A Stock-flow Consistent Model of Financialisation and Shadow Banking:

Financial Fragility in a Modern Capitalist Economy

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Abstract

Large and complex financial markets have been an increasing source of concern in regard to sustainable long-term growth and financial stability. The aim of our research is to systematically explore this topic by constructing a novel macroeconomic model which incorporates the endogenous dynamics of the creation, valuation and distribution of financial assets and their repercussions on the real economy. Our model includes complex financial markets and a large shadow banking sector, which enables us to simultaneously address issues concerning economic growth, asset price inflation, pro-cyclical leverage effects, and financial fragility. These phenomena lead to business cycles induced by financial markets, which we label 'Kindleberger cycles'.

Keywords: Macroeconomic model, stock-flow consistent, sustainable growth, financial cycles, financial fragility, financial regulation, boundary problem.

JEL Classification Numbers: E12, E17, E32, E44, E61, E63.

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1 Introduction

Developments in the financial sector have been increasingly held responsible for sluggish economic growth in industrial countries, and for creating financial fragility. Empirical evidence suggests that asset price dynamics on financial markets are characterised by a sequence of overappreciation (bubble, bull market) and overdepreciation (bear market after a bubble bursts), hence by "long swings", "boom-bust cycles", or "financial cycles". This phenomenon is most probably related to overtrading in the financial system and, more generally, to an oversized and overcomplex financial sector. Recent economic history demonstrated that the impact of revaluation and devaluation of financial wealth on the real economy is enormous.

In a recent paper, the OECD stated that over-sized and complex financial markets, which are not subject to macro-prudential regulation, can slow down economic growth (Cournède et al., 2015). Furthermore, in its latest financial stability review (ECB, 2015), the European Central Bank found that a growing shadow banking sector, the price increase of financial assets and a rising sensitivity of these asset prices to changes in market sentiments significantly account for potential fragility in the European financial system. To a large part, recent asset price bubbles were caused by over-extended lending, see Khalil and Kinsella (2015), often for speculative activity on financial and real estate markets. Financial innovations such as securitisation enabled speculative lending, and increased the return on asset markets and the profitability of financial investment while obscuring risks. Increasing income inequality and unsustainable borrowing in the household sector have exacerbated this problem (Stockhammer, 2015; Kumhof et al., 2015). Simultaneously, financial markets failed to deliver a sufficient amount of productive credit to the real economic sector, see Stockhammer (2004), Werner (2012, 2005). The resulting asset price inflation and positive balance sheet effects have increased the flow of funds into the financial sector due to expected capital gains, inducing a positive feed-back loop within the financial system. Since the financial and economic crisis of 2008/09, debt-repayment and develeraging of households, firms and the financial sector - a 'balance sheet recession' (Koo, 2014) - as well as stagnating real investment continue to weigh on the economy in the Eurozone.

Despite recent developments in the literature and historical evidence of the frequent occurence of financial cycles (see Section 2), most macroeconomic models are not capable of depicting these phenomena. To our knowledge, there has been no attempt to develop a coherent macroeconomic framework which incorporates the relations between the financial sector and the real economy so that it is able to explain financial cycles endogenously, and is at the same time calibrated to empirical data and fit to provide economic policy advice. There exist empirically calibrated or estimated models to depict boom-bust cycles in the DSGE modelling literature, but they face constraints in explaining these cycles endogenously, see Section 2 below. Empirically well-founded models that are comparable to the approach we conceptualize here such as Papadimitriou et al. (2013), Kinsella and Tiou-Tagba Aliti (2012) or Barwell and Burrows (2011), while in principle able to depict balance sheet interactions and financial fragility endogenously,

do not focus on cycles similarly to the model proposed here.

We aim to bridge this gap. The primary objective of our research is to build a macroeconomic model that is capable of analysing recent economic developments and calibrate it to econonomic data for the Eurozone. Especially, we incorporate the endogenous build-up of credit-fuelled asset price bubbles and their effect on the real economy. These credit-fuelled asset price bubbles, which we henceforth define as 'Kindleberger cycles', arise endogenously in the model, primarily due to speculative lending, asset price inflation, pro-cyclical leverage effects and expectations of capital gains. They are at the core of our model mechanics.

Our modelling concept is based on a stock-flow consistent (SFC) framework (Godley and Lavoie, 2007). The specific properties of this approach enable us to coherently incorporate the institutional structure of a complex modern financial sector and the corresponding potential financial instability (Kinsella, 2011; Bezemer, 2010). It allows to explain the build-up of asset price bubbles and to evaluate macro-prudential regulation with respect to their effects on economic growth and the business cycle. Specifically, we include institutional details by explicitly accounting for the balance sheet composition of aggregated macroeconomic agents. These agents are firms, households, banks, the shadow banking sector, the government, and a central bank. The mechanism of the endogenous emergence of Kindleberger cycles features centrally in our model as follows: Banks endogenously create credit, which is used by other agents for investment, consumption, or speculative asset purchases. In the latter case, these funds may result in a rise in asset prices, which gives rise to capital gains and increases the net worth of all agents holding these assets. This in turn enables these agents to extend their liabilities by issuing securities (bonds or equity) or by a take up of new loans, a phenomenon which is known as a pro-cyclical leverage effect (Adrian and Shin, 2010). Banks securitise part of the loans on their balance sheets, inducing more financial assets to be created via the shadow banking system. Furthermore, securitisation reduces the balance sheet size of traditional banks and thus also their leverage, as well as their (direct) exposure to default risk. As a consequence, banks can provide new loans, fuelling the asset price bubble further if part of the loans is used for financial investment. This is likely due to the expectations of capital gains agents in the model have formed after the initial rises in asset prices. When demand for financial assets decreases, asset prices fall, and the balance sheets of agents holding these assets will experience a loss in net worth. Since the financial constraints of all agents are included in the model in a consistent way, this allows us to depict the impact of a burst of an asset-price bubble on overall economic dynamics.

We link these mechanisms to real economic activity via the investment decisions of firms. Firms may undertake investment in real capital or financial assets, depending among other factors on the expected return as in Caverzasi and Godin (2015). The price of real capital corresponds to a market value that is determined by supply-demand interaction (scarcity), e.g. on the housing market, and/or on the expected future returns (investment). Besides being determined by expected returns, the price of a financial asset,

even if constitutes a claim on real capital or any form of collateral, additionally depends on the liquidity and solvency of a counterparty. Therefore, while financial assets may rise in value if expectations of capital gains are high, their price may fall abruptly in case liquidity is tight in the economic system or solvency of a counterparty is in question in an event of crisis. This will also influence the price of real capital once a crisis manifests, but the price swings of financial assets destabilise the economic system and govern its boom-bust dynamics. It is this qualitative difference in price dynamics between financial assets and real capital which is a major focus of our modelling project.

Thus we are able to capture the long-term effects of a growing financial sector on economic growth and financial fragility, distinguishing between growth of the real sector and growth in financial markets. The details of the balance sheets and the relations between the economic sectors are summarised in Section 3.

After calibrating model dynamics to the economic development of the past in a stylized way for this more conceptual paper, we will use it to conduct policy simuations to explore the properties of the model. A special focus will be put on the interaction between policy measures and possible unintentional effects, analysing positive synergies and reinforcement as opposed to joint detrimental effects. Thereby we explicitly address the boundary problem in financial regulation (Goodhart, 2008) by including the complexity of the financial sector in institutional detail. In this context, the boundary problem relates to the often-observed tendency that regulating only part of the financial sector shifts procyclical provision of credit to the still unregulated part of financial markets. Specifically, we can consider potential shifts of credit expansion from the traditional banking sector, which is increasingly subject to macro-prudential regulation, to the less regulated shadow banking sector within our evaluation of policy measures.

2 Literature Overview: Macroeconomic Modelling of Financial Markets and Macro-prudential Regulation

Financial booms and crises are among the most distinct features of the capitalist economy and their frequent historic recurrence is well documented, see Kindleberger and Aliber (2005). The build-up of booms usually contains irrational elements and biased expectations of future profits or price increases, and is thus hard to explain from an analytical perspective. Triggers for sudden financial collapse vary according to the unique coincidences and peculiarities of historic occasions. There are, however, common elements to all financial crisis that can and should be subjected to analytical treatment of suitable economic theory, not at least due to their current relevance in empirics and economic practice.

Keynes (1936) and Minsky (1986, 1982) argue that crises are mainly rooted in extended euphoria on financial markets, financial innovation, and an increasing leverage of financial and non-financial firms. Kindleberger and Aliber (2005) point out the importance of the

creation of non-bank credit used for financial investment and speculation.[1] Furthermore, Werner (2012) distinguishes productive credit, which is used for real investment and leads to GDP growth, and unproductive or speculative credit, which can lead to asset price bubbles. Jorda et al. (2015, 2013) point to the severe and long-term economic impacts of such credit-fuelled asset price bubbles. Likewise, Borio (2014) argues extensively for the presence of boom-bust cycles emanating from financial markets, and proposes that such cycles should explicitly be considered in macroeconomic modelling efforts. Despite the fact of the ample empirical evidence for financial cycles in past and present, explanations for their occurence were scarce in the macroeconomic modelling literature before the economic crisis in 2008/09 and most models are still not up to this task, see e.g. Borio (2014) and Bezemer (2011b).

The changing institutional structure of the financial sector is one of the strongest reasons for the occurence of financial cycles. Growing complexity and fragility of the financial system are both part of longer-term systemic and institutional developments of modern capitalism that have been labeled "financialisation". The most-often cited definition by Epstein (2005) broadly associates financialisation with the "increasing role of financial motives, financial markets, financial actors and financial institutions in the operation of the domestic and international economies." This definition encompasses various phenomena such as increasing shareholder value orientation of non-financial businesses, the increasing importance of institutional investors on financial markets, financial innovation processes and financial deregulation, the rise of the originate-and-distribute model of banking, as well as high and rising incomes in the financial sector, see Onaran et al. (2011) and the sources cited therein. A comprehensive analysis of the phenomen of financialisation can be found in Eatwell and Taylor (2001). Other contributions include Binswanger (2000), Skott and Ryoo (2008), and Krippner (2005), who focuses on the US economy, as well as Stockhammer (2008), who investigates the European case.

In this regard, one possible channel how an overly sized financial sector reduces real economic growth is that increasing returns on financial markets may induce economic actors, especially non-financial firms, to invest in financial assets rather than real capital. Thus, as is argued by Stockhammer (2004) and Orhangazi (2008), demand in the real economy is reduced by financial investment, which in turn reduces real economic growth unless the effect is over-compensated via another economic channel. A comparable distinction between productive and unproductive use of credit can be found in Werner (1997), Werner (2012).

Recent empirical evidence points to the fact that credit-fueled asset price bubbles produce an entirely different crisis phenomenon than bubbles due to "irrational exuberance"[2], Jorda et al. (2015, 2013). The former type of credit-driven bubbles (Kindleberger cycles) causes deeper and longer recessions. This empirical evidence based on long-run histori-

[1] It is the importance of the creation of non-bank credit, today especially within the shadow banking system, which we want to stress by naming the financial cycles central to our model design 'Kindleberger cycles'.

[2] I.e. wrong and implausibly euphoric expectations of agents on financial markets.

cal data for several countries critically supports the relevance of the central mechanism within our model design.

In case a credit-fuelled asset price bubble develops, pro-cyclical leverage effects will exacerbate the situation. Rising value of assets on financial intermediaries' balance sheet will improve their net worth, which is the residual on the liability side of their balance sheet, and thus lower their leverage, see Adrian and Shin (2010). This balance sheet effect will induce financial institutions to further extend credit potentially leading to a continued bidding up of asset prices. Once one of these credit-driven bubbles bursts, it will most likely lead into a balance sheet recession (Koo, 2003), where various economic agents, possibly households, firms, banks, the financial sector, the government and/or the foreign sector try to reduce their liabilities to improve their leverage. This has severe medium to long-term contractive effects on the economy as effective demand decreases, especially if all or many of the agents above try to deleverage at the same time.

Macro-prudential regulation is seen as essential for a financial system that healthily contributes to equitable and strong growth, as is argued by the OECD in Cournède et al. (2015). Along with implementing sufficient capital buffers and restructuring of the financial sector, such regulation would prevent the build-up of credit-fueled asset price bubbles. However, any attempt for macro-prudential policy making by regulating a part, such as the traditional banking system, of a complex financial system is likely run into the boundary problem (Goodhart, 2008; Schoenmaker and Wierts, 2015). Extended credit creation will shift to a still unregulated part of the banking sector such as the shadow banking system. As leverage will follow asset price movements pro-cyclically due to balance sheet effects, any asset price changes are likely to be exacerbated within the financial sector without regulation of the system as a whole, see Schoenmaker and Wierts (2015).

Even though the topic of financial cycles has been picked up in macroeconomic model building, particularly since the recent financial and economic crisis, most models fail to account comprehensively for the complexity and the changing nature of the financial system. Especially attempts to include a systematic explanation and simulation of interaction between the financial and the real economy into a macroeconomic framework are limited, see e.g. Borio (2014) or Bezemer (2011b, 2012).

A certain strand of the dynamic macroeconomic modelling literature has been increasingly concerned with implementing financial markets and their interaction with the real economy in a real business cycle model. Examples are Brunnermaier and Sannikov (2014), Christiano and Ikeda (2013), Kyotaki and Moore (2012), or Gertler and Karadi (2011), among many others. Bauducco et al. (2014) and Christiano et al. (2010) provide recent overviews. The modelling strategy mostly involves including financial frictions in macroeconomic equilibrium models following the New Keynesian Dynamic Stochastic General Equilibrium (DSGE) paradigm, see Borio (2014) and Brunnermeier et al. (2012). By this approach, nominal rigidities augment real business cycle fluctuations that are very often based on exogenous productivity shocks and amplify these business cycles or impediate the return of the model to an equilibrium growth path.

While this approach is well established , it fails to grasp the endogenous features of Kindleberger cycles in several ways. Firstly, credit-fuelled financial cycles are rooted in an expansion of the money supply by the issuance of new debt. In the overwhelming majority of DSGE models, money is treated as a veil. Exceptions are nominal frictions, mostly in price formation or provision of lending, in New Keynesian DSGE models. Any such lending mechanism, however, works entirely by the loanable funds theory, and does not consider banks creating money along with debt[3] - a fact that has become consensus in monetary economics literature or in publications by central banks, often under the label 'endogenous money'.[4] Secondly, the DSGE approach makes the assumption that the model always returns to an equilibrium growth path (steady-state) automatically, unless it is disturbed to do so by exogenous shocks, various frictions or nominal rigidities. Hence DSGE models cannot adequately account for inherently evolving economic dynamics, which is necessary in order to depict endogenous build-ups of bubbles and crashes. Thirdly, this approach also fails to depict the true endogenous interaction between financial markets and the real sector, specifically balance-sheet effects and positive feed-back effects between growth and asset price inflation, see Bezemer (2012, 2011a).

Due to these three reasons, the endogenous rise of credit-fuelled bubbles (Kindleberger cycles) and their potential detrimental effects on the real economy cannot be treated comprehensively in this class of models.

In another recent strand of the literature, numerous endeavours have been made to incorporate problems relating to financialisation building on the stock-flow-consistent macroeconomic originally developed by Backus et al. (1980), Tobin (1969), Tobin (1982), and Godley and Lavoie (2007). These models, based on the SFC paradigm, avoid much of the theoretical challenges the DSGE approach faces when analytically describing financial cycles as argued above. Examples of such models include (albeit not exhaustively) Van Treek (2009), Lavoie (2008), Dos Santos and Macedo e Silva (2009), Le Heron and Mouakil (2008), Le Heron (2011), Skott and Ryoo (2008), Reyes and Mazier (2014), Nikolaidi (2014), Caverzasi and Godin (2015), Bhaduri et al. (2015), Khalil and Kinsella (2015).

These models are mainly theoretical, and are not estimated to actual economies or aim to provide policy options. Financial cycles are generally not considered or focused on, rather the costs of different manifestations and phenomena of financialisation in the long run. The distinction between productive and unproductive credit is usually not made explictly or not related to boom-bust cycles. Furthermore, macro-prudential regulation, government intervention or central bank policy are not accounted for in most of the cases. None of these contributions depicts a complex financial sector including a shadow

[3]The only exceptions of an explicit considereation this fact ('endogenous money') in DSGE models known to the authors are Jakab and Kumhof (2014) and Benes and Kumhof (2012).

[4]The theory of endogenous money has been established for a long time in several strands of economic literature. See among many others McLeay et al. (2014), Keister and McAndrews (2009), Berry et al. (2007), Nichols and Gonczy (1992), Bundesbank (2012), Godley and Lavoie (2007), Moore (1988), Minsky (1982, 1986), Keen (1995), and Schumpeter (1911) for a by far non-exhaustive or representative list.

banking sector in interaction with real economic growth in order to endogenously model Kindleberger cycles as put forth in this proposal.

Another number of model focuses on financial cycles and/or financial instability. However, these are much smaller models, often in continuous time and based on few differential equations that can be solved analytically. Examples include Bezemer (2012), Bhaduri (2011), Keen (1995, 2013), Peetz and Genreith (2011) or Passarella (2012), among others.

While these show the underlying mechanisms of financial instability, as well as financial and debt crises, they mostly abstract from certain features of the economy such as real capital vs. financial capital, a complex financial sector including institutional detail, a government sector, a central bank, the distribution of wealth and income, or the like, that complete the picture of an economic system.

The number of what Caverzasi and Godin (2014) define as "fully empirical" SFC models that would be similar in spirit to the model proposed in this application is very limited. According to their definition of fully empirical SFC models, not only are the model parameters estimated from empirical data, they are also used to predict variations of endogenous model variables in a scenario analysis. Caverzasi and Godin (2014) name two groups that work with this kind of fully empirical SFC models: one set of authors at the Levy institute, who constructed fully empirical models for the U.S. (Papadimitriou et al., 2011) and Greek economies (Papadimitriou et al., 2013). The other goup can be found at the University of Limerick, see Kinsella and Tiou-Tagba Aliti (2012), where an empirical model of the Irish economy is still work in progress. A further model for the UK economy was devised by Barwell and Burrows (2011). However, none of these models features endogenous financial cycles or a complex financial market comparable to our modelling concept.

A macroeconomic model that allows for a true dynamic beyond assumptions of the economy endogenously and automatically returning to a steady state or an equilibrium growth path can be capable of depicting financial cycles endogenously with a perspective on policy analysis. Moreover, the assumption of endogenous money, i.e. the creation of money by banks through the provision of credit, which is incorporated in SFC models, is a crucial starting point to understand why asset prices form and how they evolve due to the increased provision of credit. The boundary problem and the complexity of the financial system can be considered by differentiating between a capital market based financial system, including an explicit depiction of the 'Shadow banking sector', besides a 'traditional' commercial banking sector.

In difference to the models above, we intend to incorporate dynamic economic developments comprehensively: Instead of determining the path that the model will take a priori, we analyze developments in the data, and construct the model equations according to these developments. We then estimate all parameter values, so that the evolution of the model variables fits actually observed dynamics in the recent past. Forecasting these parameter values allows us to get the resulting dynamic as a solution of the model. Using this dynamic approach, business cycles emanating from the change in the structure of the financial sector will be a truly endogenous feature of our model. Therefore, our

model as set out further in Section 3 would both extend the literature in this field and provide a valuable tool for policy advice.

Main Research Objectives Taking on this policy dimension and following the challenges to economic theory by bridging a gap in the literature, our research has the following main objectives:

Firstly, we intend to construct a macroeconomic model which adequately depicts the financial sector (including shadow banking) and its interaction with the real economy. We investigate into theoretical issues regarding how to systematically explain Kindleberger cycles. This is the focus of this paper, which is mostly of conceptual nature. Schematic policy simulation with data swiflty available from national accounting and a parameterisation that is close to the literature will be conducted to investigate the workings of the model.

For future research, we intend to calibrate the model to Eurozone data, and aim to explain the phenomena occuring before and after the recent financial crisis and the corresponding balance sheet recession. This would be the first model of its kind for the Eurozone.

After calibration to Eurozone data, we intend to conduct quantitative simulations in regard to pressing economic challenges. This simulation framework will be applied to simulate policy measures. A broad policy mix of fiscal, monetary and structural policies will be evaluated. We also aim to analyse the interaction of these policies with macro-prudential regulation of the financial sector, specifically considering the boundary problem of financial regulation.

3 Model (Work in Progress)

3.1 Theory

Our model is based on the stock-flow consistent (SFC) approach, which goes back to Backus et al. (1980), Tobin (1969), and has recently seen a revival in the literature through the seminal work of Godley and Lavoie (2007).[5] The main feature of SFC models is that they account for flows and stocks within and between various sectors of the economy, in a way that there are no 'black holes'. Flows denote transactions (e.g. public spending, or the amount that the household invests in different financial assets) while stocks denote sizes of asset positions on the active and passive sides of an agents' balance sheets (e.g. government debt, or the size of positions of different financial assets held by the household sector). In a stock flow consistent model each flow comes from one sector and goes to another. The corresponding stocks are reduced, respectively increased, by the size of the flow. Just as flows lead to a change in stocks (e.g. net worth), stocks can have an influence on flows (e.g. net worth is a determinant of consumption).

Because of the ability to explicitly depict money and other asset classes, the SFC literature has faced some revival since the 2008/09 financial crises. As reported in Section

[5]See Caverzasi and Godin (2014) for a recent overview of the SFC literature.

2, various aspects of financialisation have been included in SFC models. More recently, some papers have started to incorporate a shadow banking sector and securitisation in an SFC framework. Examples include Bhaduri et al. (2015) and Nikolaidi (2014). We build on this literature but extend the models both theoretically and empirically.

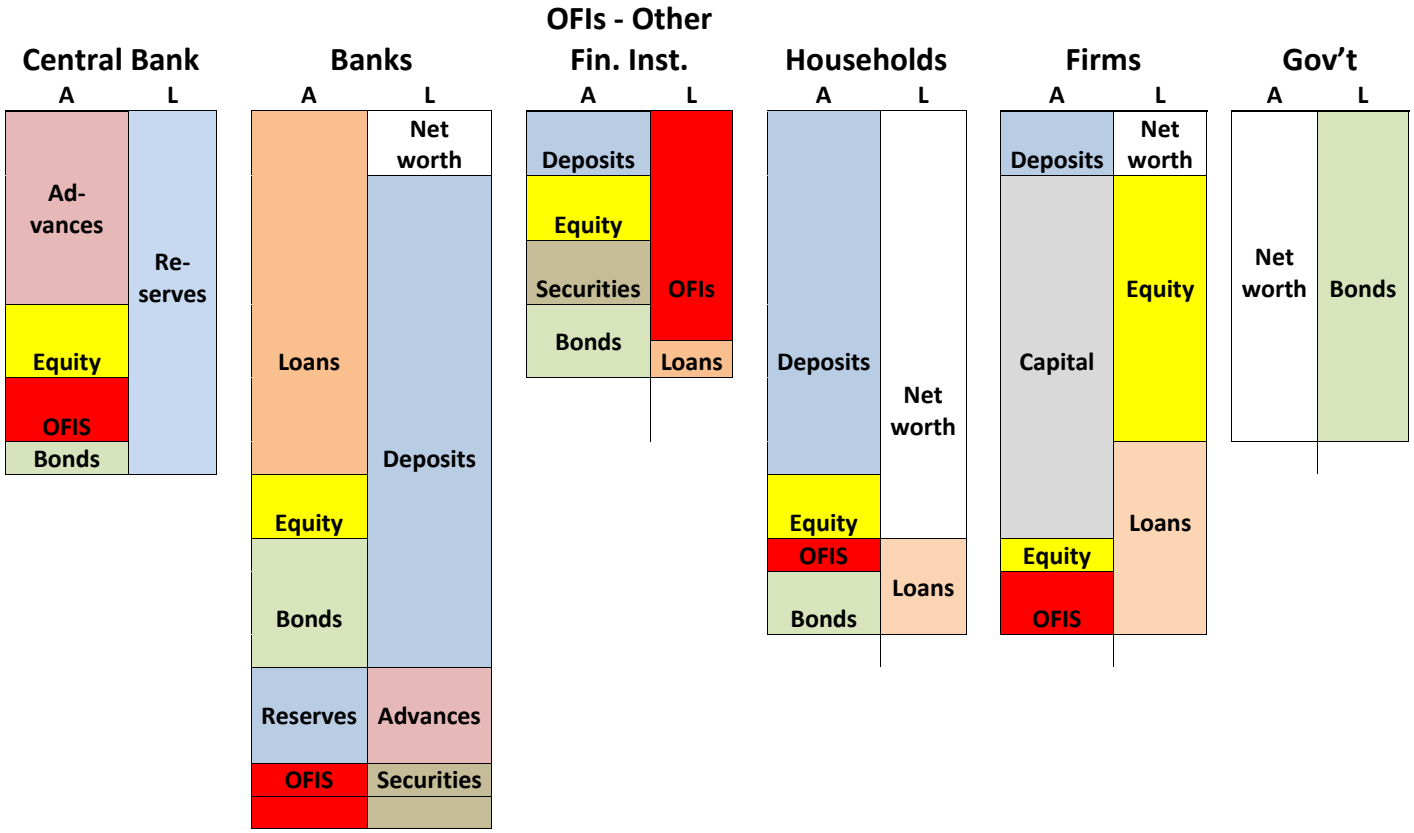
Technically, any SFC model is formulated as a dynamical system of difference equations. The behavior of such a system depends on the functional relations between the variables (i.e. the model equations), the parameter values, and the initial conditions. A model can either be unstable with the value of the variables in time going to infinity (diverging behavior), or converge to a stationary point or a limit cycle (converging behaviour). In this context, an balanced growth path corresponds to divergent behavior, where all variables diverge at the same growth rate.

Most models depicting theoretical phenomena are calibrated to a stationary state, which is used as a basis for policy experiments or the analysis of shocks. There exist also empirical models, which are calibrated to past data, see e.g. Kinsella and Tiou-Tagba Aliti (2012), that discuss several techniques. In a similar style, we do not restrict the model to a predefined dynamic, but obtain an endogenous dynamic as determined by the model equations and by the calibration of parameters. This calibration procedure ensures that model variables will fit the development of observed data from the recent past (see section 4.2).

3.2 Agents - Behaviour, Balance Sheet and Transaction Flow Matrices

We start out from a set of aggregated financial balance sheets for the following macroeconomic sectors: Households (hh), the government (gov), firms (f), commercial banks (b), a central bank (cb), and shadow banks (ofi, Other Financial Institutions). All sectors hold different types of assets and liabilities: As financial assets we consider deposits (D), loans (L), firm equity (E), government bonds (B), securities (SEC), OFI shares (OFIs), and central bank reserves (R) as well as advances (A) in the model. Since in a modern economy any financial asset is created together with a financial liability, each financial asset of a sector (the holder/creditor) is a financial liability for another sector (the issuer/debtor). There are two non-financial (real) assets in the model, which have no liability counterpart, physical capital K (held by firms), and houses H (real estate, held by households). The difference between the assets and liabilities of a sector is its net worth V (see figure 1 below for the complete balance sheets, table 1 below for the balance sheet matrix and table 2 for the transaction flow matrix).

3.2.1 Balance Sheets of Agents



Source: Own depiction. Scales are not representative

Figure 1: *Balance sheets of all asset holding agents of the economy.*
OFIS: other financial institutions' shares
Scales are not representative for Eurozone

3.2.2 Matrices

Table 1: Balance Sheet Matrix (preliminary)

Assets \ Sectors	**Households**	**Firms**	**Banks**	**OFI**	**Gov**	**CB**	Σ
Deposits	$+D_{hh}$	$+D_f$	-D	$+D_{ofi}$			0
Equities	$+p_e.E_{hh}$	$-p_e.E^S + p_e.E_f$	$+p_e.E_b$	$+p_e.E_{ofi}$		$+p_e.E_{cb}$	0
Bonds	$+p_b.B_{hh}$		$+p_b.B_b$	$+p_b.B_{ofi}$	$-p_b.B$	$+p_b.B_{cb}$	0
Securities			$-p_{sec}.SEC$	$+p_{sec}.SEC$			0
Houses	$+p_h.H$						$+p_h.H$
OFI Shares	$+p_{ofi}.OFIs_{hh}$	$+p_{ofi}.OFIs_f$	$+p_{ofi}.OFIs_b$	$-p_{ofi}.OFIs$		$+p_{ofi}.OFIs_{cb}$	0
Loans	$-L_{hh}$	$-L_f$	+L $\cdot(1-z)$	$-L_{ofi}$			0
Real K		+K					K
Reserves			+R			-R	
CB Advances			-A			+A	
Net Worth	V_{hh}	V_f	V_b	0	V_{gov}	V_{cb}	V

Legend The naming convention in the matrix above is set up as follows:

An asset class held by an agent is named after the first letter of the asset class name in capital letters, followed by capital letters indicating the agent. Therefore, D_{HH} indicates Deposits held by the Household sector. Similarly, B_{ofi} e.g. denotes Bonds held by the OFI (Other Financial Institutios) sector, etc. Houses (owned by households and firms) and real capital (owned by firms) are real assets, and thus do not feature a corresponding liability held by a counterparty. The net worth of an agent (difference between assets and liabilities) is denoted by a capital V and the name of the agent in lowercase letters, so that e.g. V_{ofi} signifies the net worth of the OFI sector. V denotes total net worth in the economy. A special case regarding the decision between real and financial investment for real and financial firms is the distinction, as in Caverzasi and Godin (2015), between amount of equities $p_e.E^S$ that is supplied to other agents and the amount $p_e.E^F$ that is purchased by the firms themselves in form of share-buybacks, among others to inflate their stock market value. The latter is a well-known feature of financialisation, see e.g. Van Treek (2009) or Caverzasi and Godin (2015). z is the fraction of loans that is securitised.

Prices and interest rates in the model are denoted by a lowercase p, followed by the abbreviation of the asset class in lowercase letters. Thus, p_e signifies the price of equities, p_{ofi} the price of shares issued by other financial institutions, etc. Similarly, e.g. i_b denotes the interest rate paid on bonds.

Table 2: Transaction Flow Matrix (preliminary)

Real Side	**HH**	**Firms current**	**Firms capital**	**Banks**	**OFI**	**GOV**	**CB**	$\sum$
Consumption	-C	+C						0
Wages	+ W	$-W$						0
Taxes	$-T$					+T		0
Investment		$+I$ $(= \Delta K)$	$-I$ $(= -\Delta K)$					0
Government Expenditure		$+G$				-G		0
Financial Side								
Interest on Deposits	$+i.D_{hh,-1}$	$+i.D_{f,-1}$		$-i.D_{-1}$				0
Interest on Loans and securitised assets	$-_{i_l}.L_{hh,-1}$	$-i_l.L_{f,-1}$		$+i_l . L_{-1}(1 - z)$	$-i_l.L_{ofi,-1} + i_l(1-\mu) L_{-1}z$			0
Interest on Bonds	$+i_b.B_{h,-1}$			$+i_b.B_{b,-1}$	$+i_b.B_{ofi,-1}$	$-i_b.B_{-1}$	$+i_b.B_{cb,-1}$	0
Dividends on Equities	$+F_{hh}$	-F	$+F_f$	$+F_b$	$+F_{ofi}$		$+ F_{cb}$	0
Retained Earnings		-FU	+FU	+ FUB				0
Interest on OFI shares	$+i_{ofi} . OFIs_{hh,-1}$	$+i_{ofi} . OFI_{f,-1}$		$+i_{ofi}. OFI_{b,-1}$	$-i_{ofi}. . OFIs_{-1}$		$+i_{ofi} . OFI_{cb,-1}$	0
Cash for Securities				$+p_{sec} . \Delta SEC$	$-p_{sec} . \Delta SEC$			
Bank profits	$+\Pi_b$			$-\Pi_b$				
CB profits						$+\Pi_{cb}$	$-\Pi_{cb}$	
Total saving	SAV_{hh}	0	SAV_f	SAV_b	SAV_{ofi}	SAV_{gov}	SAV_{cb}	0
Revaluation Matrix								
Δ Deposits	$-\Delta D_{hh}$		$-\Delta D_f$	$+\Delta D$				0
Δ Firm Equities	$-p_e \Delta E_{hh}$		$+p_e . (\Delta E - \Delta E^f)$	$-p_e \Delta E_b$	$-p_e \Delta E_{ofi}$			0
Δ Bonds	$-\Delta B_{hh}$			$-\Delta B_b$	$-\Delta B_{ofi}$	$+\Delta B$	$-\Delta B_{cb}$	0
Δ OFI shares	$-p_{ofi} .\Delta OFIs_{hh}$		$-p_{ofi} . \Delta OFI_f$	$-p_{ofi} . \Delta OFI_b$	$+p_{ofi} . \Delta OFI$		$-p_{ofi}. \Delta OFI_{cb}$	0
Δ Loans	$+\Delta L_{hh}$		$+\Delta L_f$	$-\Delta L_b$	$+\Delta L_{ofi}$			0
Δ capital			-I					-I
Δ Houses	$p_h . \Delta H$							$p_h.\Delta H$
Δ advances				$+\Delta A$			$-\Delta A$	0
Δ reserves				$-\Delta R$			$+\Delta R$	0
Δ Net Worth	ΔV_{hh}	0	ΔV_f	ΔV_b	0	ΔV_{gov}	ΔV_{cb}	0

3.2.3 Behaviour of Agents

This section lines out the behaviour of agents in the model, including selected equations to clarify our assumptions. We kindly ask the reader to view this representation of the model as work in progress. This model is still subject to further research regarding the underlying economic theory, data availability and will be adapted according the dynamic properties the model exhibits once it has been implemented in computer code as well as calibrated to preliminary data, and after exploratory simulations have been conducted.

Government The agent (sector) with the simplest behaviour and balance sheet is the government. The government sells bonds to households, banks, OFIs and the central bank:

$$p_b \cdot B = p_b \cdot (B_{hh} + B_b + B_{ofi} + B_{cb}) \tag{1}$$

The government's savings (SAV_g) is given by its tax receipts T plus profits from the central bank (which by our assumption accrue to the government) minus its expenditure on goods produced by firms (G) and interest payments on government debt $i_B \cdot B$. For simplicity, taxes are assumed to be an exogenous fraction θ of household income (Y_{hh}) (preliminary assumption: only income taxes in economy). Government expenditure (G) is assumed to be exogenous.

$$SAV_{gov} = T + \Pi_{cb} - (G + i_B \cdot B) \tag{2}$$

$$T = \theta \cdot Y_{hh} \tag{3}$$

$$G = exogenous \tag{4}$$

The government typically runs a deficit on its current account, since tax income is less than public spending, and by our assumption the government deficit is financed by additional government debt. Therefore, new bonds will be issued in each period and the deficit of the government (its negative saving $-SAV_g$) equals the amount of newly issued bonds each period:

$$-SAV_{gov} = \Delta B \tag{5}$$

The nominal amount of newly issued bonds (supply of new bonds) thus is entirely determined by the government's budget deficit. Demand for bonds is formed by the buyers' portfolio decisions, in which the risk premium and the risk itself (the debt-to-GDP ratio is used as a proxy) enter. We assume for our bonds to be long term debt and for simplicity we abstract from any expectations about the future price of bonds, but we include a (subjective) risk evaluaton $\chi(\frac{B}{Y})$ reflecting the perceived risk of government default, which for simplicity is a linear function of the government debt-to-GDP ratio.

As we assume the debt to be long-term, the price of the bond corresponds to the infinite sum (of the geometric series) of the return to a perpetuity as in Godley and Lavoie (2007), chapter 5:

$$p_b = \frac{1}{i_b} \tag{6}$$

Hence, in the bond market, price p_b and the interest rate i_b adapt according to equation (30) so that all issued bonds are bought at market interest rates to clear the market of additional government debt that is determined by the government deficit. We differ in our depiction of government bonds to the often-cited reference SFC model LP, chapter 5 of Godley and Lavoie (2007), since we want to stress the value of government bonds on financial markets, which influences their interest rate, and account for capital gains on the bond market. Therefore, while the base interest rate is set exogenously by the central bank, the value of government bonds is determined on the market. This assumption, which might underestimate the power of the central bank and the government to control the value of new government bonds, e.g. by bond purchases by the central bank, is made to simplify complexity in the model to concentrate on the effects of capital gains on financial markets, among others. However, the central bank might intervene in order to keep the price and yield to government bonds close to a certain target range, see equation (57).[6]

Firms play a critical role in our model. In the goods and services market as described in 2, they produce and sell goods and services to households (C) and the government (G) for consumption and to other firms for investment purposes (I). Firms' current expenditures are on wages (W), loan repayments ($i_l \cdot L_{f,-1}$) and dividends (F), while they receive interest payments on their deposit accounts D_f. Total firm profit Π_f, equation (7), is kept as retained earnings (FU) or expended as firm dividends according to exogenous fractions, see equation (8). F_f is the amount of dividends that accrues to firms themselves due to shares firms owned by firms (share buybacks), constituting a further source of income.

$$\Pi_f = C + I + F_f + i \cdot D_f - W - i_l \cdot L_{f,-1} \tag{7}$$

$$FU = \xi_f \cdot \Pi_f \quad F = (1 - \xi_f) \cdot \Pi_f \tag{8}$$

An important feature of our model is that firms, besides investing in their physical capital stock, also engage in financial markets through financial investment. In order to finance investment, real and financial, they retain some of their revenues from sales, take out loans and issue equity. They are modelled to have an active portfolio management, holding real estate, OFI shares, and equity (including buybacks of shares issued by the firms itself) on their asset side, as well as loans and equity as liabilities. In the equity

[6] This assumption is preliminary, and open to further research in regard to the underlying economic theory, as well as model implementation.

market households, banks, and OFIs are the buyers. The supply of newly issued equities is determined by the firms' investment decision. Nominal demand for equities is determined by buyers in the course of their portfolio decision. The equity price freely adapts so that nominal expenditures on newly issued equity equals the nominal amount of new equity.

In determining the amount of firm investment, we follow Caverzasi and Godin (2015) in their three-step process:

Firstly, firms decide how much they want their total assets (real and financial) to grow (g_a), based on the expected rate of return to their total assets, r^e_{tot} - see equation (80), and exogenously chosen parameters. Their chosen asset growth g_a affects the amount of new investment depending on the existing stock of total assets from previous period ($A_{f,-1}$), together with the depreciation of capital stock DK (replacement investment), and form expectations (A^e_f) about the future level of total assets.

$$g_a = \gamma_0 + \gamma_1 \cdot r^e_{tot} \tag{9}$$

$$I_A = A_{f,-1} \cdot g_a + DK \tag{10}$$

$$DK = \delta_k \cdot K_{-1} \tag{11}$$

$$A^e_f = A_{f,-1} \cdot (1 + g_a) \tag{12}$$

Real physical investment (I) is then given as the difference between this and last year's capital stock ($\Delta K = K - K_{-1}$) plus replacement investment DK:

$$I = \Delta K + DK \tag{13}$$

Each year's capital stock is subject to the portfolio decision of firms, equations (16) to (20).

Secondly, as pointed out in Caverzasi and Godin (2015) with reference to Minsky, every investment decision is also a decision about financing and a liability structure: besides using internal funds for investment, i.e. retained earnings FU and the parts of dividends that accrue to firms themselves F_f, firms have the choice to finance additional investment beyond the value of their internal funds by issuing new equity ΔE^s or by taking out new loans (ΔL_f). Since the amount of investment is determined before the financing decision, some variable has to adapt to ensure consistency. Since it seems natural to assume the amount of newly issued equities (ΔE^s) to be some function of the expected financing gap between total investments and internal funds, see equation (14).

$$\Delta E^s = \frac{\chi_f (I_A - FU^e - F^e_f)}{p^e_e} \tag{14}$$

we assume the amount of new loans taken by the firm (ΔL_f) to act as a buffer stock as in Caverzasi and Godin (2015):

$$\Delta L_f^d = I_A - (FU + F_f + p_e \cdot \Delta E^s) \tag{15}$$

Thirdly, we account for the empirically observed fact (see section 2) and crucial new development in the age of finacialisation that firms increasingly allocate their funds to financial investment. Following Caverzasi and Godin (2015), we use a Tobinesque portfolio choice approach, employing the functional form developed in Brainard and Tobin (1968) and Tobin (1969) and as laid out in Godley and Lavoie (2007).[7] However, we extend the depiction of Caverzasi and Godin (2015) by the OFI sector to analyse the influence of volatile financial markets on the real economy.

Firms have the choice to allocate their funds between deposits (D_f), equities (share buybacks, $p_e \cdot E_f$), real capital (K), and OFI shares according to the expected value of returns to the respective stock, as well as their total stock of assets (except for the stock of housing, which is assumed to be fixes) A_f^e given in (19). Here, deposits act as a buffer stock as in Caverzasi and Godin (2015). The reason is that in this type of model agents' expectations generally do not correspond to the actual developments of the macro system and one asset has to adapt to correct this difference, see also Godley and Lavoie (2007).

$$[D_f^d = (\gamma_{10} + \gamma_{11} \cdot i - \gamma_{12} \cdot r_e^e - \gamma_{13} \cdot r_k^e - \gamma_{14} \cdot i_{ofi}^e) \cdot A_f^e]$$

$$p_e \cdot E_f^d = (\gamma_{20} - \gamma_{31} \cdot i + \gamma_{22} \cdot r_e^e - \gamma_{23} \cdot r_k^e - \gamma_{24} \cdot i_{ofi}^e) \cdot A_f^e \tag{16}$$

$$K^d = (\gamma_{30} - \gamma_{31} \cdot i - \gamma_{32} \cdot r_e^e + \gamma_{33} \cdot r_k^e - \gamma_{34} \cdot i_{ofi}^e) \cdot A_f^e \tag{17}$$

$$OFIs_f^d = (\gamma_{40} - \gamma_{41} \cdot i - \gamma_{42} \cdot r_e^e - \gamma_{43} \cdot r_k^e + \gamma_{44} \cdot i_{ofi}^e) \cdot A_f^e \tag{18}$$

$$A_f = A_{f,-1} + FU + F_f + \Delta L_f + p_e \cdot \Delta E^s + CG$$
$$-DK + p_{ofi} \cdot \Delta OFIs \tag{19}$$

$$D_f = A_f - K - p_e \cdot E_f - p_{ofi} \cdot OFI_f \tag{20}$$

Where i is the interest rate on deposits as determined by commercial banks, r_e^e and r_K^e are the expected rate of return on firm equity and real capital, respectively. i_{ofi}^e is the expected return on OFI shares. The composition of returns is explained in section 3.2.4, where also the formation of expectations is given by equation (88).

By including firm portfolio choice between financial and real investment, we are able to capture beneficial and detrimental effects on the real economy resulting from the interaction of the financial sector with the rest of the economy, see section 3.3.

Households The **household** sector consumes goods and services and receives income from labour (W), interest on deposit accounts, dividends from firm equities, bank profits

[7] The parameters obey the usual constraints: the *adding up constraint* implies that $\sum_{i=1}^{n} \lambda_{i,0} = 1$, and the *symmetry constraint* implies that $\lambda_{i,j} = \lambda_{j,i} \forall i \neq j$, see (Godley and Lavoie, 2007, Chapter 5).

and return on assets. Household disposable income (YD) net of taxes, interest payments on loans and loan repayment (REP) as a constant fraction δ_{rep} of previous loans is given in equation (21). They choose to consume according to fixed parameters out of disposable income and wealth, equation 22.

Following Caverzasi and Godin (2015), we model the wage bill (W) to be a function of total output and the profit share (π), see equation (23), while normalising the price of consumption and capital goods to one. However, we deviate in the sense that the profit share in our economy will be endogenous and subject to the amount of profits accruing to households via the financial sector, i.e. bank profits (Π_b), equation (50), and OFI sector interest rate payments ($i_{ofi} \cdot p_{ofi} \cdot OFIs$), equation (61). The exact functional form of the endogenous profit share, see equation (24), is subject to further research. The benchmark value of the profit share will be the profit share of the calibration year, around which it will be allowed to fluctuate reasonably according to developments on financial markets.

Household wealth takes the form of deposits, equity, real estate, OFI shares, and government bonds, while on the liability side there are loans, equation (27). While (27) has to be true by definition for accounting reasons, the evolution of households' net worth is given by equation (87) accounting for savings and capital gains as the change in last period's net wealth.

$$YD = W + i \cdot D_{hh,-1} + F_{hh} + FB + i_b \cdot B_{hh,-1} + i_{ofi} \cdot OFIs_{hh} - T - i_l \cdot L_{hh} - REP \tag{21}$$

$$C = \alpha_1 \cdot YD + \alpha_2 \cdot V_{hh,-1} \tag{22}$$

$$W = Y \cdot (1 - \pi) \tag{23}$$

$$\pi = f(\Pi_b, i_{ofi}) \tag{24}$$

$$REP = \delta_{rep} \cdot L_{hh,-1} \tag{25}$$

$$L_{hh} = \Delta L_{hh} + L_{hh,-1} \cdot (1 - \delta_{rep}) \tag{26}$$

$$[V_{hh} = D_{hh} + p_e \cdot E_{hh} + p_b \cdot B_{hh} + p_h \cdot H - L_{hh}] \tag{27}$$

The **household portfolio choice** equations take the following form similar to firms' portfolio choice above, where again deposits act as buffer stock:

$$[D^d_{hh} = (\lambda_{10} + \lambda_{11} \cdot i - \lambda_{12} \cdot r^e_e - \lambda_{13} \cdot i_b - \lambda_{14} \cdot i_{ofi} - \lambda_{15} \cdot r^e_h) \cdot V^e_{hh}] \tag{28}$$

$$E^d_{hh} \cdot p_e = (\lambda_{20} - \lambda_{21} \cdot i + \lambda_{22} \cdot r^e_e - \lambda_{23} \cdot i_b - \lambda_{24} \cdot i_{ofi} - \lambda_{25} \cdot r^e_h) \cdot V^e_{hh} \tag{29}$$

$$B^d \cdot p_b = (\lambda_{30} - \lambda_{31} \cdot i - \lambda_{32} \cdot r^e_e + \lambda_{33} \cdot i_b - \lambda_{34} \cdot i_{ofi} - \lambda_{35} \cdot r^e_h - \chi(\frac{B}{Y})) \cdot V^e_{hh} \tag{30}$$

$$OFIs^d_{hh} \cdot p_{ofi} = (\lambda_{40} - \lambda_{41} \cdot i - \lambda_{42} \cdot r^e_e - \lambda_{43} \cdot i_b + \lambda_{44} \cdot i_{ofi} - \lambda_{45} \cdot r^e_h) \cdot V^e_{hh} \tag{31}$$

$$H^d \cdot p_h = (\lambda_{50} - \lambda_{51} \cdot i - \lambda_{52} \cdot r^e_e - \lambda_{53} \cdot i_b - \lambda_{54} \cdot i_{ofi} + \lambda_{55} \cdot r^e_h) \cdot V^e_{hh} \tag{32}$$

$$D_{hh} = V_{hh} - E_{hh} \cdot p_e - B^d \cdot p_b - OFIs^d_{hh} \cdot p_{ofi} - H^d \cdot p_h \tag{33}$$

The real estate sector is an important variable for household behavior, and clearly important for overall financial stability of the economy. We model the housing stock to be fixed similar to Caverzasi and Godin (2015). Households buy new houses from firms, while existing houses are traded among the household sector itself as part of their portfolio decision. Since housing demand is determined in the portfolio decision, again, the price is the equilibrating varible.

Financial Sector Since our aim is to model a detailed financial sector, we differentiate the central bank, commercial banks and other financial institutions (OFI, including the shadow banking sector).

Banks Under the banking sector, we subsume traditional banking activities, such as the creation of loans and the acceptance of deposits. On their balance sheet, banks hold loans, government bonds, central bank reserves, firm equity and OFI shares as assets, vis a vis deposits, securities, central bank advances and the banks' net worth at the liability side.

$$L + R + p_e \cdot E_b + p_b \cdot B_b + p_{ofi} \cdot OFIs_b = D + A + p_{sec} \cdot SEC + V_b \tag{34}$$

Banks are the main actors in the credit market, issuing loans to firms and households. Thereby they simultaneously create two kinds of assets: checkable deposits, which are liabilities for the bank and assets for all other sectors, and loans, which are liabilities for the debtors and assets for the bank, see also McLeay et al. (2014). The demand for new loans by firms depends on their investment and financing decisions, equations (9) to (20), the demand for loans by other financial institutions on the amount of securities and their capital gains, see equation (62). We assume the demand for new loans by households (ΔL_h^d) to be elastic and to follow the supply of new loans to households by banks (ΔL_h^s) similar to Caverzasi and Godin (2015), equation (35). Loans supplied to firms and the OFI sector, on the contrary, are equal to loans demanded by these institutions by assumption in our model, equations (36) and (37). This assumption is made for reasons of model simplicity, but also to capture the endogenous rise in credit within this economy due to the various aspects of financialisation depicted in this model.

$$\Delta L_h^d = \Delta L_h^s \tag{35}$$

$$\Delta L_{ofi}^s = \Delta L_{ofi}^d \tag{36}$$

$$\Delta L_f^s = \Delta L_f^d \tag{37}$$

The supply of new loans by banks to households is risk-constrained and depends the banks' own leverage ratio (lev_b), that of the debtor households (lev_h) and on leverage target ratios by the bank for households (lev_h^T) and for the bank itself (lev_b^T), equation (39). Bank leverage has to be greater than an capital adequacy ratio (CAR) which is set

exogenously as a policy parameter plus a margin of safety (MS) the bank maintains so as not to fall short of the CAR, equation (44).

The price for new loans does not equilibrate, but is modelled as a markup on the central bank's base interest rate, so the supply for new loans is a natural limit for demand. We assume for the target ratios to start at a level that reflects the flow of new loans to households according to the data at the period of calibration, and let them depend on the development of housing and financial markets thereafter.

Banks are also able to securitise some of their loans, assumed to be a fixed fraction z for simplicity, equation (54), so as to reduce their exposure to potential defaults and improve their leverage, see equation (41). Selling these securities to OFIs, banks also reduce the size of their balance sheets and their leverage (outstanding loans to net worth ratio), which provides room for the issuance of new loans. While we assume the demand for loans by firms and the OFI sector to be satisfied by banks, the supply of loans to households is subject to leverage and profit targets by the banks as put forth in Caverzasi and Godin (2015). Thus, we want to capture the destabilising forces of increasing debt financing by firms as argued by Minsky, as well as phenomena of increased lending to households based on asset price inflation and securitisation techniques observed during the recent crisis of 2007/2008. By including securitisation techniques, we add an additional element to the analysis as compared to Caverzasi and Godin (2015), which decisively influences the behaviour by banks.

Please note that in equation, (41), securitisation decreases the banks' leverage level. Since banks receive money (deposits) reducing their liability side for selling a fraction z of their loans L to the OFI sector as securities, their net worth V_b in the denominator does not change, while the numerator decreases for $z > 0$. Thereby, while keeping accounting consistency, we account for the fact that banks actually sell off their loans from their books, thereby lowering their leverage and enabling them to follow a more aggressive strategy of loan provision.

$$\Delta L^s = \Delta L^d_f + \Delta L^d_{ofi} + \Delta L^s_h \tag{38}$$

$$\Delta L^s_h = \tau_1 \cdot (lev^T_h - lev_{h,-1}) \cdot V_{h,-1} + \tau_2 \cdot (lev^T_b - lev_{b,-1}) \cdot (V_{h,-1} + A_{f,-1}) \tag{39}$$

$$lev_h = \frac{L_h}{V_h} \tag{40}$$

$$lev_b = \frac{L(1-z)}{V_b} \tag{41}$$

$$lev^T_h = lev_{h,-1} + \zeta_{h,hh} \cdot (p_h - p_{h,-1}) + \zeta_{f,hh} \cdot (p_e - p_{e,-1} + p_{ofi} - p_{ofi,-1}) \tag{42}$$

$$lev^T_b = lev_{b,-1} + \zeta_{h,b} \cdot (p_h - p_{h,-1}) + \zeta_{f,b} \cdot (p_e - p_{e,-1} + p_{ofi} - p_{ofi,-1}) \tag{43}$$

$$lev^T_b \geq CAR + MS \tag{44}$$

Banks choose their assets via a portfolio choice equation similar to the ones above. However, as the amount of deposits in the system is already determined by the portfolio choice of other agents, this time government bonds act as buffer stock (similar to Godley and Lavoie (2007)[chapter 10]). Furthermore, banks decide on loan provision before their

portfolio choice, while the amount of reserves closes the model as in Godley and Lavoie (2007)[chapter 10]. Thus, the portfolio choice regards only the remainder of banks' net worth. Furthermore, it does not consider the returns to deposits, since the difference on returns between loans and deposits is determined by a fixed mark-up and thus does not influence banks' portfolio allocation.:

$$D = D_{hh} + D_f + D_{ofi} \tag{45}$$

$$E_b^d \cdot p_e = (\omega_{10} + \omega_{11} \cdot r_e^e - \omega_{12} \cdot i_b - \omega_{13} \cdot i_{ofi}) \cdot (V_b^e - L - R) \tag{46}$$

$$[B_b^d \cdot p_b = (\omega_{20} - \omega_{21} \cdot r_e^e + \omega_{22} \cdot i_b - \omega_{23} \cdot i_{ofi} - \chi(\frac{B}{Y})) \cdot (V_b^e - L - R)] \tag{47}$$

$$OFIs_b^d \cdot p_{ofi} = (\omega_{30} - \omega_{31} \cdot r_e^e - \omega_{32} \cdot i_b + \omega_{33} \cdot i_{ofi}) \cdot (V_b^e - L - R) \tag{48}$$

$$B_b^d \cdot p_b = L + R + E_b \cdot p_e + OFIs_b \cdot p_{ofi} - (D + A) \tag{49}$$

Bank profits, consisting of interest payments on loans, OFI shares and bonds, as well as capital gains, cash receipts for the sales as securities minus interst paid on deposits, equation (50). They are partly used to accumulate net worth in the form of retained earnings of banks (FUB), and partly distributed to households in (FB), each according to a certain fraction ξ_i, equation 51, dependent on the required capital adequacy ratio (CAR) for banks as a minimal value for the bank leverage ratio lev_b. For simplicity, the interest on deposits i is set by banks according to a fixed mark-up on the exogenously set interest by the central bank i_{cb}. Similarly, the interest on loans is determined by a fixed mark-up on interest on deposit accounts, equation (53).

$$\Pi_b = i_l \cdot L_{-1}(1 - z) + CG_b + p_{sec} \cdot \Delta SEC - i \cdot D_{-1} \tag{50}$$

$$FUB = \xi_b(CAR) \cdot \Pi_b, \quad FB = (1 - \xi_b(CAR)) \cdot \Pi_b \tag{51}$$

$$i = i_{cb} \cdot (1 + \sigma_1) \tag{52}$$

$$i_l = i \cdot (1 + \sigma_2) \tag{53}$$

We assume that loans are repaid by households according to a constant fraction of their previous loans, see equations (21) and (25).

Securitisation The process of securitisation has been simplified decisively to reduce the complexity of the model while capturing the main dynamics relevant for financial cycles.

The main question is whether *additional (near) money is truly created in the financial sector* to inflate asset prices. Due to the complexity of financial operations within and between the modern commercial banking sector as well as the shadow banking sector which we want to pin down to its essence in our model, we rely on sources like Botta et al. (2015), Bhaduri et al. (2015) and Nikolaidi (2014) to abstract the workings of the system to make it suitable for depiction in an SFC model.[8]

[8] See figure 3 in the appendix for a stylized depiction of the functioning of the shadow banking system, taken from Botta et al. (2015).

Firstly, we group different institutional entities such pecial purpose vehicles (SPVs), special investment vehicles (SIVs), and other parts of the shadow banking system such as money markets funds, investment funds, equity funds, real estate funds, hedge funds and other type of funds into one sector, OFIs. Secondly, we model money creation within the financial sector by interaction between the commercial banking sector and the OFI (shadow banking) system in two ways, see Botta et al. (2015)[p. 20 f]:

1. *Loan securitisation* by traditional banks lowers their leverage and thus enables additional credit creation by the traditional banking system.

2. Credit creation by the provision of *REPO loans* from the commercial banking system to the OFI sector in exchange for securitised assets (SEC) and capital gains as collateral, equation (62). The loans may then be used, among others, to buy additional securities that the commercial banking system implicitly provides via securitisaion, creating an inner-finance cycle" (Botta et al., 2015) that is self-reinforcing. Using these REPO loans for investment in other financial assets such as equities may inflate asset prices and induce pro-cyclical leverage effects.

These facts abstracted from the literature are reflected in our model. Banks' tendency to supply securities is a constant fraction of their loan provision:

$$\Delta SEC = z \cdot \Delta L \tag{54}$$

Banks' loan provision is dependent, on their leverage ratio depicted in equation (41) as well as by the loand demand of firms and the OFI sector, equation (38).

The demand for securities is determined by the OFI sector's portfolio choice (see equations (65) to (66)). There, the price for securities is the equilibrating variable.

Securitisation decreases the banks' leverage level, see equation (41).

Central Bank The assets of the **central bank** consist of advances (credit) to commercial banks and other asset types, which it may purchase when pursuing unconventional monetary policy. On the liability side, the central bank holds monetary reserves, which are assets for banks.[9]

$$R + V_{cb} = A + p_b \cdot B_{cb} + p_e \cdot E_{cb} + p_{ofi} \cdot OFIs_{cb} \tag{55}$$

In the reserves market, banks demand the amount of reserves determined by their legal minimum reserve requirements, and the central bank supplies them. When the central bank purchases assets from other sectors, e.g. in the conduct of unconventional monetary

[9] Just as banks can issue loans to firms, the **central bank** can issue loans to banks, which are then called advances. It thereby creates reserves, which banks hold on their asset side.

policy (an exogenous policy variable in the model), it creates new reserves, which are injected into the monetary system via the asset purchase, or it reduces its net worth.

$$\Delta(B_{cb} + p_b \cdot B_{cb} + p_e \cdot E_{cb} + p_{ofi} \cdot OFIs_{cb}) = \Delta(R + V_{cb}) \tag{56}$$

The base interest rate i_{cb} is set exogenously by the central bank as a policy variable. Furthermore, the amount of government bond purchased by the central bank may be set according policy goals to stabilise prices (and yields) on the government bonds market. Possibly, the central bank might act so as to keep the price above a lower bound z_1 and below an upper bound z_2:

$$\Delta B_{cb} = f(p_b) \quad \text{so that} \quad z_1 \leq p_b \leq z_2 \tag{57}$$

Other Financial Institutions The sector of other financial istitutions, OFIs, includes investment funds and mutual funds, financial auxiliaries and captive institutions, and other financial intermediaries. It largely represents the unregulated shadow banking sector. OFIs hold deposits, firm equity, securities and government bonds, issue shares and take up bank loans.

$$p_{ofi} \cdot OFIs + L_{ofi} = D_{ofi} + p_e \cdot E_{ofi} + p_b \cdot B_{ofi} + p_{sec} \cdot SEC \tag{58}$$

The OFI sector issues shares, and sells them to households, banks, and firms, thereby expanding the supply of non-bank credit. These shares subsume all kinds of near-moneys (liquid assets that can easily be converted into cash), which are bought in return for cash (deposits). OFI shares yield a rate of return i_{ofi} that has a fixed mark-up on deposit accounts, but have a variable part in their return connected to their appreciation in value, which accrues to the holders of OFI shares in the form of capital gains.[10]

The demand for OFI shares is determined by the buyers' portfolio decisions (portfolio choices of households, firms, banks, as well as central bank intervention), in which the expected price increase and the fixed return component enter. Supply of new OFI shares $\Delta OFIs^s$ is determined by the OFI sector in such a way that the price for OFI shares remains just high enough to yield capital gains (in normal times). The price then adapts to the level the OFI agent intends and steers it via a supply choice.

$$\Delta OFIs^s = f(p_{ofi,t}) \tag{59}$$

$$p_{ofi,t} \geq p_{ofi,t-1} + \epsilon \quad \text{(in normal times)}, \quad \epsilon > 0 \tag{60}$$

[10]The fixed component ensures other agents in the economy to invest in OFI shares. While they exhibit a higher risk of default as compared to checkable deposits, there is no government-guaranteed deposit insurance for OFI shares.

where $f(p_{ofi,t})$ is a function dependent on the price of OFI shares guaranteeing that condition (60) is fulfilled. ϵ is a small positive number.

OFI profits accrue due to dividends and interest flows from assets held as well as capital gains, and are diminished by interest to be paid on outstanding liabilities (loans). We assume that the interest rate paid on OFI shares i_{ofi} adapts so that the profits of the OFI sectors are equal to zero, i.e. that all profits are distributed to shareholders, equation (61). Thus, we account for the fact that there are no official reserve requirements for the OFI sector (preliminary assumption subject to further research).

$$i_{ofi} \cdot p_{ofi} \cdot OFIs - (CG_{ofi} + F_{ofi} + i_b \cdot B_{ofi} + -i_l \cdot L_{ofi}) = 0 \tag{61}$$

We assume furthermore that the OFI sector uses a fraction its securities and last period's capital gains as collateral for REPO loans from the commercial banking sector, thus feeding the inner-finance cycle and increasing price inflation for financial assets due to pro-cyclical leverage effects:

$$\Delta L^d_{ofi} = \nu_1 \cdot p_{sec} \cdot SEC + \nu_2 \cdot CG_{ofi,-1} \tag{62}$$

The portfolio choice mechanism also determines the price for securities that the OFI sector demands from commercial banks, equilibrating between the fixed supply by banks as given in (54) and the demand by OFIs, equations (63) to (67). In times of crises, the supply steering mechanism of OFI collapses and OFI shares may rapidly lose value (fire sale). Times of crisis wil be defined to mimic first signs of a financial depression, e.g. by near-zero or even lower growth rates, or a significant decrease in the price of more than one asset class for 2 consecutive periods. The exact definition will then depend on the properties the model exhibits in simulations and will be kept close to stylized empirical evidence.

With the obtained revenues from the issuance of OFI shares, OFIs buy other assets such as bonds, equity or securities according to portfolio choice equations similar to above (deposits are buffer stock).

$$D^d_h = (\kappa_{10} + \kappa_{11} \cdot i - \kappa_{12} \cdot r^e_e - \kappa_{13} \cdot i_b - \kappa_{14} \cdot r^e_{sec}) \cdot V^e_{ofi} \tag{63}$$

$$E^d_{hh} \cdot p_e = (\kappa_{20} - \kappa_{21} \cdot i + \kappa_{22} \cdot r^e_e - \kappa_{23} \cdot i_b - \kappa_{24} \cdot r^e_{sec}) \cdot V^e_{ofi} \tag{64}$$

$$B^d \cdot p_b = (\kappa_{30} - \kappa_{31} \cdot i - \kappa_{32} \cdot r^e_e + \kappa_{33} \cdot i_b - \kappa_{34} \cdot r^e_{sec} \chi(\frac{B}{Y}) \cdot V^e_{ofi} \tag{65}$$

$$SEC^d \cdot p_{sec} = (\kappa_{40} - \kappa_{41} \cdot i - \kappa_{42} \cdot r^e_e + \kappa_{43} \cdot i_b + \kappa_{44} \cdot r^e_{sec}) \cdot V^e_{ofi} \tag{66}$$

$$D_{ofi} = V_{ofi} - E_{hh} \cdot p_e - B^d \cdot p_b - OFIs^d_{hh} \cdot p_{ofi} \tag{67}$$

3.2.4 Capital Gains, Returns, Expectations and Net Worth

Capital gains are an important aspect of our model, since the expectations of capital gains are a major force for asset price inflation in our model. Furthermore, capital gains will tend to improve the leverage of agents in the model in general, thereby increasing

the propensity to take up additional loans, which are partly invested in financial assets and thus tend to create credit-fuelled asset price bubbles.

Generally, capital gains are depicted as the price change for the asset between this and last period, e.g. Δp_{ofi}, times the amount of assets held by the agent last period, OFI_{-1}. Thus, in the revaluation matrix depicted in table 2, only quantity changes are denoted in the matrix, while capital gains enter the agents' net worth line. Capital gains accrue to all agents in the model specific for each asset class:

$$\text{Households:}$$

$$CG_{hh,e} = \Delta p_e \cdot E_{hh,-1} \quad CG_{hh,b} = \Delta p_b \cdot B_{hh,-1}$$

$$CG_h = \Delta p_h \cdot H_{-1} \quad CG_{hh,ofi} = \Delta p_{ofi} \cdot OFI_{hh,-1} \tag{68}$$

$$CG_{hh} = CG_{hh,e} + CG_{hh,b} + CG_h + CG_{hh,ofi} \tag{69}$$

$$\text{Firms:}$$

$$CG_{f,e} = \Delta p_e \cdot E_{f,-1} \quad CG_{f,ofi} = \Delta p_{ofi} \cdot OFI_{f,-1} \tag{70}$$

$$CG_f = CG_{f,e} + CG_{f,ofi} \tag{71}$$

$$\text{Banks:}$$

$$CG_{b,e} = \Delta p_e \cdot E_{b,-1} \quad CG_{b,b} = \Delta p_b \cdot B_{b,-1}$$

$$CG_{b,ofi} = \Delta p_{ofi} \cdot OFI_{b,-1} \tag{72}$$

$$CG_b = CG_{b,e} + CG_{b,b} + CG_{b,ofi} \tag{73}$$

$$\tag{74}$$

$$\text{OFIs:}$$

$$CG_{ofi,e} = \Delta p_e \cdot E_{ofi,-1} \quad CG_{ofi,b} = \Delta p_b \cdot B_{ofi,-1}$$

$$CG_{ofi,sec} = \Delta p_{sec} \cdot SEC_{-1} \tag{75}$$

$$CG_{ofi} = CG_{ofi,e} + CG_{ofi,b} + CG_{ofi,sec} \tag{76}$$

$$\text{Central Bank:}$$

$$CG_{cb,e} = \Delta p_e \cdot E_{cb,-1} \quad CG_{cb,b} = \Delta p_b \cdot B_{cb,-1}$$

$$CG_{cb,ofi} = \Delta p_{ofi} \cdot OFI_{cb,-1} \tag{77}$$

$$CG_{cb} = CG_{cb,e} + CG_{cb,b} + CG_{cb,ofi} \tag{78}$$

$$\tag{79}$$

Returns to the respective assets are composed of interest flows (bonds, OFI shares), dividends (equities) or profits plus capital gains for the respective asset class. Note that below different agents are subsumed under the label a.

$$r_{tot} = \frac{FU + F_f + CG_f}{A_{f,-1}} \tag{80}$$

$$r_{a,e} = \frac{F_a + CG_{a,e}}{p_{e,-1} \cdot E_{a,-1}} \quad \forall a \in (hh, f, b, ofi, cb) \tag{81}$$

$$r_k = \frac{FU + F_f}{K_{-1}} \tag{82}$$

$$r_{a,b} = \frac{i_b + CG_{a,b}}{p_{b,-1} \cdot B_{a,-1}} \quad \forall a \in (hh, b, ofi, cb) \tag{83}$$

$$r_{a,ofi} = \frac{i_{ofi} + CG_{a,ofi}}{p_{ofi,-1} \cdot OFI_{a,-1}} \quad \forall a \in (hh, f, b, cb) \tag{84}$$

$$r_h = \frac{CG_h}{p_{h,-1} \cdot H_{-1}} \tag{85}$$

Net Worth An agent's net worth (net wealth) is calculated by the wealth of last period (V_{-1}) plus savings SAV and capital gains CG. One, however, has to differ between expected and realized net worth, as expectations in general are not fully realized:

$$V_a^e = V_{a,-1}^e + SAV_a^e + CG_a^e \quad \forall a \in (hh, f, b, ofi, cb, gov) \tag{86}$$

$$V_a = V_{a,-1} + SAV_a + CG_a \quad \forall a \in (hh, f, b, ofi, cb, gov) \tag{87}$$

Expectations We assume expectations to be adaptive, see Godley and Lavoie (2007), and to be formed as in Caverzasi and Godin (2015) for any variable X in the model unless specified differently. They are given by a weighted sum $\overline{X}$ consisting of an average of past observations (possibly of the last four to five observations), and include an adaption mechanism taking into account the development of a variable from the last period as regarding the gap between the expected value X_{-1}^e and the realised value X_{-1} within the last period:

$$X^e = \overline{X} + \zeta(X_{-1}^e - X_{-1}) \tag{88}$$

3.3 Modelling Financialisation and Kindleberger Cycles

This section conceptually describes how the phenomena of financialisation, as discussed in sections 1 and 2, are depicted in the model lined out above. Specifically, we describe how we model the above defined Kindleberger cycle. We use different mechanisms leading to the build-up of a credit-fuelled asset price bubble in the model, and also different trigger events, leading to the burst of such a bubble.

As is consensual for financial markets, if nominal demand for financial assets is higher than the nominal supply of financial assets, the price will rise, thus equilibrating the

asset market.[11] Hence, in order to depict a Kindleberger-type asset price bubble in our formal model, we introduce a mechanism that consists of two parts. In a first step, we stimulate a rise in demand for a certain asset class exogenously. The cause for this is mainly due to the deregulation of financial markets, depicted in the rise of the OFI sector. Trigger events can be changes in portfolio preferences, or a specific set of initial conditions or dynamics at a certain time period, see below. Secondly, the mechanism must make sure that this rise in demand triggers an endogenously accelerating positive feedback loop between two or more agents in the model, relating credit creation to financial investment. Once triggered, this loop keeps pushing the demand for, and hence the price of the asset endogenously, thus forming a bubble.

The concrete manifestation of the initial (exogenous) trigger can take various forms at different times, which will be further studied in different scenarios and simulations. Currently, we consider four specific types:

1. More credit for speculative reasons.
Here we consider an increase in the credit supply by banks to the OFI sector (L_{ofi}) that is channeled into investment in financial assets and tends to inflate asset prices, depicting an institutional change in the financial system. Furthermore, we explicitly depict the possibility of credit creation within the OFI sector, i.e. the issuance of shares and purchase of assets with the cash flow received for selling OFI shares. The latter mechanism corresponds to a balance sheet extension of the OFI sector, depicting additional credit creation due to the complex interaction of various institutions within the modern financial system.

2. Decreasing returns in the real economy.
If returns to financial investment become more profitable relative to real investment, firms are induced to shift to financial rather than real investment according to their portfolio choice as given in equations (16) to (20).

3. Securitisation
Securitisation improves commercial banks' balance sheet and allows more aggressive loan provision to households and the OFI sector as described in section 3.2.3.

4. A preference shift of households.
An increasing propensity of the household to invest in OFI shares will increase demand for these assets and hence tend to inflate asset prices, i.e. the portfolio choice parameters $\lambda_{i,4}$ regarding investment in OFI shares increase relative to the other parameter values.

The way we model the endogenous feedback loops leading to the build-up of the bubble is as follows. In each of the above trigger cases, there is a rise in nominal demand for financial assets. As said before, if there is more money available for demanding financial assets than the nominal value of financial assets, prices rise. Increasing asset prices

[11] While the use of mark-up pricing and supply adjustment is quite common in heterodox modelling literature for goods markets, Godley and Lavoie (2007) argue that the price equilibrating mechanism makes sense for financial markets.

then induce pro-cyclical leverage effects, Adrian and Shin (2010), as agents' net worth increases due to capital gains as described in section 3.2.4.

As the value of financial assets held by firms and households rise, also their net worth rises. Through these capital gains, firm and household leverage goes down, and they can take up more new loans. Since also banks hold some of these assets, also their net worth rises, improving their leverage ratio, allowing also the issuance of more credit. For banks, however, there is an additional effect; securitising loans from firms and households, and selling these to the OFI sector, improves their leverage even more.

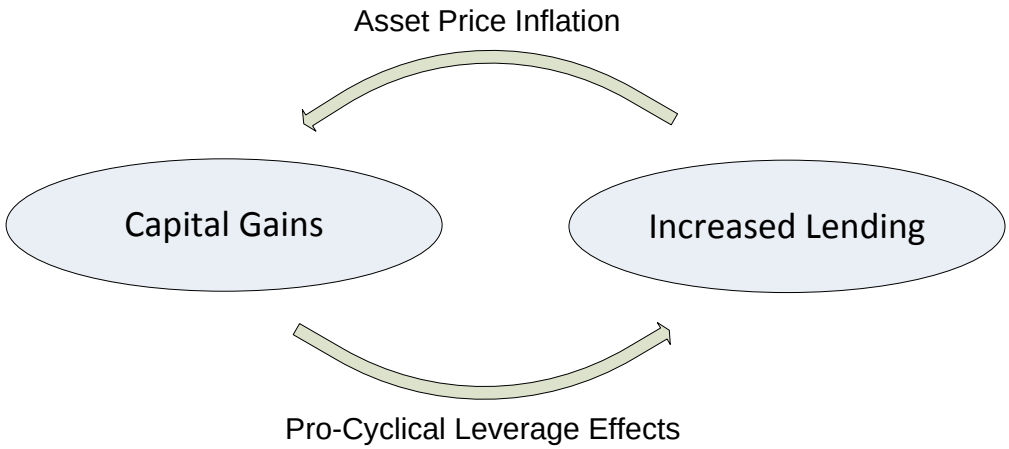
These additional lending possibilities can be drawn upon by firms and households, who use the new funds for real investment (housing and capital stock). The housing market plays a special role. Firstly, increased mortgage lending further fuels the credit cycle by providing more collateral for loans and securitisation. Secondly, increased lending or rising profits generally imply not only a rise in prices of financial assets, but also a rise in demand and hence prices for housing. This price rise might even be steeper, since the stock is quasi limited. Also here capital gains imply a pro-cyclical leverage effect, and may start a lending fuelled boom. Nikolaidi (2014) provide a similar mechanism in an SFC model.

While conventional bank credit may be used mainly for real investment, in their portfolio choice households and firms shift to financial assets due to higher returns of OFI shares compared to more traditional forms of saving (deposits). Hence the main feature of increased bank lending is that, thinking in aggregate terms, the newly created credit is channelled back into the financial sector to a high degree.

The shadow banking sector plays a very complex and probably the most important role in our framework. OFIs issue shares (near-monies), which are bought by households, firms and banks as assets in return for cash/deposits. Issuing shares, this sector expands the supply of non-bank credit. Regulation in respect to the leverage ratio (outstanding shares to net worth) is much less stringent for OFIs than for the banking sector (we even assume a net worth of zero in this preliminary version of the model). In search for a high yield, OFIs use the revenues from their share sales to purchase equity, bonds and securities, thus also indirectly raising demand for financial assets. Rising demand for financial assets again raises prices, yielding capital gains and improved leverage.

As this process iterates, the dynamic also reinforces all of the initial trigger situations. Such a boom is actually characterised by (1) increased lending for speculative reasons, (2) increasing returns on financial investment (and decreasing real returns), (3) a worsening of the functional income and wealth distributions, due to capital gains, and (4), a preference shift towards financial investment due to further expected capital gains.

Figure 2: Central Model Mechanism: Dynamics of a Kindleberger Cycle



While the build-up of a Kindelberger-type asset price bubble is quite similar in each case, the initial triggers of the mechanism, as described above, vary according to historical circumstances. The same is true for the timing of and the reason for the burst of such a bubble.

In a historical perspective, the importance of bank credit (used for real investment) is typically diminishing during the course of a long swing of a financial cycle, while the importance of non-bank credit (the issuance of OFI shares that fuel demand for financial assets) is increasing. Once it exceeds a certain size, the OFI sector is left with a severe liquidity problem. On its balance sheet short term liabilites, the OFI shares that can be claimed any time, are opposed by long term assets, such as bonds, equity, and securities. A run on these near-monies (OFI shares) is the classic trigger for the burst of an asset price bubble, see Pozsar et al. (2013).

Another crucial matter arises from securitisation. We model securitisation techniques similar in spirit to Bhaduri et al. (2015) and Nikolaidi (2014). As OFIs buy securities from banks, they take risk off the balance sheets of banks, who improve leverage ratios. The risk, however, accumulates at the OFIs balance sheets, though in the somewhat hidden form of securities. This creates another possibly severe instability emanating from the unregulated OFI sector. As loans may default, OFIs face the risk of a devaluation of its assets, and may not be able to pay all their depositors, a situation that would again lead to a run on OFI shares.

Bursting of an asset price bubble It will be crucial to specify at what point and due to what reason the asset price bubble breaks and potentially leads to a crisis. This will be determined by a mechanism in the model, depending on certain endogenous indicators, e.g. the debt-to-GDP ratio, see also Godley and Lavoie (2007) for similar mechanisms in SFC models. Certain parameters in behavioural functions will be made endogenous

in the sense that they are first kept constant, and then change their values continuously, if a certain ratio rises above or below a certain threshold. This represents a prudential behavioural reaction of the agent, induced by some looming constraint that the agent might face, e.g. a budget constraint.

Specifically, households may cap their demand for new loans in the case when the debt-to-wage ratio has risen above a certain threshold. This could reduce consumption, and multiply into reduced real output growth. Demand for government bonds might go down in the case that the public debt-to-GDP ratio exceeds some limit. A high level of the price-earnings ratios on firm equity may induce households, banks and OFIs to disinvest in firm equity. Households may also reduce demand for OFI shares in several cases. For example, this could happen , if the amount of reliable collateral in the economy seems too low, or if the share of risky assets (OFI shares) in the household's balance sheet may be too high. All these incidences would lead to a reduced demand for certain asset types, setting a negative impulse to the corresponding price.

These trigger points (the ceillings for the various ratios) are set exogenously, while they are invoked by the endogenous model dynamics. The way the model reacts to these events, once triggered, depends on the specification of the model equations, but is truly endogenous. Typically, in a downward movement of asset prices, net worths of agents will shrink due to negative capital gains. Thus it is quite probable in such a case that behavioural reactions of many other agents will be triggered soon after, leading into a downward spiral. In this way we can depict the burst of an asset price bubble, and its overall economic effects.

An alternative mechanism for boom and burst of an asset price bubble might be to introduce for each sector a *noise trader*, who trades according to past development of asset prices (trends), as well as a *fundamentalist trader*, who trades according to the deviation of the price trend from an (exogenous) fundamental price of the asset, see e.g. Beja and Goldman (1980). While this approach is well-explored for agent based models, it has not been used extensively for SFC models according to the knowledge of the authors. Therefore, even though a highly promising direction of further research, early versions of this model will most probably rely on the trigger ratios as specified above.

Defaults of assets held by the OFI sector (e.g. securitised loans) are somewhat hard to depict in model with aggregate agents and asset positions like this. This also brings up the issue of credit default swaps (CDS). CDS are specifically tricky, since only the risk premium appears on the subscribers' balance sheets, and not the amount of insurance provided in case of the event of a loss. Therefore we propose to research recent empirical data to quantify a reasonable size of reduction of the OFI's balance sheet in such a case, and to pursue an ad-hoc approach in modelling credit defaults and its consequences.

4 Model Implementation and Simulation (Work in Progress)

4.1 Data

WORK in PROGRESS

To construct the balance sheets and other elements of the SFC framework (the transaction flow matrix and the re-evaluation matrix), we use historical data from the financial and non-financial sector accounts for the Eurozone provided by Eurostat, see Eurostat (2013) and Bê Duc and Le Breton (2009).[12] The size of the OFI sector, however, cannot be inferred from the Eurostat data alone. For the calculation of OFIs' balance sheets, Eurostat Sector Accounts data will be supplemented by data on the balance sheets of monetary and other financial institutions, as provided by the European Central Bank (ECB)[13]. Furthermore, we will use the ECBs financial balance sheet, following the methodology of Bakk-Simon et al. (2012) and IMF (2014), and verify our aggregates for the Eurozone with the results obtained in ECB (2014).

4.2 Calibration Procedure Foreseen

WORK IN PROGRESS

After building the theoretical structure of the model, it will be calibrated to the historical developments in the Eurozone in the past two decades, using yearly ESA data from 1995-2014.

Thereby, we also take into account macroeconomic policies which were implemented in the period from 1995 to 2014. Additionally, we consider exogenous shocks such as the collapse of the US housing bubble in 2008, its contagion to the Eurozone and the corresponding reaction of European policy makers.

The model equations emerging from this second step will contain behavioural parameters, such as elasticities and marginal propensities. In the third step, we will reformulate the model equations in terms of these parameters and calculate (from the time series of the balance sheets obtained in the first step) yearly values for these parameters for 1995-2014. In the fourth and last step we will analyze the resulting time series of parameter values concerning their development, and make a medium term forecast of these parameter time series.

The model will be set to have 1995 as starting year. The parameter values for 1995-2014, which were determined in the third step, will be used for these years. This guarantees that the model results fit the data for this period, and the model is able to adequately replicate the past.

Calibrating Kindleberger cycles will be the most interesting part. The kind of event triggering a financial bubble, and the degree to which it is credit-fuelled, vary over the past according to historical reasons. As we calibrate the model to Eurozone data and, we fit it to empirical evidence of cycles of the recent past. Thereby the aim is to make

[12] See `http://ec.europa.eu/eurostat/web/sector-accounts` [Last accessed July 20, 2015].

[13] Data of the ECB on balance sheets of various financial agents can be found in the ECB statistical data warehouse, `http://sdw.ecb.europa.eu/home.do` [Last accessed July 20, 2015]

sure to identify the decisive trigger for the build-up of a bubble driving the model in past periods, and to use it in the calibration.

4.3 Future Work - Simulations Foreseen

WORK in PROGRESS

In a first step, we will run a 10-year 'business-as-ususal' scenario of our model. Starting from the balance sheets for 2014, the parameter values of the equations will be forecasted as described above and used to calculate the baseline trajectory of the model. The baseline scenario will depict the evolution of the balance sheets of the model from 2015-2025. The trajectory of the model economy will follow an endogenous dynamic, possibly but not necessarily depicting a balanced growth path. The 'business-as-usual' scenario does not include any policy measures and will thus be the baseline for the following scenarios.

In a second step, we will simulate the effects of different policy measures with the aim to assess their suitability for fostering sustainable long-term growth in Europe. Among these scenarios are the following:

- Firstly, we analyze different possbilites of financial regulation (e.g. leverage ratios) and macro-prudential policies, especially regarding their effects on the creation of (bank and non-bank) credit used for financial investment. Generally, attempts of macro-prudential financial regulation relating only to a part of the financial system, e.g. the traditional banking sector, might lead to increased credit expansion in other parts within the model, e.g. in the shadow banking sector (boundary problem). This might influence the effectiveness and ability of policy to curb asset price bubbles, see Goodhart (2008). Since in our model we picture a differentiated view on the financial sector with institutional detail, we can assess detailed policy options specifically relating to the now largely unregulated OFI sector.

- Secondly, analyze the effects of fiscal expansions and fiscal consolidations. Most importantly, we simulate different tax regimes, different debt roll-over scenarios, paths of debt-to-GDP ratios, as well as implications on interest rates and solvency conditions. Thereby, among others, we are able to assess the economic effects of different ways to handle high government debt levels.

- Also, we simulate a coherent investment plan for the Eurozone, financed by the European Investment Bank (EIB). Within the logic of our model, the EIB is part of the banking sector. In the scenario we analyze the role of different financing conditions for this investment plan. Among these are the direct credit issuance from the EIB to the member states, and extensive bond purchases by the EIB. Thereby, the EIB can either finance national, government-fundend projects supported by government bond purchases, or provide direct credit to corporations.

- We simulate the effects of an expansion and contraction of both conventional and unconventional monetary policy measures by the central bank. Specifically, we

analyze the impact of the current asset purchase program. We look at effects of increases and decreases in the ECB's asset purchases from banks and other financial institutions, and at the implications of a change in the volume of general liquidity assistance, which it regularily grants to banks.

By means of the simulations, we will obtain the effects of each of these measures on the overall macroeconomic dynamic. Depending on the speed, the timing and the order of implementation of these policies, the effects will be more or less severe, and may even change direction after some time. This is due to the endogeneity of the model's dynamics. We will analyze the impact of the policy measures in the short, medium and long run. Specifically, we will evaluate which policies are effective in fostering sustainable growth in Europe, and which are not. We will furthermore assess which sectors benefit from these policies, and which will lose.

All of these scenarios, and others to be developed, shall serve to find a policy mix effectively capable of stimulating long-term economic growth in Europe. While we can account for financial-real interactions and macro-prudential regulations, we are also able to include fiscal stimulus, unconventional monetary policy and direct investment financing by an investment bank.

Our comprehensive framework will be uniquely suited for this task, providing credible scenario projections of growth-sustaining policy options in the Eurozone. By catering to the complexity of the modern financial system, we also consider for the boundary problem in financial regulation, further supporting our results.

4.4 Future Work: Simulation Results

WORK in PROGRESS

5 Conclusions (Work in Progress)

WORK in PROGRESS

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Figure 3: An extended financialised monetary circuit - functioning of the shadow banking systems, taken from (Botta et al., 2015, p. 48)