	-8.573***	-8.523***
	CREDIT	-1.530	-1.974	-3.840***	-3.804**
AT	*NSFR*	-1.887	-3.100	-13.708***	-13.762***
	DNSFR	-2.894*	-2.889	-7.164***	-7.104***
	CREDIT	-1.380	-1.120	-3.352**	-3.486**
LU	*NSFR*	-2.187	-1.044	-11.278***	-12.472***
	DNSFR	-2.225	-2.076	-9.010***	-9.035***
	CREDIT	-1.287	-1.876	-4.303***	-4.324***

Note: The table reports Z_t statistics according to equation (F.1). The Z_t statistics tests the null hypothesis $\beta = 0$ to examine whether a unit root is present. For all variables for which the null hypothesis cannot be rejected, there is strong evidence of non-stationarity. The symbols ***, **, and * denote statistical significance at 0.01, 0.05 and 0.10 levels, respectively.

Appendix H. Zivot and Andrews (1992) unit root tests with one structural break

		Model A		Model C	
		t	**Break point**	***t***	**Break point**
BE	*NSFR*	-3.311	2008-10	-3.635	2006-09
	DNSFR	-3.902	2008-09	-3.760	2008-09
	CREDIT	-5.254**	2008-03	-4.025	2010-12
GE	*NSFR*	-15.711***	2010-12	-14.764***	2010-12
	DNSFR	-3.571	2008-04	-3.860	2008-04
	CREDIT	-5.177**	2008-07	-6.127***	2008-07
IR	*NSFR*	-3.520	2008-10	-3.868	2008-10
	DNSFR	-3.315	2007-07	-3.538	2007-02
	CREDIT	-1.926	2008-01	-2.991	2008-06
GR	*NSFR*	-3.810	2008-11	-2.282	2008-12
	DNSFR	-3.277	2006-03	-3.776	2009-06
	CREDIT	-0.156	2011-01	-1.792	2010-09
SP	*NSFR*	-4.513	2009-05	-4.708	2009-05
	DNSFR	-4.164	2009-05	-4.056	2007-09
	CREDIT	-2.370	2005-08	-3.555	2009-01
FR	*NSFR*	-3.981	2005-11	-4.809	2006-01
	DNSFR	-4.415	2008-08	-5.399**	2008-10
	CREDIT	-5.165**	2010-09	-5.297**	2009-06
IT	*NSFR*	-4.000	2010-08	-4.045	2006-03
	DNSFR	-3.351	2007-09	-3.614	2007-09
	CREDIT	-3.147	2010-06	-6.108***	2008-11
PT	*NSFR*	-5.326**	2004-12	-5.755***	2004-12
	DNSFR	-3.996	2008-10	-3.875	2008-10
	CREDIT	-3.137	2007-04	-3.380	2008-04
FI	*NSFR*	-3.338	2010-12	-3.599	2008-10
	DNSFR	-3.724	2008-10	-4.308	2008-10
	CREDIT	-4.021	2007-12	-4.597	2009-06
NL	*NSFR*	-4.709	2006-10	-4.708	2006-10
	DNSFR	-5.809**	2006-10	-6.636***	2006-10
	CREDIT	-4.723	2007-01	-4.452	2007-01
AT	*NSFR*	-3.684	2005-09	-7.417***	2005-09
	DNSFR	-4.637	2006-06	-4.818	2006-06
	CREDIT	-2.697	2007-10	-3.614	2007-10
LU	*NSFR*	-2.757	2004-06	-3.432	2006-01
	DNSFR	-3.504	2005-07	-4.364	2007-02
	CREDIT	-6.273***	2006-09	-7.623***	2006-09

Note: The table reports the *t*-test statistics for model A and model C according to equations (F.2) and (F.3), respectively. The null hypothesis is that the time series has a unit root without a structural break; the alternative hypothesis suggests that there is a trend stationary series with a structural break. Critical values for model A (model C) are equal to -5.43 (-5.57) and -4.80 (-5.08) at 0.01 and 0.05 significant levels, respectively. The symbols *** and ** denote statistical significance at 0.01 and 0.05 levels, respectively.

Appendix I. Chow tests results for equation (16)

	NSFR and *CREDIT*		*DSFR* and *CREDIT*	
	Without trends	**With trends**	**Without trends**	**With trends**
BE	-1.13 [0.26]	-1.29 [0.20]	-2.79 [0.006]	-2.81 [0.006]
GE	-1.56 [0.12]	-1.65 [0.10]	-1.52 [0.13]	-3.01 [0.003]
IR	4.66 [0.00]	4.01 [0.00]	0.70 [0.48]	-0.72 [0.46]
GR	1.49 [0.13]	1.13 [0.26]	-1.58 [0.11]	-2.39 [0.01]
SP	0.47 [0.63]	1.14 [0.25]	-1.74 [0.08]	-2.38 [0.01]
FR	0.54 [0.58]	0.24 [0.80]	-2.56 [0.01]	-2.58 [0.01]
IT	0.09 [0.92]	0.51 [0.60]	-0.99 [0.32]	-0.93 [0.35]
PT	-0.36 [0.71]	-1.15 [0.25]	-2.60 [0.01]	-3.36 [0.001]
FI	-0.92 [0.35]	-0.78 [0.43]	-2.83 [0.006]	-3.03 [0.003]
NL	-3.91 [0.00]	-3.87 [0.00]	-5.82 [0.00]	-5.07 [0.00]
AT	3.21 [0.002]	3.19 [0.002]	-0.68 [0.49]	-0.69 [0.49]
LU	1.00 [0.32]	0.87 [0.38]	-0.53 [0.59]	-0.44 [0.65]

Note: The table shows the *t*-test statistics; *p*-values are reported in brackets. The *t*-test statistic checks that $\hat{\delta}_6 = 0$ in equation (16). The rejection of the null hypothesis implies that a dummy variable should be included in equation (16).

Appendix J. Statistics for selecting the lag order of equation (16)

		NSFR and *CREDIT*					
		Without trends			With trends		
	r	*AIC*	*SBC*	x^2_{SC}	*AIC*	*SBC*	x^2_{SC}
BE	1	-253.9	-263.4	23.28 [0.02]	-254.2	-265.0	22.33 [0.03]
	2	-254.9	-267.1	23.61 [0.02]	-255.5	-269.1	22.46 [0.03]
	3	-254.4	-269.3	18.76 [0.09]	-254.4	-270.7	17.24 [0.14]
GE	1	-243.3	-252.8	20.06 [0.06]	-243.6	-254.4	21.64 [0.04]
	2	-238.2	-250.3	38.77 [0.00]	-238.2	-251.7	35.55 [0.00]
	3	-231.8	-246.7	32.35 [0.001]	-232.8	-249.0	33.25 [0.001]
IR	1	-183.8	-193.2	11.13 [0.51]	-184.6	-195.5	11.22 [0.50]
	2	-182.1	-194.3	8.54 [0.74]	-182.8	-196.4	8.76 [0.72]
	3	-183.9	-198.8	9.00 [0.70]	-184.6	-200.9	9.08 [0.69]
GR	1	-253.3	-262.8	18.43 [0.10]	-245.0	-255.8	26.88 [0.008]
	2	-254.5	-266.7	12.68 [0.39]	-246.0	-259.5	27.31 [0.007]
	3	-256.1	-271.0	15.99 [0.19]	-247.0	-263.2	29.55 [0.003]
SP	1	-141.8	-151.3	7.48 [0.82]	-141.5	-152.3	7.24 [0.84]
	2	-143.6	-155.8	9.18 [0.68]	-142.9	-156.4	9.01 [0.70]
	3	-145.5	-160.4	17.16 [0.14]	-144.6	-160.8	16.88 [0.15]
FR	1	-209.7	-219.2	17.78 [0.12]	-210.7	-221.5	17.82 [0.12]
	2	-210.4	-222.6	15.45 [0.21]	-211.3	-224.9	15.64 [0.20]
	3	-211.4	-226.3	19.15 [0.08]	-212.2	-228.5	19.52 [0.07]
IT	1	-194.1	-203.6	10.53 [0.56]	-191.8	-202.7	11.07 [0.52]
	2	-194.3	-206.5	12.88 [0.37]	-192.9	-182.9	12.28 [0.42]
	3	-195.7	-210.6	12.97 [0.37]	-194.6	-210.8	13.20 [0.35]
PT	1	-188.3	-197.7	7.61 [0.81]	-187.3	-198.2	10.14 [0.60]
	2	-189.7	-201.9	9.74 [0.63]	-189.0	-202.5	9.33 [0.67]
	3	-191.5	-206.4	11.66 [0.47]	-190.5	-206.8	9.88 [0.62]
FI	1	-271.6	-281.1	17.17 [0.14]	-272.6	-283.5	17.16 [0.14]
	2	-268.7	-280.9	9.63 [0.64]	-269.7	-283.3	9.83 [0.63]
	3	-270.0	-284.9	8.25 [0.76]	-271.0	-287.2	8.79 [0.72]
NL	1	-168.9	-177.6	44.32 [0.00]	-169.1	-179.0	42.58 [0.00]
	2	-169.0	-180.1	44.00 [0.00]	-169.5	-181.8	42.79 [0.00]
	3	-169.8	-183.3	37.54 [0.00]	-170.1	-184.9	34.79 [0.001]
AT	1	-118.5	-126.6	16.12 [0.18]	-119.2	-128.5	14.99 [0.24]
	2	-119.6	-130.1	16.60 [0.16]	-119.9	-131.5	14.00 [0.30]
	3	-119.1	-131.8	16.77 [0.15]	-119.9	-133.8	15.60 [0.21]
LU	1	-174.9	-183.5	19.67 [0.07]	-175.8	-185.6	20.64 [0.05]
	2	-172.4	-183.5	13.22 [0.35]	-173.1	-185.4	12.61 [0.39]
	3	-173.5	-187.0	15.72 [0.20]	-174.3	-189.1	16.93 [0.15]

		DNSFR and *CREDIT*					
		Without trends			With trends		
	r	*AIC*	*SBC*	x^2_{SC}	*AIC*	*SBC*	x^2_{SC}
BE	1	-298.9	-308.4	25.82 [0.01]	-299.4	-310.3	29.44 [0.003]
	2	-298.8	-310.9	24.02 [0.02]	-299	-312.5	28.65 [0.004]
	3	-298.9	-313.8	21.30 [0.04]	-299.6	-315.9	26.10 [0.01]
GE	1	-324.9	-334.3	31.98 [0.001]	-322.4	-333.2	32.80 [0.001]
	2	-323.0	-335.2	21.74 [0.04]	-321.3	-334.8	22.47 [0.03]
	3	-318.7	-333.6	24.00 [0.02]	-317.7	-333.9	19.34 [0.08]
IR	1	-283.9	-293.4	9.92 [0.62]	-283.2	-294.1	10.01 [0.61]
	2	-285.7	-297.9	13.31 [0.34]	-285.1	-298.6	10.24 [0.59]
	3	-286.8	-301.7	17.64 [0.12]	-286.3	-302.5	10.70 [0.55]
GR	1	-295.2	-304.7	15.35 [0.22]	-293.8	-304.7	22.83 [0.02]
	2	-296.8	-309.0	18.97 [0.08]	-294.6	-308.1	21.57 [0.04]
	3	-298.4	-313.3	22.01 [0.03]	-296.1	-312.4	22.19 [0.03]
SP	1	-290.3	-299.8	22.05 [0.03]	-289.9	-300.8	20.62 [0.05]
	2	-291.2	-303.4	34.83 [0.00]	-289.9	-303.4	31.66 [0.002]
	3	-292.9	-307.8	35.32 [0.00]	-291.5	-307.7	31.07 [0.002]
FR	1	-284.8	-294.3	27.18 [0.007]	-285.7	-296.5	29.37 [0.003]
	2	-285.7	-297.9	25.63 [0.01]	-286.6	-300.1	26.84 [0.008]
	3	-287.7	-302.6	28.08 [0.005]	-288.5	-304.8	30.86 [0.002]
IT	1	-298.9	-308.4	30.46 [0.002]	-299.3	-310.2	27.02 [0.008]
	2	-300.1	-312.3	22.76 [0.03]	-300.9	-314.4	26.23 [0.01]
	3	-301.7	-316.6	28.79 [0.004]	-302.3	-318.5	34.72 [0.001]
PT	1	-280.9	-290.4	27.85 [0.006]	-280.3	-291.2	25.31 [0.01]
	2	-281.6	-293.8	31.54 [0.002]	-280.3	-293.9	24.36 [0.01]
	3	-283.5	-298.4	31.44 [0.002]	-282	-298.2	24.47 [0.01]
FI	1	-296.4	-305.9	27.57 [0.006]	-297.1	-307.9	28.56 [0.005]
	2	-297.2	-309.4	23.15 [0.02]	-297.5	-311	23.70 [0.02]
	3	-296.9	-311.8	15.56 [0.21]	-297.4	-313.6	16.60 [0.16]
NL	1	-207.8	-216.4	18.61 [0.09]	-208.2	-218.1	20.74 [0.05]
	2	-208.4	-219.5	19.01 [0.08]	-208.9	-221.3	20.18 [0.06]
	3	-208.7	-222.2	28.84 [0.004]	-209.6	-224.3	28.67 [0.004]
AT	1	-225.7	-233.9	12.43 [0.41]	-226.7	-236	15.07 [0.23]
	2	-227.1	-237.6	18.70 [0.09]	-228.1	-239.7	20.11 [0.06]
	3	-226.6	-239.3	17.36 [0.13]	-227.5	-241.4	19.07 [0.08]
LU	1	-265.7	-274.4	10.10 [0.60]	-266.7	-276.6	10.14 [0.60]
	2	-266.2	-277.3	13.84 [0.31]	-267.2	-279.5	13.99 [0.30]
	3	-265.4	-278.9	20.72 [0.05]	-266.1	-280.9	20.36 [0.06]

Note: *r* is the lag order for the error correction model in equation (16); AIC and SBC denote Akaike's and Schwarz's Bayesian Information Criteria, respectively; x^2_{SC} is the chi-squared statistics to test for the null hypothesis of no serial correlation. The criterion to choose *r* is the minimisation of the AIC and SBC Bayesian Information Criteria as well as the existence of no autocorrelation. *p*-values are reported in brackets.

6. Extending Minsky’s financial taxonomy to the government sector: An application to Greece

6.1 Introduction

One of the defining features of Minsky’s theoretical framework is his well-known classification of economic units into various regimes (hedge, speculative and Ponzi) according to their financial position. Minsky’s financial taxonomy is a useful tool for the assessment of economic units’ degree of financial fragility and thereby for the evaluation of the financial fragility of the whole macroeconomic system. It is also at the core of his ‘financial instability hypothesis’ in which he explains how economic units can gradually shift from hedge finance regimes to speculative and Ponzi ones.

Minsky’s financial taxonomy has been basically applied to the private sector and, in particular, to the non-financial firms. This is the case in Minsky’s original texts (see e.g. Minsky, 1975, 1982, 2008) as well as in more recent theoretical and empirical contributions (see, *inter alia*, Foley, 2003; Lima and Meirelles, 2007; Chalres, 2008; Arza and Español, 2008; Mulligan, 2013). However, his classification could also be employed for the analysis of the government sector’s financial fragility. Although Minsky has in some cases used his financial taxonomy when he describes the financial structure of the government sector (see e.g. Minsky, 1982, pp. 32-33; 1992A, p. 28), the analysis of the financial fragility of the government is limited in his writings. The main reason for this is that his argumentation has largely concentrated on sovereign countries in which the government sector appears to be a potential source of financial stability. He has not explicitly considered the case of non-sovereign countries in which the government sector might be a potential source of financial instability.

Lemmen and Goodhart (1999), Sawyer (2001), Bell (2003), Wray (2003), Sardoni and Wray (2006) and Kelton and Wray (2009) have pointed out that the financial posture of the government sector of non-sovereign countries matters, because these countries cannot finance their expenditures and debt obligations by issuing their own currency. They have also argued that within the current institutional structure of the Eurozone the non-sovereign government spending depends on the perceived credit risk of government bonds in the financial markets. If this risk is conceived to be high, then the financing of government expenditures and debt commitments can be disrupted.[1] Moreover, the institutional framework of the European Central Bank (ECB) which does not authorise the latter to function as 'lender of last resort' to the government sector of the Eurozone countries is the major reason that the sovereign bonds of these countries face default risk.[2] As long as the ECB does not guarantee the non-default of the euro states, the debt-financing of the government deficits is susceptible to financial perceptions, the judgments of credit rating agencies and the speculation of investors, especially when these deficits are higher than the percentage defined by the Maastricht Treaty.[3] Consequently, the financial posture of the national government sectors in the Eurozone has become of paramount importance for the analysis and evaluation of economies' financial stability and possibility of default. As the recent sovereign debt crisis has indicated, a government sector with increasing financing needs is susceptible to potential changes in financial perceptions. The latter may lead to its incapability to borrow, with devastating effects on the implementation of fiscal policy as well as on the financial and macroeconomic stability. Therefore, the application of Minsky's financial taxonomy to the government sector of non-sovereign countries, like the Eurozone ones, can provide some useful insights into the financial fragility of these economies.

[1] The financial posture of the government sector can also be important in the case of sovereign countries, in as far as the fiscal balance affects the external balance. In particular, under fixed exchange rate regimes, fiscal deficits are likely to cause an undesirable reduction in international reserves (see Wray, 2006). Under flexible exchange rate regimes, fiscal deficits can lead to domestic exchange rate depreciation, with potential detrimental effects on inflation and the ability of a country to meet its financial commitments denominated in foreign currency. Furthermore, in both regimes fiscal deficits may have adverse effects on the interest rates. However, in non-sovereign countries the risks stemming from a financially fragile government sector are, arguably, more significant and straightforward.

[2] Of course, even if the ECB was authorised to operate as 'lender of last resort', this would not eliminate all risks of partial default for bond holders. In particular, both the exchange rate risk and the inflation risk would still exist. However, the main source of default risk would not be present.

[3] On 6 September 2012, the ECB announced its Outright Monetary Transactions (OMT) programme. Through this programme the ECB committed to set a floor to the price of government bonds by making unlimited purchases in the secondary sovereign market. The OMT framework has substantially promoted ECB's role as 'lender of last resort' to national governments. However, it has not arguably rendered the ECB a full 'lender of last resort' to the public sector basically for two main reasons. First, the ECB continues to be prohibited to intervene in the primary bonds market. Second, a necessary condition for a country to qualify for bond purchases by the ECB is to have previously committed to some kind of austerity programme. The latter implies that the ECB supports the fiscal policies of Eurozone national governments only when it approves them.

In this chapter we put forward a liquidity index that applies Minsky's financial taxonomy to a non-sovereign government sector and we estimate this index for Greece. Our index extends and improves the index developed by Ferrari-Filho *et al*. (2010) along various lines. The chapter is organised as follows. In section 6.2, we develop a liquidity index that enables us to measure the financial fragility of a government that has relinquished its monetary independence. In section 6.3, we apply the liquidity index to the Greek government sector over the period 2001-2009. Section 6.4 concludes.

6.2 Applying Minsky's financial taxonomy to a non-sovereign government sector

The constructed liquidity index relies on the relationship between the cash inflows and the cash outflows of the government. The cash inflows refer only to the revenues from the main operations of the government. Thus, they do not include inflows from liquid financial assets or from the sale of less liquid financial assets. The cash outflows comprise government primary expenditures and debt commitments (interest and principal repayment). Utilising the relationship between these cash flows, we make a distinction between four finance regimes.

The first finance regime is the hedge one, in which government is capable of covering all its debt commitments from its primary surplus. Algebraically, it holds that:

$$TR - TE \geq INT + AMORT \qquad (1)$$

where *TR* denotes the total government revenues, *TE* stands for the total government primary expenditures, *AMORT* symbolises the amortisation of debt and *INT* denotes the interest payments. The hedge finance regime reflects the case in which there is sufficient liquidity to ensure the repayment of the debt obligations without new borrowing.

The second case is that of a speculative government, which can repay its interest without resorting to new borrowing. However, its primary surplus is not enough to cover the principal repayment. The speculative finance regime is characterised by the following relationship:

$$INT \leq TR - TE < INT + AMORT \tag{2}$$

Government's finance regime is Ponzi when the primary surplus is not enough to cover its interest payments. The relationship between the cash flows of a Ponzi finance regime is expressed as:

$$0 \leq TR - TE < INT \tag{3}$$

Finally, when the government sector exhibits an ultra-Ponzi finance regime, it runs a primary deficit. This implies that a part of government's primary expenditures cannot be covered without new borrowing. The margins of safety are, therefore, at their lowest level. Algebraically, it holds that:

$$TR - TE < 0 \tag{4}$$

Several important points are in order. First, each of the above-mentioned finance regimes generates certain dynamics in the government's debt and financial commitments. In particular, if the government's finance regime is characterised as Ponzi or ultra-Ponzi, the net debt increases (assuming no changes in asset prices and exchange rates).[4] Since a higher net debt implies more debt commitments and less financial assets in the future, the more a government remains in the Ponzi or ultra-Ponzi regime, the more difficult it is to improve its liquidity position. This may give rise to problems of debt sustainability, insolvency and loss of credibility. On the contrary, if the government is hedge or speculative its net debt declines. Thus, the risks of illiquidity and insolvency are lower.

[4] The net debt is defined here as the difference between the market value of financial liabilities and the market value of financial assets. The gross debt does not necessarily rise in the case of Ponzi or ultra-Ponzi finance, as the government may, for instance, sell some financial assets in order to reduce its gross debt. Similarly, the gross debt does not necessarily decline in the case of hedge or speculative finance as the government may decide to purchase a significant amount of financial assets, offsetting the favourable effects of fiscal surplus on gross debt. For a detailed analysis of the relationship between gross debt, net debt and fiscal balance see Milesi-Ferretti and Moriyama (2006) and Hartwig Lojsch *et al*. (2011).

However, it should be remarked that the link between the finance regimes and the gross debt-to-GDP dynamics is not straightforward. The government sector may be for many years in the ultra-Ponzi regime without seeing an explosion in its debt-to-GDP ratio. This is more likely to be the case when government expenditures have a significant growth-enhancing effect and the real (after-tax) lending interest rate is low relative to the real growth rate of the economy. On the other hand, the government sector may run a primary surplus that proves insufficient to prevent a rise in its debt-to-GDP ratio due to the existence of a much higher real (after-tax) lending interest rate than the real growth rate of the economy.

Second, the ability of a government to attain and sustain a sufficiently large budget surplus depends on various macroeconomic factors, which may not be directly controlled by itself. According to the 'financial balances approach' (Wray, 2006, 2012; Godley *et al*., 2007; Kregel, 2011; Sawyer, 2011; Semieniuk *et al*., 2011; Zezza, 2012), the financial position of the government is, by definition, a function of the balances of the private and the foreign sector of the economy.[5] The fiscal balance can improve only if there is a deterioration in the balance of the private sector and/or in the balance of the foreign sector. Thus, a rise in private sector expenditures and/or a rise in exports can improve, everything else given, the fiscal balance without any change in the behaviour of fiscal authorities. On the contrary, cuts in government expenditures may not be effective in reducing a fiscal deficit to a target level if the expenditures of the private and the foreign sector do not increase enough to counter the contractionary effects of these cuts. In this case, the output is adversely affected and the automatic stabilisers may prevent the attainment of the intended balance. Similarly, a rise in tax rates may have, under certain circumstances, important detrimental effects on output and tax evasion, leading to lower rather than to higher tax revenues.[6]

Furthermore, the sustainability of the private sector's financial position is of paramount importance. Since government has a prominent role to play in stabilising

[5] See also Minsky's (2008, ch. 2) analysis for the budget effects of the 'Big Government'.
[6] See, for instance, the theoretical and the empirical literature on the Laffer curve (e.g. Fullerton, 1982; Matthews, 2003; Heijman and van Ophem, 2005).

the macroeconomy, a highly fragile private sector increases the possibility of unexpected government interventions (e.g. bank bailouts) which can substantially deteriorate the financial posture of the public sector. Moreover, if the tax revenues from various Ponzi activities of the private sector are significant, the financial position of the government sector can rapidly deteriorate as a result of financial or other shocks that dampen these activities.

Third, Ponzi and ultra-Ponzi governments might need to take further initiatives to create the liquidity that restores their solvency and credibility. For instance, if there are credit constraints, then the sustainability of a Ponzi, and especially, of an ultra-Ponzi government sector might require debt restructuring, as a complement to adequate macroeconomic and fiscal policies.[7] Without debt restructuring, the restoration of a viable financial structure might not be possible. Besides, without debt restructuring money managers are likely to speculate on the default of Ponzi or ultra-Ponzi governments, triggering higher interest rates.

Employing the classification among the four finance regimes, the following liquidity index (*LI*) is constructed and proposed:

$$LI = \begin{cases} \dfrac{TR - TE - INT}{AMORT}, & \text{if} \quad TR - TE \geq INT \\[2ex] \dfrac{TR}{TE + INT + AMORT} - 1, & \text{if} \quad 0 \leq TR - TE < INT \\[2ex] \dfrac{TR}{TE + INT + AMORT} - 2, & \text{if} \quad TR - TE < 0 \end{cases} \qquad (5)$$

The financial fragility of the government increases as the liquidity index becomes lower. The government is: (i) hedge when the index is higher than *1*; (ii) speculative

[7] See also Ferrari-Filho *et al*. (2010).

when the index takes values between *0* and *1*; (iii) Ponzi when the index lies between *-1* and *0*; and (iv) ultra-Ponzi when the index takes values between *-2* and *-1*.[8]

Our proposed liquidity index improves and extends the index suggested by Ferrari-Filho *et al*. (2010) along the following lines.[9] First, in the index proposed by Ferrari-Filho *et al*. (2010), when $TR - TE < 0$, the financial fragility of the government turns out to increase as the sum of interest and amortisation $(INT + AMORT)$ becomes smaller. This seems counterintuitive since an increase in debt commitments of the government decreases, *ceteris paribus*, its liquidity. On the contrary, when our index takes negative values, it becomes more negative as the debt commitments increase. Second, and more importantly, when the primary budget surplus does not cover the sum of interest and amortisation, the index proposed by Ferrari-Filho *et al*. (2010) does not distinguish between a regime in which the government can cover its interest payments and a regime in which the government needs new debt to repay its interest. In our index, when the primary budget surplus does not cover the debt commitments, there are two cases: first, the case in which the index takes values between *0* and *1* which implies that the government can cover its interest payments (speculative government), and, second, the case in which the index takes values between *-1* and *0* which implies that the government cannot cover its interest payments (Ponzi government).

It should be pointed out that the government's liquidity index provides accurate information only about the past and the present situation of the government's financial structure. The estimation of the future values of the liquidity index requires projections over the government's primary balance and debt commitments. Both variables are dynamic and depend on prior knowledge about many other monetary, fiscal and macroeconomic variables.

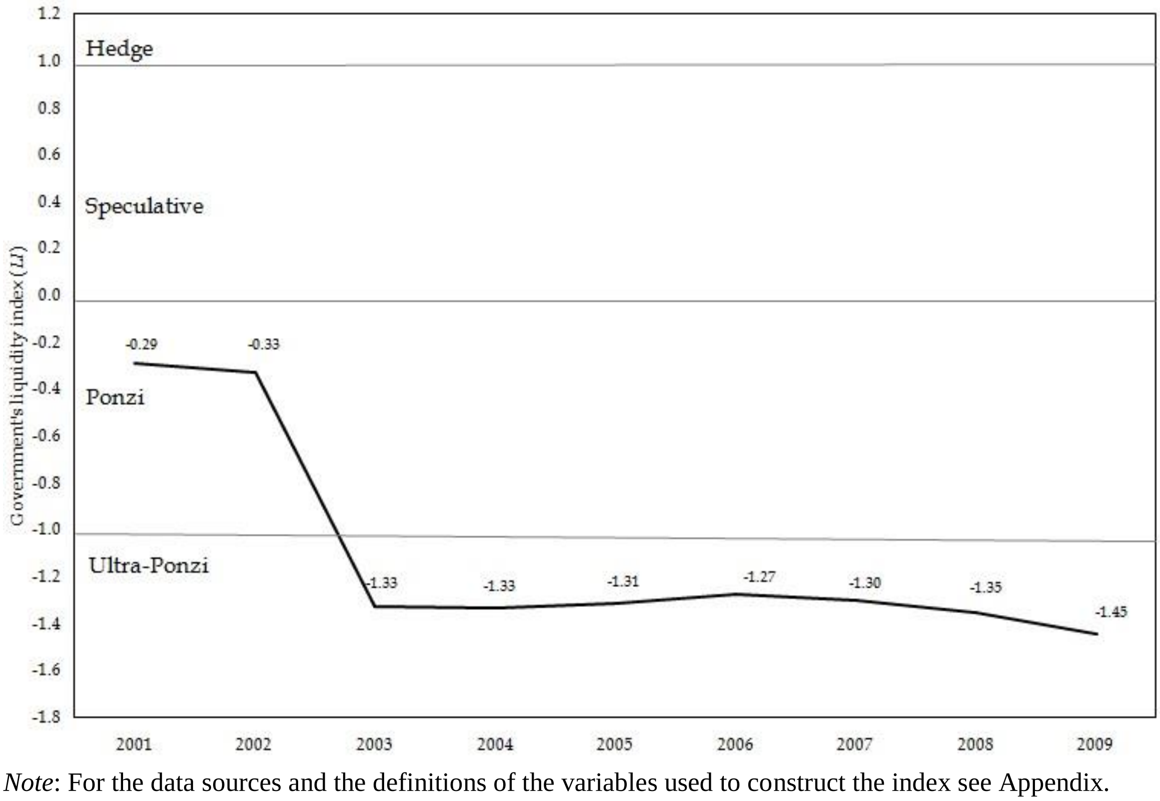
[8] Note that the mathematical formula used in the cases of hedge and speculative finance is the same. Moreover, the mathematical formula is almost identical in the cases of the Ponzi and the ultra-Ponzi finance: the only difference is that in the case of the ultra-Ponzi regime, *-1* has been added to penalise for the existence of a primary deficit. In this way it is ensured that the index for a government that runs a primary deficit always lies between *-2* and *-1*. This enables a clear distinction between a Ponzi and an ultra-Ponzi regime.

[9] In Ferrari-Filho *et al*. (2010) when the index is higher than one, the government sector is hedge: total revenues are larger than the sum of total primary expenditures, interest and amortisation. If the index lies between zero and one, the government sector is speculative: the primary budget surplus is unable to cover the sum of interest and amortisation. If the index is negative, the government sector is Ponzi: the public sector runs a primary budget deficit.

6.3 The application of the liquidity index to Greece

Figure 1 displays the liquidity index for the Greek government sector over the period 2001-2009. This corresponds to the period after the entrance of Greece in the European Monetary Union (EMU) and before the onset of the sovereign debt crisis. We observe that the Greek government sector was in the Ponzi finance regime in the years 2001 and 2002 while it shifted to the ultra-Ponzi regime in 2003. We also observe that the index deteriorated significantly over the time span 2006-2009. It is noteworthy that the ratio of total government revenues to the sum of government primary expenditures, interest and amortisation in percent decline from 72.8% in 2006 to 55.2% in 2009.

Fig. 1. Government's liquidity index (*LI*), Greece, 2001–2009



Note: For the data sources and the definitions of the variables used to construct the index see Appendix.

Using as a basis the data presented in Table 1, it can be argued that the main driving forces behind this evolution of the index were (i) the gradual deterioration of the primary fiscal balance and (ii) the rise of the amortisation payments in the period 2007-2009. In particular, the primary fiscal balance decreased from 2% in 2001 to

-10% in 2009. While the government revenues in percent of GDP declined over the period under examination, the primary government expenditures increased substantially. The rise in the primary expenditures was basically due to the increase in the intermediate consumption, the compensation of employees and the social benefits. It should, however, be highlighted that in 2001 the government primary expenditures were in percent of GDP much lower than in the average in the Eurozone. Therefore, the rise in government expenditures after 2001 can be interpreted as a process of convergence to the Eurozone average. The problem, hence, was not the rise in government expenditures *per se*. It was that this increase in expenditures was not accompanied by a corresponding rise in government revenues. Note also that the important deterioration of the fiscal balance in 2008-2009 partly occurred due to the recession of the economy and the resulting impact of the automatic stabilisers.[10]

Regarding the amortisation payments, their rise in the period 2007-2009 is associated with the accumulation of a significant amount of long-term debt that started just before the entrance of Greece in the EMU. The easy access that the Greek government attained to the global bond markets enabled it to substitute long-term debt for short-term one. This substitution caused a fall in the amortisation payments in the early 2000s. However, after 2007 a significant amount of long-term debt needed to be refinanced, causing a rise in principal repayments. Note that the interest payments of the Greek government sector remained low over the period under examination basically because of the low lending interest rates due to Greece's participation in the EMU.

Due to the ultra-Ponzi finance regime of the Greek government, its debt in absolute terms increased substantially over the period 2003-2009 and so did the need for debt refinancing. The surge in debt did not initially lead to a much higher debt-to-GDP ratio since the growth rate of the economy remained till 2007 higher than the real interest rate (see Table 1).[11] However, when the economy slipped into a recession in 2008, the real growth rate became lower than the real interest rate leading to a significant rise in the government debt-to-GDP ratio in 2009. This rise was enhanced by the substantial increase in the budget deficit in the period 2008-2009. The increase

[10] See Papadimitriou *et al*. (2010).

[11] In Table 1 the real pre-tax interest rate has been used instead of the real after-tax interest rate due to the absence of available data for the tax rate on interest payments.

in the debt-to-GDP ratio combined with the increasing financing needs rendered the Greek government sector extremely vulnerable to the expectations of the sovereign bond holders and the speculation in the global financial markets.

Table 1. *Fiscal variables, Greece, in million euros unless otherwise stated, 2001-2009*

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total general government revenue in percent (%) of GDP	**40.9**	**40.3**	**39.0**	**38.1**	**39.0**	**39.2**	**40.7**	**40.7**	**38.4**
Market output, output for own final use and payments for other non-market output	1,910	2,049	2,562	2,888	3,077	3,810	5,014	5,491	5,536
Other subsidies on production, receivable	0	0	0	0	0	0	0	0	2
Taxes on production and imports, receivable	19,519	20,159	20,756	21,637	22,753	25,948	28,425	28,985	26,153
Property income, receivable	2,339	2,223	1,964	1,810	1,633	1,839	2,442	2,420	1,806
Current taxes on income, wealth, etc., receivable	12,528	13,415	13,498	14,825	16,589	16,975	18,219	18,714	19,146
Social contributions, receivable	18,397	21,310	23,722	24,671	26,104	25,942	28,962	30,749	29,457
Other current transfers, receivable	3,091	1,965	1,839	1,662	1,984	2,176	2,131	3,252	3,291
Capital transfers, receivable	2,145	1,920	2,949	3,090	3,079	5,154	5,721	5,236	3,237
Total government primary expenditures in percent (%) of GDP	**38.9**	**39.5**	**39.7**	**40.6**	**39.9**	**40.6**	**42.7**	**45.5**	**48.8**
Intermediate consumption	9,063	10,236	10,388	10,156	10,885	12,387	15,025	15,053	17,125
Compensation of employees, payable	15,180	17,308	18,641	21,345	22,384	23,334	25,464	28,000	31,020
Subsidies, payable	195	205	238	240	257	277	144	70	123
Social benefits	22,499	24,184	27,332	28,873	31,814	35,634	39,942	45,753	48,981
Capital transfers, payable	3,691	2,816	3,305	4,493	2,718	2,453	3,246	4,255	4,363
Gross capital formation	5,227	5,261	5,961	6,518	5,479	7,116	7,528	8,606	7,260
Acquisitions less disposals of non-financial non-produced assets	-436	307	299	302	233	198	342	351	359
Other current expenditure	1,556	1,563	2,393	3,421	3,321	3,239	3,628	3,969	3,587
Interest payments, in percent (%) of GDP	**6.5**	**5.6**	**5.0**	**5.0**	**4.5**	**4.4**	**4.5**	**5.0**	**5.2**
Amortisation, in percent (%) of GDP	**12.2**	**14.9**	**13.6**	**11.6**	**12.3**	**8.9**	**11.0**	**12.1**	**15.5**
Real pre-tax interest rate, in percent (%)	**2.1**	**1.7**	**0.3**	**1.3**	**0.8**	**1.6**	**1.1**	**0.1**	**2.8**
Real growth rate, in percent (%)	**4.2**	**3.4**	**5.9**	**4.4**	**2.3**	**5.5**	**3.5**	**-0.2**	**-3.1**
Government debt to GDP ratio, in percent (%)	**104.7**	**102.6**	**98.3**	**99.8**	**101.2**	**107.5**	**107.2**	**112.9**	**129.7**

Note: For the data sources of the variables see Appendix.

6.4 Conclusion

In this chapter, a liquidity index has been developed that applies Minsky's well-known financial taxonomy to the government sector. This index has been estimated for the Greek government sector over the period 2001-2009. It has been shown that the Greek government sector was Ponzi in the years 2001-2002 and ultra-Ponzi thereafter. Moreover, the proposed index deteriorated substantially since 2006 revealing the growing fragility of the public sector in the years before the onset of the sovereign debt crisis. This deterioration of the index is among the factors that contributed to the financial instability that the Greek economy has been experiencing over the last years.

Appendix Definitions and data sources

Variable/ Index	Definition	Data source
Total government revenues (*TR*)	Sales of market output and output- for own final use + payments for other non-market output + other subsidies on production, receivable + taxes on production and imports, receivable + property income, receivable + current taxes on income and wealth, receivable + social contributions, receivable + other current transfers, receivable + capital transfers, receivable.[1] The data refer to the general government.[2]	AMECO database (code: URTG)
Total primary government expenditures (*TE*)	Intermediate consumption + gross capital formation + compensation of employees, payable + other taxes on production, payable + subsidies, payable + property income, payable + current taxes on income and wealth, payable + social benefits other than social transfers in kind, payable + social transfers in kind related to expenditure on products supplied to households via market producers, payable + other current transfers, payable + adjustment for the change in the net equity of households on pension funds reserves + capital transfers, payable + acquisitions of non-produced non-financial assets.[1] The data refer to the general government.[2]	AMECO database (code: UUTGI)
Interest payments (*INT*)	Interest paid by the general government[2] (EDP).	AMECO database (code: UYIGE)
Amortisation (*AMORT*)	Amortisation of the medium- and long-term debt of the central government and social security funds + short-term debt of the central government at the end of the previous period.[3]	Hellenic Republic Ministry of Finance and Bank of Greece
Gross domestic product (*GDP*)	Gross domestic product at current market prices.	AMECO database (code: UVGD)
Real interest rate	The real long-term interest rate (based on the GDP deflator), in percent (%). The data refer to the central government.	AMECO database (code: ILRV)
Real growth rate	The growth rate of gross domestic product at constant (2005) market prices, in percent (%).	AMECO database (code: OVGD)
Government debt-to-GDP ratio	The gross general government[2] debt (EDP), in percent (%) of GDP.	AMECO database (code: UDGGL)

Notes:
1/ For a description of these variables see AMECO (2005).
2/ The general government in Greece comprises the central government, the social security funds and the local government.
3/ There are no available data for the amortisation payments of the local government.

7. Conclusion

The purpose of this thesis was to provide some new theoretical and empirical insights into the issues of financial fragility and instability of the macroeconomic systems. The thesis paid attention and explored various aspects of the financial fragility of both the private and the public sector of the economy. In the private sector, the analysis covered the fragility of households, firms and banks, while in specific cases emphasis was also given to the investigation of the interaction of the financial structures of these sectors. A number of factors that can contribute to the financial fragility and instability of the economy were investigated in an innovative way. These, *inter alia*, included endogenous changes in the euphoria of economic units, wage stagnation and financial innovation. Furthermore, various links between financial fragility and fiscal policy were scrutinised, while emphasis was also placed on specific aspects of bank regulation policy concerning its role in preventing financial fragility.

The main findings of the thesis can be summarised as follows. According to the theoretical macrodynamic model developed in chapter 3, the endogenous change in the desired margins of safety of firms and banks plays a critical role in the emergence of investment cycles and instability. The mathematical and simulation analysis indicated that higher sensitivivity of the firms' and banks' desired margins of safety to the investment cycle makes the system more prone to instability. They also illustrated that the endogeneity of the margins of safety can produce, under certain conditions, investment and leverage cycles during which investment and leverage move both in the same and in the opposite direction. An important finding is that the implementation of fiscal expansion (contraction) during periods in which the the derired margins of safety are excessively high (low) relative to the actual ones can be conducive to stability.

The stock-flow consistent model developed in chapter 4 illustrated the potential destabilising effects of securitisation practices. It was shown how securitisation can be conducive to a borrowing-induced expansion, a housing boom and an appreciation in MBSs prices that are of temporary nature. It was also indicated that the adverse effects of securitisation on financial fragility can be substantial reinforced by wage stagnation. The latter is likely to influence financial fragility by inducing households to get more credit in order to attain some specific living standards, by strengthening financial speculation due to the redistribution of wealth towards investor households and by reducing the income of indebted households. According to our simulation experiments, the joint rise in securitisation and wage stagnation is likely to increase financial fragility in the short run and lead to financial instability in the long run.

Chapter 5 highlighted the need for a dynamic definition of liquidity in the regulatory framework of banks. By constructing an index that allows for a time-varying definition of bank balance sheet items' liquidity and stability and applying this index to the EMU countries it was shown that the actual liquidity problems of banks can more successfully captured by this index rather than by the static index proposed by Basel III. Furthermore, the econometric evidence presented in this chapter illustrated that in most EMU countries bank liquidity is not positively related with macroeconomic fragility. This implies that the banking sector in the EMU does not broadly self-impose fragility-related requirements. Based on this evidence, it was argued that the regulatory agents should introduce a positive link between bank liquidity and macroeconomic fragility.

Chapter 6 pinpointed the importance of the financial fragility of the public sector in countries that are not currency-issuers (like the EMU ones). Using Minsky's well-known financial taxonomy of economic units, it developed a liquidity index that can be used as a measure of the government sector's financial fragility. The estimation of this index for Greece over the period 2001-2009 illustrated that the Greek government was Ponzi in 2001-2002 and ultra-Ponzi in 2003-2009. Moreover, the data analysis indicated that the proposed index deteriorated substantially since 2006 revealing the growing fragility of the public sector in the years before the onset of the sovereign debt crisis. It was argued that this deterioration of the index was among the factors that contributed to the financial instability that the Greek economy has been experiencing over the last years.

The essays of this thesis covered only some certain issues which are at the heart of the current research on financial fragility and instability of the macroeconomic systems. Clearly, there are many other important topics in this field that have not been deeply explored both in the current thesis and in the related literature and is essential, therefore, to be the subject of future research. Some of them are the following.

First, a more thorough understanding of the functions and the effects of the shadow banking system is essential. Although in this thesis some specific macroeconomic implications of securitisation were explored at a theoretical level, many other aspects of the shadow banking system, which are likely to have important effects on financial fragility and instability, have not yet been adequately studied theoretically and empirically. Some important issues include (i) the factors that determine the liquidity and the leverage of the financial vehicles corporations, money market funds, hedge funds and other shadow banking institutions, (ii) the various interlinkages within the shadow banking sector and between the shadow and the regulated financial institutions and (iii) the links between inequality, household wealth and hedge funds. Lysandrou (2011-2), Adrian and Ashcraft (2012B), Bakk-Simon *et al*. (2012), Godfrey and Golden (2012) and Pozsar *et al*. (2012) have provided some initial useful insights into these issues.

Second, the open economy aspects of financial fragility need further investigation. International capital flows have in the past played a critical role in the boost of domestic credit growth and the development of unsustainable financial structures. Although this role has quite often been the subject of economic research, the recent events, most notably the rise in global imbalances, the tremendous development of the shadow banking sector, the rise in wealth and income inequality and the new geopolitical structures require a fresh look into this issue. This new look is essential to shed light not only on the factors that explain international capital flows but also on the conditions under which these flows can lead to the financial fragility of the domestic economies. Some interesting recent works towards this direction include Acharya and Schnabl (2010), Borio and Disyatat (2011) and Lane and McQuade (2013). It is also important to note that the open economy aspects of financial fragility have only scarcely been the subject of theoretical macroeconomic models.

Third, further research is necessary in the field of banking regulation. The proper regulation of the financial system is of paramount importance for the stability of the macroeconomic systems in the future but remains a quite complex issue with many unexplored dimensions. Some topics that should be investigated in greater detail include the macroeconomic effects of the various regulatory rules, the links between the financial cycle and the fragility of banks, the impact of the regulation rules on the incentives and the behaviour of banks, as well as the ways through which the shadow banking sector can be regulated effectively. For a discussion of these topics see, for instance, Blundell-Wignall and Atkinson (2010), Kregel (2010), Shin (2010), Bank of England (2011), Wray (2011), Arnold *et al*. (2012) and Adrian and Ashcraft (2012A).

The investigation of the above and other issues on the field of financial fragility and instability can significantly contribute to a more thorough understanding of the factors that lie behind the emergence of fragility and instability in modern macroeconomies. This understanding is crucial for the proper design of policies that can lead to more sustainable economies and prevent the adverse consequences that stem from major economic crises.

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