UNIVERSITY OF MILAN

LOMBARDY ADVANCED SCHOOL OF ECONOMIC RESEARCH

PhD in Economics
XXVIII Cycle

Essays on Inequality, Household Debt and Financial Instability

Candidate: Alberto Cardaci

Supervisor: Prof. Domenico Delli Gatti

PhD Coordinator: Prof. Paolo Garella

Academic Year 2014-2015

Table of Contents

Introduction

1 Content of the Thesis

My Ph.D. thesis contributes to the growing literature on the link between inequality and economic crises, focusing in particular on the relationship between rising income disparities, household debt dynamics and the resulting financial instability.

In the first paper, I review both the theoretical and the empirical literature on inequality, by paying particular attention to the way this topic has been treated over time by the economics research agenda. I show that the impact of growing income disparities on the macroeconomy has been ignored for a long period of time, particularly starting from the 80s. Only after the recent financial crisis, the issue of income and wealth distribution has come back on the top of the agenda of economists as well as policymakers.

In the other two papers, I build two macroeconomic models that focus on the link between income inequality, household debt and economic crises.

The first one is an Agent-Based (AB) macroeconomic model aimed at describing the key mechanisms through which rising inequality jeopardises economic stability in an economy with peer effects in consumption and equity extraction processes. I show that greater income disparities imply stronger expenditure cascades along the income distribution as well as asset (i.e. house) price appreciation. In the presence of home-equity based borrowing behaviour by households, private debt rises thus pushing aggregate demand upwards despite income stagnation over much of the distribution. However, debt-driven consumption endogenously triggers the accumulation of a larger amount of non-performing loans on banks' balance sheets which eventually lead to a credit crunch and an economic downturn.

The second model, a joint work with Francesco Saraceno which I carried out during my visiting period at OFCE-SciencesPo in Paris, is a macroeconomic model with an Agent-Based household sector and a stock-flow consistent structure. The goal of this work is to analyse the impact of rising income inequality on the likelihood of a crisis under different institutional settings and degrees of financialisation. In particular, we reproduce a multitude of scenarios showing how financial and credit conditions interact with the impact of growing inequality on the performance of the economy and the accumulation of household debt. Our results show the relevance of the

"degree" of financialisation of an economy. In fact, when inequality grows, a *Scylla and Charybdis* kind of dilemma seems to arise: on the one hand, economies with low credit availability experience a drop in aggregate demand and output; on the other hand, where credit constraints are relaxed and the willingness to lend is higher, greater financial instability emerges and a debt-driven boom and bust cycle. We also show that policy reactions play a key role: a real structural reform that tackles inequality, by means of a more progressive tax system, actually compensates for the rise in income disparities thereby stabilising the economy. Results also show that this is a much better solution compared to a stronger fiscal policy reaction, which, instead, has no significant impact on the performance of the economy.

2   Complexity and Agent-Based Models

In this section, I would like to point out the key features of AB models and as this is the methodological approach used for the purpose of my work.

The agent-based methodology lies within the paradigm of Complex Adaptive Evolutionary Systems, a highly interdisciplinary approach that ranges from physics to linguistics, as well as economics, of course. As defined by Flake (1998), a complex system is one that has macro properties that may be traced back to the interactions of the micro units that are not properties of the individual units themselves. Therefore, the idea of complexity is that "the laws that describe the behaviour of a complex system are qualitatively different from those that govern its units" (Vicsek, 2002). Put it differently, Vicsek (2002) points out complexity is the idea that the world is made of several interconnected parts (agents, in our case) whose interactions produce a complex result and global regularities that need different interpretations of each level. As such, complexity fosters a holistic and organicist approach in that the behaviour of the whole system depends on its single units but it does not stem simply from sum of them. To clarify this, we can recall the example by Denis (2010) who makes a comparison between the points of view of two prominent economists on this matter: Friedman and Hayek. Friedman (1962), who has a reductionist view, argues that the macro result is simply an aggregation of a large numbers of isolated microelements: economics is based on the study of "a number of independent households, a collection of Robinson Crusoes". On the contrary, Hayek (1978) sees individuals merely as "the foci in the network of relationships", thus stressing the importance of the interconnections among individuals.

Friedman's reductionist perspective drives current economic modelling: as highlighted by Delli Gatti et al. (2011), "contemporary models postulate that there is not any significant difference between microeconomics and macroeconomics: the dynamics of the whole is nothing but a summation of the dynamics of its components".

Agent-based models break the mainstream paradigm as they allow to model the economy as a seldom system showing a tendency towards self-organisation (Delli Gatti et al., 2011; Dolphin, 2012). That is, the economy is modelled as a complex evolving system: it is an ecology populated by heterogeneous agents whose interactions continuously change the structure of the system (Fagiolo and Roventini, 2012). Indeed, at the micro level, agents repeatedly interact with each other based on adaptive and imitative behaviours thus giving rise to stable and predictable aggregate configurations at the macro level (Delli Gatti et al., 2011; Tesfatsion, 2006). However emerging aggregate patterns and global regularities such as employment and growth rates, income distributions, market institutions, and social conventions have a feedback effect into the determination of local interactions among agents. That is to say, there is a mutual feedback between the system of microstructures and the emerging macro regularities mediated by agent interactions.

In AB models, agents may be economic and social entities as well as biological or physical ones. In economics, agents are typically assumed to have bounded rationality a là Simon (1957; 1997; 2000) as well as adaptive expectations. Indeed, the complexity of the human environment, the limited cognitive and information processing capacities make the goal of optimisation virtually unrealisable in real life[1]; people, instead, rank viable options in terms of degrees of satisfaction and act accordingly, until a previously identified threshold of acceptability is met or exceeded (Schwartz et al., 2002). In other words, the decision making process is based on a *satisficing* principle (Simon, 1987): "to satisfice is to pursue not the best option, but a good enough option" (Schwartz et al., 2002). Individual behaviour is driven by simple heuristics that are nothing but encoded algorithmic programs or instructions telling agents what to do (or not to do) when facing certain contingencies (Delli Gatti et al., 2011). The design of such behavioural rules and algorithms may evolve over time through adaptation to environmental conditions.

Finally, another relevant feature of AB models deals with the solving mechanism. As a matter of fact, despite the introduction of some Keynesian elements of rigidities (e.g. sticky prices, imperfect competition or financial frictions), the standard approach in macroeconomics still entails a Walrasian perspective: a general equilibrium solution that implicitly or explicitly implies the presence of a fictitious auctioneer who sets prices before exchanges take place, thus paving the way for market clearing. However, this is "a coordination device that eliminates the possibility of strategic behavior" (Tesfatsion, 2006). Indeed, it rules out almost by definition the possibility of interactions carried out by heterogeneous individuals (Fagiolo

---

[1]Some agent-based models with optimising agents exist though. See for example Dosi and Staccioli (2015).

and Roventini, 2012). Contrary to the mainstream approach, agent-based models do not assume any centralised solving mechanism: no equilibrium is exogenously chosen; instead, AB models allow for the endogenous formation of an equilibrium, if it exists (Delli Gatti et al., 2011).

All the features mentioned above make agent-based models extremely flexible tools that can be used as computational laboratories for the analysis of policies under more realistic scenarios.

References

Delli Gatti, D., Desiderio, S., Gaffeo, E., Cirillo, P., and Gallegati, M. (2011). *Macroeconomics from the Bottom-Up*. Milano, IT: Springer.

Denis, A. (2010). A century of methodological individualism part 1: Schumpeter and menger. Report 10/02, London, UK: Department of Economics, City University London.

Dolphin, T. (2012). Macroeconomic policy in a complex world. In Dolphin, T. and Nash, D., editors, *Complex New World: Translating New Economic Thinking into Public Policy*, pages 70–81. London, U.K.: Institute for Public Policy Research.

Dosi, G. and Staccioli, J. (2015). Bubble-and-bust dynamics under walrasian asset pricing and heterogenous traders. *Working paper*.

Fagiolo, G. and Roventini, A. (2012). Macroeconomic policy in dsge and agent-based models. *Revue de l'OFCE / Debates and Policies*, (124).

Flake, G. W. (1998). *The Computational Beauty of Nature: Computer Explorations of Fractals, Chaos, Complex Systems and Adaptation*. Cambridge, MA: MIT Press.

Friedman, M. (1962). *Capitalism and Freedom*. Chicago, IL: Chicago University Press.

Hayek, F. A. (1978). *New Studies in Philosophy, Politics, Economics and the History of Ideas*. London, UK: Routledge and Kegan Paul.

Schwartz, B., Ward, A., Monterosso, J., Lyubomirsky, S., White, K., and Lehman, D. R. (2002). Maximizing versus satisficing: Happiness is a matter of choice. *Journal of Personality and Social Psychology*, 83(5).

Simon, H. A. (1957). A behavioral model of rational choice. In *Models of Man, Social and Rational: Mathematical Essays on Rational Human Behavior in a Social Setting*. New York, NY: Wiley.

Simon, H. A. (1987). Satisficing. In Eatwell, J., Milgate, M., and Newman, P., editors, *The New Palgrave: A Dictionary of Economics*. New York, NY: Wiley.

Simon, H. A. (1997). *Models of bounded rationality, vol. III*. Cambridge, MA: MIT Press.

Simon, H. A. (2000). Barriers and bounds to rationality. *Structural Change and Economic Dynamics*, (11).

Tesfatsion, L. (2006). Agent-based computational economics: A constructive approach to economic theory. *Computing in Economics and Finance*, (527).

Vicsek, T. (2002). The bigger picture. *Nature*, (418).

Inequality and Economics: a Literature Review

Alberto Cardaci

Lombardy Advanced School of Economic Research, Milan

Abstract

This paper provides a review of both the theoretical and empirical literature on inequality, by paying particular attention to the way this topic has been treated over time by the economics research agenda. Indeed, after being at the core of the economic profession for decades, the issue of inequality has entered a phase of declining interest starting from the 80s. The issue of inequality has been ignored for so long due to several reasons, among which we find Kuznets's optimistic conclusions (Piketty, 2013), the emergence of new mathematical models based upon the representative agent postulate (Piketty, 2013; Mian and Sufi, 2014), and the belief that people can make an efficient use of credit markets to insure against temporary fluctuations of income (van Treeck, 2012). However, after the recent financial crisis, the issue of income and wealth distribution has come back on top of the agenda of economists as well as policymakers.

Keywords: Inequality, Household Debt, Credit Markets, Literature Review

JEL Classification: A31, D31, E21, G01

1 Introduction: Key Facts About Inequality

How unequal is our world? How has income distribution changed over the last decades? After being neglected for the past years, inequality has come back on top of the agenda of both economists and policymakers. The former have been collecting a wide range of data in order to answer to the questions mentioned above; the latter are increasingly concerned about local and global widening income disparities.

The empirical literature suggests we live in an incredibly unequal planet.

Ortiz and Cummins (2011) provide an overview of global, regional and national income inequalities based on World Bank, UNU-WIDER and Eurostat data. Using two different methodologies[1], they find that "the wealthiest 20 percent of mankind enjoyed nearly 83 percent of total global income compared to the poorest 20 percent" (Ortiz and Cummins, 2011). Even more striking is that the poorest 40 percent increased its income share by less than 1 percent in the period between 1990 and 2007. Data are slightly better under a different estimation methodology but "both models reveal a world that is deeply corroded by income disparities" (Ortiz and Cummins, 2011). In addition, as far as some progress seems to be taking place for the poorest, the authors estimate that, at this speed, it would take 855 years for the bottom billion people to gain 10 percent of global income.

Moatsosm et al. (2014) use six different data sources to estimate Gini coefficients across countries over time starting from 1820. Their results show that, apart from very few exceptions (including Japan and South Africa) the vast majority of countries analysed experienced a major increase in income inequality starting from the 1980s. Interestingly enough, they also show that between 1820 and 2000 global inequality (i.e. income inequality as if the world were one country) increased mostly due to rising between-country inequality rather than within-country inequality. However, "the exceptions to this pattern are the years leading to 2000, when the increase in within-country inequality just offset the decrease in between-country income inequality". Finally, they also point out that, within the same long period of time, global interpersonal income inequality increased by 30%.

In line with these results, a recent report by the OECD (2011) highlights that the average Gini coefficient for OECD countries increased from 0.29 in the mid-1980s to 0.316 in the late 2000s: a rise of almost 10%. Put it differently, in OECD countries, the average income of the richest 10% of the population is roughly nine times that of the poorest 10%. The same report concludes that the main explanation for such a dramatic upsurge in income disparities is to be found in the changing distribution of wages and salaries, "which account for 75% of household incomes among working-age

---

[1]Ortiz and Cummins (2011) use both global and inter-country accounting models to look at global income distribution under (1) market exchange rates, comparing national income estimates in constant 2000 U.S. dollars and (2) PPP-adjusted exchange rates.

adults" (OECD, 2011). Indeed, earnings' shares at the top have increased particularly rapidly, whereas those at the bottom have declined steadily (Atkinson, 2009).

This paper is structured as follows: Section 2 introduces a historical perspective on the role of inequality in economics, starting from the second half of the last century; Section 3 focuses on the relationship between inequality, growth and financial stability, a topic of research that has become undoubtedly more important after the outbreak of the recent financial crisis in the United States; Section 4 provides an overview of the main models that have been used to analyse the issue of inequality and its impact on growth and stability; Section 5 concludes.

2 Inequality and Economics: a Historical Perspective

As Pasinetti (2000) points out, the origin of the exploration of distribution can be traced back to David Ricardo in 1817, whose work "may be taken as a synthesis of classical theory". Since then, the literature has been growing and the link between inequality and growth has been studied in both directions. Yet, changes in the prevailing economic theory, as well as in the political and social institutions, have prevented economics to come up with a shared point of view on this matter.

For the sake of simplicity, we focus on the debate on the relationship between inequality and growth in the second half of the twentieth century. This "short" period of time can be split up in three main time slots based on the prevailing view. The period from the 50s until the 70s was characterised by Kuzents' ideas as well as the contributions by the post-keynasian school (Kaldor, in particular). In the following period, from the 80s until mid-90s, less attention was paid to the role of inequality as the prevailing theory of that time was more concerned with the link between innovation and growth. This is particularly surprising, since starting from the late 70s income inequality, particularly in the United States, started to grow dramatically. In addition, economic analysis was carried out by means of representative agent models that ruled out any consideration about distributional issues. Only starting from the late 90s and the 2000s the economic literature has turned back to inequality. Eventually, in the wake of the recent financial crisis in the U.S., some economists have also argued that growing income disparities should be identified as the main cause of the financial disaster.

Let us go through these stages.

2.1 1950s-1970s: Kuznets and the Pioneers

In the early 50s, most of the literature dealt with the relationship between distribution and growth by exploring one direction of causation, that is the long-run impact of growth on income distribution, while no attention was paid to the reverse causality.

The most important contribution dating back to that period is the research by Simon Kuznets who, as a matter of fact, tried to find an answer to the following question: "Does inequality in the distribution of income increase or decrease in the course of a country's economic growth?" (1953; 1955). Kuznets provided useful insights on this matter: compared to previous authors, he based his analysis on an outstanding collection of national accounting data, as well as fiscal declarations, for the United States over the period 1913-1948 (Kuznets, 1953). In particular, in his work "Economic Growth and Income Inequality" (1955) he mainly focused on the effects of economic development on income distribution in the long run. By means of a two-sector model, he suggested that income inequality tends to rise in the early stages of a country's economic development while it narrows in the later stages. In particular, as Atkinson (1997) puts it, Kuznets claimed that "a rise in the proportion employed in the higher income industrial sector could, on certain assumptions, lead first to rising and then falling overall inequality". This inverted-U relationship, also known as the Kuznets' curve, became very popular in the following years thus being the backbone of the economic literature until the late seventies. For example, since then, several works have focused on the empirical validation of the inverted-U hypothesis, with results that both support and reject it.[2]

In the same period, however, a different branch of the literature focused on aspects related to the functional distribution of income and its determinants. Such contributions came from the (post-)Keynasian school of thought that was particularly concerned with the direction of income distribution and the way the factors of production are remunerated. In particular, Kaldor (1955) built a "Keynesian" theory of distribution based upon the works by Harrod (1939; 1948) and Domar (1946). Put it simply, the major contribution of the post-Keynesian school is the so-called "Cambridge Equation": $\pi = g/s_p$, where π is the rate of profits, g is the natural growth rate and s_p is the average propensity to save of capitalists. This equation determines the distributive shares of profits and wages, challenging the neo-classical view that factors of production are remunerated at their marginal product. In particular, in their view, the category of profits "is determined in first instance, by the requirements of the accumulation necessary to sustain the given growth of the working population and the given growth of productivity" (Pasinetti, 2000). Eventually, wages are determined as a residual.[3]

---

[2]Galor and Tsiddon (1996) provide a list of both types of works.

[3]Note that this Kaldorian theory of distribution reverses the causality suggested by

2.2   1980s: Neoclassical Economics Strikes Back

Post-keynesian contributions did not succeed in gaining long-lasting attention. Indeed in the late 1970s emerging economic problems such as stagflation, together with the inability of policymakers to react to supply shocks, yielded a spectacular policy failure that carried with it the Keynesian paradigm which was eventually left aside.

Starting from the 80s, economists neglected the role of distributional matters, thereby shifting their focus towards other issues. The rational expectations revolution, started by Lucas (1973, 1976), contributed to bringing back to the top the essence of the old neoclassical model. As a matter of fact, in that period, the emerging typology of models dealt with the issue of "how technical progress may not only be received from external sources, but could itself be produced by an economic activity explicitly targeted on it" (Pasinetti, 2000). Hence, as pointed out also by Stern (1991), the role of inequality became a less prominent topic in the "endogenous growth" models developed in the 80s: they were built as inter-temporal optimisation problems á la Ramsey, featuring infinitely-lived and perfectly rational representative agents who maximise an objective function under some constraints. As a result of such "micro-foundations", this typology of models rules out the role of distribution and inequality. As Pasinetti (2000) puts it:

> Among whom could income be distributed, if it always and entirely goes to the same 'representative' individual? Of course, it could go to the same individual in different forms; for example as wages and/or as profits. But to this distinction, if the 'representative' individual pockets all, it becomes difficult, or at any rate problematic, to find any significance. It is in fact the same individual who, by acting with maximising behaviour, will have her income emerging as profit or as wage according as to which is more appropriate for the maximisation of the utility and production functions. In other words, whether the income is received in one form or in the other becomes a consequence of the maximising process. Once again, the characteristics of the income distribution become purely secondary, which is a logical consequence of a basically neoclassical scheme.

The issues highlighted by Pasinetti were valid for the 90s but they have a certain relevance even today. As a matter of fact, Atkinson claims that in the past, "changes in income distribution have often been dismissed as too insignificant to be worth attention" (1997). Also Piketty (2013) stresses

---

Ricardo who believed that wages are determined first, whereas wages come afterwards. Further details about the controversy between Neoricardians and Post-Keynesians can be found in the discussion between P. Garegnani and J. Robinson in the Cambridge Journal of Economics in 1978-1979 (Garegnani, 1978, 1979a,b; Robinson, 1979)

that for a long period of time, economists have ignored distributional issues "partly because of Kuznets's optimistic conclusions and partly because of the profession's undue enthusiasm for simplistic mathematical models based on the so-called representative agents". Mian and Sufi (2014) argue that income and wealth distribution matters when dealing with macroeconomic issues but this is not taken into account by most of the economists as they adopt the representative-agent modelling framework that drops all the distributional considerations.

2.3   1990s: Inequality Gets Back on the Agenda

Starting from the mid-1990s, the role of distributional issues has come back on top of the agenda. Bourguignon (1996) claims that "distribution is again seen as an important dimension of development" and he also mentions a number of studies that "seem to confirm the significance of the statistical link between growth and inequality".

For example, at the World Bank, Deininger and Squire (1996) compile a new dataset of Gini coefficients and other measures of distribution for 108 countries. In their paper the authors re-examine the interactions between growth and inequality and their effects on poverty reduction. To this purpose, they use two new datasets focusing on income inequality and the distribution of land (a proxy for assets). This latter provides a better measure of initial allocation since information on the distribution of land in 1960 is available for a much larger number of countries. Deininger and Squire also incorporate some inter-temporal elements into the analysis of Kuznets, in contrast to past efforts that relied on cross-country information. Their main finding is that initial income inequality is not a robust determinant of future growth, while land inequality (i.e. the distribution of original assets) has a significant and negative impact on overall growth. Reduced inequality is therefore important, because it might modify, possibly positively, the future rate of growth (Bourguignon, 1996).

Hence, the main focus of the literature was on the inequality-growth causality, since "the central concern does not basically consist any more in considering the degree of income inequality as the result of economic growth in the long run (and more exactly as the consequence of the level of development) but mainly focuses on the role of the distribution of income and wealth in the process of economic growth." (Ehrhart, 2009). That is, "the present debate on the relationship between inequality and growth is based on the idea that, through different channels, equality may serve as an engine for growth" (Bourguignon, 1996).

Deininger and Squire's results (see also Deininger and Squire, 1998) give new impulse and empirical justification to a theoretical literature that introduces rigidities in the standard representative agent model, thus bringing back income distribution in macroeconomic and growth models. A typical

example is the two-period model by Galor and Zeira (1993) (see also Aghion et al. 1999): in such a model, the capacity of individuals to invest in human capital and acquire and improve skills is constrained by their initial endowment, which therefore impacts investment in the short run and productivity in the long run. In a more recent example, Cingano (2014) stresses the negative link between income inequality and growth via insufficient accumulation of human capital.

The impact of inequality is also analysed in the presence of imperfect capital/credit markets. Two important contributions, namely Aghion and Bolton (1997) and Piketty (1997), show that an increase in inequality worsen the credit constraint that agents face "and thereby reducing the possibility for poor agents to cross the threshold of wealth needed to become entrepreneurs" (Colombo and Driffill, 2003).

Aghion and Bolton (1997) introduces inequality in a model with imperfect capital markets in order to analyse the trickle-down effect of capital accumulation. The authors find that the process of capital accumulation has a widening effect on inequality in the early stages, thus inverting the trend in the later ones. In addition, they also show that the redistribution of wealth from rich lenders to poor borrowers results in greater equality of opportunities and it also accelerates the trickle-down process thereby improving production efficiency.

Piketty (1997) extends the standard Solow model with the introduction of imperfect credit markets. This allows to overcome the irrelevance of wealth distribution in the original setting, as the resulting credit rationing may upset the relationship between interest rates and the marginal product of capital. The model shows that higher interest rates result in lower long run capital accumulation as credit-constrained individuals need long time to rebuild their capital.

Another strand of the literature describes the impact of inequality on growth by focusing on the political economy channel. As a matter of fact, Alesina and Perotti (1996) show that a highly unequal distribution of income and wealth entails social tensions and increases political instability. This in turn can lead to sub-optimal investment, jeopardising the ability of political systems to respond effectively to external shocks: a greater share of resources is dedicated to bargaining over the distribution of rents, thus threatening the security of property rights, and discouraging capital accumulation. In a related contribution, Alesina and Rodrick (1994) build a model showing that excessive inequality may lead the median voter to opt for higher tax rates that, being distortionary, in turn reduce incentives for investment and long term growth.

As far as inequality gets back on the agenda, the economic literature in the '90s did not challenge the key aspects of the dominant paradigm. Indeed, most works still assume that frictionless markets work efficiently and factors are remunerated at their marginal product. As such, income

distribution needs not to be a policy objective. In addition, when markets are not well-functioning, optimality can be restored by means of structural reforms that aim at eliminating frictions. Hence, income redistribution may be accepted only as long as it does not introduce further distortions, thereby remaining a second best option.

3   Inequality and Financial Instability

In the late 2000s, after the outbreak of the financial crisis a growing number of economists argued that there exists a link between the reported major widening of income disparities and the jeopardisation of financial stability (Fazzari and Cynamon, 2013; Fitoussi, 2013; Fitoussi and Saraceno, 2011; Frank et al., 2014; Galbraith, 2012; Stiglitz, 2012, 2013; Van Treeck, 2012). This argument gave impulse to the emergence of an empirical literature debating the relationship between inequality and economic crises. Yet, contrasting positions have emerged. For example, Bordo and Meissner (2012) find strong evidence that credit booms lead to banking and financial crises but no significant evidence that such booms are a result of changes in income concentration. This is in line with Atkinson and Morelli (2011), who claim that there is limited support for the hypothesis of causality between variations in income inequality and economic crises. As a matter of fact, by collecting data for the period 1911-2010 in 25 countries, the authors find that inequality rose prior to only 6 out of 22 banking crises and 9 out of 24 macroeconomic crises. However, Atkinson and Morelli (2011) point out that both their work and that by Bordo and Meissner (2012) focus only on the relationship between crises and changes in income distribution: "we have not investigated whether inequality level was relatively higher before identified macroeconomic shocks. Therefore, the level hypothesis cannot be ruled out at this stage" (Atkinson and Morelli, 2011). Hence, as an attempt to provide a more complete analysis, Malinen (2013) extends the work by Bordo and Meissner (2012) by evaluating also the relationship between inequality levels and leverage. The author finds a long-run causal link between income inequality and increased leverage in the economy.

Despite the importance of these empirical contributions, there have been few economic models showing how inequality can generate a greater risk of crisis as stressed by Atkinson and Morelli (2011): in the case of financial crises, most accounts of their origins give no role to distributional considerations. For example, "the indexes to three authoritative studies of financial crises, by Kindleberger and Aliber (2005), Krugman (2009) and Reinhart and Rogoff (2009), contain neither inequality nor income distribution" (Atkinson and Morelli, 2011). Similarly, the FCIC (2011) in its final report on the causes of the financial and economic crisis in the United States does not mention inequality at all. Also Galbraith (2012) argues that before the

crisis the relationship between inequality and financial instability was not even thought of, as there was no study of the link between the two.

One may reasonably wonder why the link between inequality and financial instability has been ignored for so long. To answer that question, Van Treeck (2012) points out economics has fostered the belief that people can make an efficient use of credit markets to insure against temporary fluctuations of income. Thus, several prominent economists have come to underestimate the relevance of growing inequality (after all, Lucas (2004) a Nobel prize winner, thought that nothing is as poisonous to sound economics as "to focus on questions of distribution"[4]). In fact, in 1996 the former Chairman of the Federal Reserve, Alan Greenspan, held a speech in which he stressed that variations in asset holdings and debt buffer changes in income: in his view, this explains why the well-being of the lower-income segments of society had not worsened that much by looking at consumption from the late 1960s, even in the face of growing income disparities (1996).

Greenspan's interpretation of the data stems from Friedman's Permanent Income Hypothesis (1957): consumption choices are largely determined by a change in permanent income rather than in temporary income and "even with a higher variability in the transitory component of income, consumption can be smoothed through lending and borrowing in the presence of efficient credit markets" (Van Treeck, 2012).

Van Treeck blames this view for being unable to establish a proper link between rising inequality on the one hand and the fall in the aggregate saving rate together with rising household indebtedness on the other hand. Krueger and Perri (2006) bring about further evidence: they find a strong correlation between the ratio of unsecured consumer credit to disposable income and the Gini coefficient. Based on this result, they conclude, consumers made stronger use of credit markets "exactly when they needed to (starting in the mid-1970s), in order to insulate consumption from bigger income fluctuations".

In other words, the optimistic point of view of Greenspan and others suggests that credit markets worked efficiently by compensating for rising income inequality. However, by looking at the recent financial disaster one may reasonably wonder whether this confident position is well grounded. Indeed, there is a growing consensus in the literature that financial and economic stability was jeopardised not only by the development of bizarre financial instruments, but also by a more structural real factor: income inequality could, and in fact did, play a role in boosting the risk of a crisis.

A comprehensive explanation links inequality, financial instability and

---

[4]More precisely, Lucas (2004) claims: "Of the tendencies that are harmful to sound economics, the most seductive, and in my opinion the most poisonous, is to focus on questions of distributions." He also adds that "the potential for improving the lives of poor people by finding different ways of distributing current production is nothing compared to the apparently limitless potential of increasing production".

global macroeconomic imbalances.

Fitoussi and Saraceno (2010, 2011) argue that the root causes of the crisis are to be found in the structural weakness of the world economy in 2007, caused by the progressive accumulation of imbalances of opposite sign in different areas of the world. Prior to the crisis, the United States had an excess of demand over domestic production, offset by an increasingly big trade deficit (which in 2006 peaked at almost 6 percent of GDP) which was financed by the excess savings that, with different causes, characterised other regions of the world for more than a decade. In China and in other East Asian countries, the lack of a proper welfare state, as well as a reliable financial system, yielded an excess of precautionary savings for businesses and households. In addition, after the 1997 crisis, policy authorities in these countries started to accumulate reserves to deal with possible sudden stops (like the one of 1998). In Europe, instead, excess savings were being caused by the inertia of economic policy authorities and by low investment rates, which depressed demand and income, so as to force the economy to rely on export-led growth alone. These opposite imbalances compensated each other for almost two decades, resulting in an apparently stable global balance. However, the crisis proved it to be fragile. What role did inequality play in this pattern?

Building on Kaldor's (1955) framework, Fitoussi and Saraceno (2010, 2011) as well as Stiglitz (2012) and Fitoussi (2013), put forward a theory linking inequality, aggregate demand, monetary policy and financial bubbles. They stress two main points: (1) rising inequality is the main source of the 2007-2008 financial crisis; and (2) rising inequality goes together with structural weaknesses of aggregate demand. The mechanism is straightforward: starting from an equilibrium position, with supply equal to demand, a transfer of income from low/middle-income households to rich ones, who have a lower propensity to consume, results in higher savings and therefore a lower aggregate demand, thus pushing the economy into a recession. The institutional framework then plays a key role. If monetary authorities step in by implementing an expansionary policy (often accompanied by lax regulation), they stimulate the economy and sustain consumption for a while. Indeed, by lowering the interest rate, the central bank facilitates household access to credit markets thereby increasing the level of private debt. Therefore, as highlighted by Galbraith (2012), the link between radical inequality and financial crisis runs precisely through private debt.

The mechanism introduced above is a suitable explanation for the events that took place in the United States before and during the 2007-2008 financial crisis. The expansionary monetary policy implemented by the Federal Reserve in the 2000s successfully pushed low and middle-income households to increase their private consumption faster than their disposable income by borrowing (Fitoussi and Saraceno, 2010). However, the other side of the story is that the incredibly small part of the American society who ben-

19

efited from higher inequality needed to find a way to profitably use their newly accumulated savings: "a huge pool of available financial capital - the product of increased inequality - went in search of profitable opportunities in which to invest" (Milanovic, 2010). As stressed by the CJEC (2010), the ever-richer wealthy started to invest their amassed sums of money in new financial products, prompted by bank deregulation that allowed for the development of exotic financial instruments. With the mediation of mortgage companies, ratings agencies, investment banks, government-sponsored enterprises and the derivatives markets, the rich 1% lent to the remaining 99% thereby contributing to net wealth overvaluation with rising asset prices well above their real value and to the emergence of bubbles. For a while, this gave the false impression that high levels of debt were sustainable (Fitoussi and Saraceno, 2010). Eventually the bubble exploded and net wealth returned to normal levels. The crisis revealed itself because the terms of credit were built upon the intrinsic instabilities involved in lending to those who cannot pay: "like any Ponzi scheme, or any bubble, it is a matter of timing: those who are in and out early do well and those who are not nimble always go bust" (Galbraith, 2012). Hence, even though the crisis emerged in the financial sector, "its roots are much deeper and lie in a structural change in income distribution that had been going on for twenty-five years" (Fitoussi and Saraceno, 2010). Also Iacoviello (2008) points out that the increase in household debt, the large widening of wealth inequality and the relative stability of consumption inequality can all be explained by the rise in income inequality of the 1980s and the 1990s. Similarly, Frank et al. (2014) find a strong link between inequality and household indebtedness, by predicting a clear relationship between income inequality and observed savings rates.

3.1 Inequality, Household Debt and the Housing Market

Higher inequality results in a major amount of wealth accumulated by the richest 1% who want to use it for profitable investment. As a result, the financial sector is "overwhelmed by the volume of funds seeking investment relative to profit opportunities in the productive sector" (Perugini et al., 2013) thus becoming more reckless. So, as Fitoussi and Saraceno (2010) put it, those who benefit from higher inequality search for high-return investment thereby leading to the emergence of market bubbles. This is created via strong house price appreciation, "fueled by the availability of mortgage credit to a riskier set of new home buyers" (Mian and Sufi, 2009). That is, under the pressure of reckless rich households, and thanks to deregulation and loosen monetary policies, banks and financial intermediaries seek for profitable opportunities in the housing market by supplying mortgage credit not only to trustworthy new home buyers but also to risky ones. This results in growing demand for houses and therefore higher house prices.

As pointed out by the Financial Crisis Inquiry Commission (2011), house

prices grew considerably due to lower interest rates and greater access to mortgage credit for households who had traditionally been left out. Evidence of higher credit availability to poorer people is reported in Mian and Sufi (2009) who show that subprime ZIP codes experienced an unprecedented relative growth in mortgage credit. However, such expansion in mortgage credit from 2002 to 2005 to subprime ZIP codes occurred despite sharply declining relative (and in some cases absolute) income growth in these neighborhoods. That is, income growth and credit growth are statistically significantly negatively correlated from 2002 to 2005. This shows that more credit was available where people were relatively poorer.

Mian and Sufi (2009) stress that strong house price appreciation has an "important feedback effect on household leverage through existing homeowners" as higher house prices lead to a higher value of their home equity. Mian and Sufi (2009) refer to this as home equity-based borrowing (HEBB). HEBB was a key mechanism that contributed to the dramatic rise of private debt in the United States.[5] Indeed, since "credit standards and the cost of external finance are determined by considering the value of households collateral, which is influenced by housing prices" (Arestis and Gonzalez, 2013), as home prices rise, homeowners with greater equity feel more financially secure and, partly as a result, save less and less. Many others go one step further, borrowing against the equity. The effect is unprecedented debt (FCIC, 2011).

In addition to this, it is crucial to understand what households do with the amount of credit they get. As reported in the Fed's 2004 Survey of Consumer Finances, "45% of homeowners who tapped their equity used that money for expenses such as medical bills, taxes, electronics, and vacations, or to consolidate debt; another 31% used it for home improvements; and the rest purchased more real estate, cars, investments, clothing, or jewelry" (FCIC, 2011). Also Mian and Sufi (2009) show that a large fraction of HEBB is used to finance consumption (or home improvement). Therefore the HEBB channel can provide "a quantitative explanation for the decline in the US saving rates previous to the financial crisis" (Mian and Sufi, 2009). New financial products like the home equity line of credit allowed households to borrow against their homes to compensate for investment losses or unemployment (FCIC, 2011).

3.2   The Politics of Inequality

In identifying the link between rising inequality and the financial crisis, Stiglitz (2013) puts particular emphasis on the functioning of the American system which, in his view, "has been working overtime to move money from

---

[5]Notice that 65% of U.S. households already owned a house before house prices started to rise so fast in the late 1990s (Mian and Sufi, 2009). This stresses the importance of the HEBB channel.

the bottom and middle to the top, but the system is so inefficient that the gains to the top are far less than the losses to the middle and bottom". As a result of such growing and huge inequality, the economy pays a high price in terms of slower growth, lower GDP and even more instability. In other words, there is a vicious circle in that "a weak economy (one with a low aggregate demand) leads to higher inequality which in turn leads to a weaker economy, and so on" (Stiglitz, 2013).

Hacker and Pierson (2010), Galbraith (2012) and Stiglitz (2013) point out that the increase of inequality in the past decades has been due mostly to the rise of predatory behavior rather than fundamentals, like globalization and technological progress. Precisely because the elites have gained more than a fair share of national wealth, rising inequality has hampered well-being and distorted the economy. The rise of rent-seeking and predatory behaviour has coincided with the paramount role played by an increasingly deregulated financial sector, where the distance between wages and marginal productivity quickly became noticeable. Empirical evidence also seems to discard the traditional view. A recent work by Ostry et al. (2014) shows that there is a robust negative correlation between inequality and growth and that countries which implement redistributive policies tend to grow faster. Emphasising rent-seeking behaviour (Gaffard and Saraceno, 2014) helps explaining why the increase of income inequality in the past decades benefited incomes at the top level (Atkinson et al., 2011). More importantly, it also highlights the importance of policy choices. The economic power of the elites and the conservative revolution in politics mutually reinforced each other, leading to increasingly less progressive tax systems and to a downsizing of the welfare state (Creel and Saraceno, 2010; Hacker and Pierson, 2010). For the same reasons, the usual response to reduced aggregate demand is a monetary expansion rather than a fiscal one. As a matter of fact Stiglitz (2012) suggests that political reasons matter in this case:

> High inequality is often accompanied by a demand for a smaller government and more fiscal restraint. (...) Policies are often affected by lobbying, campaign contributions, and revolving doors, so that the wealthy have disproportionate influence. Thus, as inequality grows, at least in many countries, so too do constraints on the governments fiscal space.

Following the same line, Rajan (2010) emphasises in particular the role of government failure by claiming that "the political response to rising inequality whether carefully planned or an unpremeditated reaction to constituent demands was to expand lending to households, especially low-income ones", so as to end up with rising household debt.

4   Economic Models

As already pointed out, an increasing number of works has focused on the link between inequality and growth, even though a few of these have dealt with the impact that growing income disparities play in increasing the likelihood of a financial crisis.

Different approaches have been used in the macroeconomic literature:

- standard New-Keynesian Dynamic Stochastic General Equilibrium (DSGE) models;

- Post-Keynesian Stock-Flow Consistent (SFC) models;

- Macro Agent-Based (AB) Models with heterogenous interacting agents.

Let us summarise the key findings of such contributions, starting from those based on DSGE models. Among the most relevant and discussed works in the recent literature we find those by Kumhof and his coauthors.

Kumhof et al. (2015) aim at showing how high leverage and economic crises can stem from changing income distributions. They build a standard DSGE model in which financial assets are backed by loans to workers: as a result of higher inequality (modelled as a shock to the relative bargaining powers of the two income groups), investors contribute to the emergence of a bubble as they use part of their increased income to buy more of such assets. As a consequence, workers can limit their drop in consumption but find themselves with higher debt-to-income ratios. The result of this process is higher financial fragility that eventually leads to an economic crisis.

In a more recent work, Kumhof et al. (2012) carry out an empirical analysis of the link between increases in income inequality and current account imbalances, thus showing that a substantial part of the observed current account deteriorations in deficit countries (e.g. United States, United Kingdom) is accounted for by the dramatic rise in inequality. Moreover, Kumhof et al. (2012) build a two-country DSGE model in order to study the mechanism at work in these economies. Similarly to Kumhof et al. (2015), workers in one country are able to smooth consumption, even in the face of rising income disparities, because of loans coming from both domestic and foreign investors. Workers in the other country do not have access to credit markets and as such they cannot borrow. Therefore, two kind of economies emerge in the model: a borrowing-economy with greater household debt and a current account deficit and a lending-economy where investors deploy their funds abroad thereby resulting in a current account surplus.

Tirelli and Motta (2012) focus on the "causality link between long-run inequality and macroeconomic volatility". In particular, they build a medium-scale DSGE model with limited asset market participation and agents that

are endowed with different wealth holdings. By including external consumption habits, they manage to capture concern for relative consumption in agents' preferences so as to show that "redistributive polices targeting consumption inequality have beneficial implications for macroeconomic stability".

Iacoviello (2008) builds a DSGE model with heterogenous agents which traces the link between growing inequality and higher household debt. In particular, he finds that "the cyclicality of debt primarily reflects the behavior of credit constrained agents, whose credit constraints get relaxed in good times, thus allowing them to borrow more". As a consequence, according to the author, the rise in income inequality in the period between 1980s and 1990s is the main factor behind "the increase in household debt, the large widening of wealth inequality, and the relative stability of consumption inequality".

Another contribution addressing the impact of inequality on output and employment is the paper by Charpe and Kuhn (2012) which builds a standard DSGE model with a search and matching component with Nash bargaining over income distribution. The paper shows that a decline in workers' bargaining power results in a lower labour share of income and as such leads to lower consumption and aggregate demand. The authors thus suggest that the implementation of a minimum wage policy might limit the drop in output and employment, so as to challenge the standard conclusion of New Keynesian DSGE models which usually find virtue to wage moderation. This contrasting result has been achieved by reinforcing the "transmission channel from income distribution to consumption decisions by combining rule-of-thumb households and nominal price rigidities. This transmission is strengthened in the presence of the zero lower bound in monetary policy".

The Post-Keynesian literature has recently started to focus on the application of SFC models to the issue of inequality and its impact of growth and financial stability. Two key contributions within this literature are those by Zezza (2008) and Van Treeck (2013).

Zezza (2008) notices that household propensity to save out of income in the United States has decreased markedly starting from the '80s. Hence he builds a SFC growth model with integrated real and financial markets to show that the increase in private expenditure relative to income, in the face of growing inequality, is explained by the rise in household debt and the dynamics that took place in the housing market. Results show that changing income distribution in favour of the top implies that "growth will be faster as the propensity to save drops, but the increase in the stock of mortgages relative to disposable income puts the economy into a potentially unstable growth path" (Zezza, 2008).

Van Treeck (2013) follows the same line of research as Kumhof et al. (2012): the paper develops a three-country SFC model to assess the impact of changing income distribution on current account imbalances. However,

compared to Kumhof et al. (2012), the model features three country (calibrated as the United States, Germany and China) and deals with both personal and functional income distribution. In addition, it also includes upward-looking comparisons in household demand for consumption, based on the relative income hypothesis. Results show that the substantial increase in household debt in the United States, as well as the decline in their current account since the early '80s, "can be explained by the interplay of rising (top-end) household income inequality and institutions".

The literature on macroeconomic agent-based models has been growing fast in the recent years. By using this approach, economists can model the economy as a complex system populated by heterogenous interacting agents. This is a big advantage when dealing with matters of (personal) distribution. In addition, it is possible to model credit networks among households (or firms) and banks and thus taking into account the consequences of a small number of defaults, which represent a negative externality that might impact the dynamics of the whole system due to the presence of feedback effects among different agents. Let us introduce the key works on inequality based on macroeconomic agent-based models.

Dosi et al. (2013) study the link between income inequality and monetary/fiscal policies in an agent-based model, which features "Keynesian mechanisms of demand generation, a Schumpeterian innovation-fueled process of growth and Minskian credit dynamics". They model the economy as an "ecology of heterogenous agents whose far-from-equilibrium interactions continuously change the structure of the system itself". Their result shows that countries with more unequal societies suffer from more severe business cycles fluctuations as well as higher unemployment rates and higher likelihood of crises. As a consequence, they find that fiscal policies might reduce the magnitude of business cycle oscillations and, in some cases, have a positive impact on long-term growth.

Russo et al. (2015) focus on the impact of growing inequality on financial stability. Their agent based model simulates a simple credit economy (with non-collateralised loans) that links households and banks thus leading to the endogenous emergence of credit networks. The work concludes that higher inequality jeopardises economic stability: higher household debt results in a greater number of defaults that impacts the availability of credit for future borrowers. As a result, consumption smoothing by poorer households cannot take place and aggregate demand and output fall.

The contribution by Carvalho and Di Guilmi (2014) combines a SFC model with an agent-based sector. This innovative approach allows to provide some micro-foundations to fully aggregate SFC models, thus capturing bottom-up dynamics as in the tradition of AB models. In particular they introduce heterogeneous agents into a demand-driven stock-flow consistent model with endogenous credit creation in order to study the dynamics of both the personal and the functional distribution of income and their im-

pact on household debt and aggregate demand. Their results show that the functional and the personal distributions of income, jointly with the interest rate, are key factors in determining the degree of financial fragility and debt sustainability. As a policy conclusion, they suggest that a rise in the minimum wage negatively impact debt-to-income ratios as well as the degree of financialisation of the economy. Moreover, they find that a reduction in wage inequality further contributes to leading the economy toward more sustainable paths in both household debt and the degree of financialisation.

5 Conclusions

By providing an extensive analysis of both the theoretical and the empirical literature on inequality, this paper shows how this topic has been analysed by economists starting from the second half of the nineteenth century. Our historical perspective highlights that income distribution was a key issue for the economic profession for decades. Eventually, starting from the 80s, the topic entered a phase of declining interest. The issue of inequality has been ignored for so long due to several reasons, most importantly due to Kuznetss optimistic conclusions (Piketty, 2013), the emergence of new mathematical models based upon the representative agent postulate (Mian and Sufi, 2014; Piketty, 2013), and the belief that people can make an efficient use of credit markets to insure against temporary fluctuations of income (Van Treeck, 2012). However, inequality has come back on top of the agenda only in the recent years. A key factor for the renewed interest in distributional issues is the recent financial crisis. The works by some prominent economists have indeed suggested a strong link between rising income disparities and the instability of the financial and economic system. In presence of highly financialised systems with articulated credit markets, households have been able to increase their private consumption even with stagnant income growth over much of the distribution. The consequence has been the dramatic rise in household debt that has eventually led to the collapse of credit and the recession.

In spite of useful insights on this matter, most of the works provide theoretical suggestions that are not supported by means of formal and rigorous modelling. Moreover, the models built so far either lie in the representative agent framework (as in the DSGE litetararature), or do not consider the interaction between rising inequality, household debt dynamics in the presence of articulated credit and housing markets. In addition, it seems that policy conclusions rarely focus on the need for a structural reform with a more progressive taxations system to tackle increasing inequality. Our two models, presented in the next two works of this Ph.D. thesis represent a first attempt to fill the gap in the existing literature.

References

Aghion, P. and Bolton, P. (1997). A theory of trickle-down growth and development. *Review of Economic Studies*, 64(2).

Aghion, P., Caroli, E., and Garcìa-Peñalosa, C. (1999). Inequality and economic growth: The perspective of the new growth theories. *Journal of Economic Literature*, 37(4).

Alesina, A. and Perotti, R. (1996). Income distribution, political instability, and investment. *European Economic Review*, 40(6).

Alesina, A. and Rodrick, D. (1994). Distributive politics and economic growth. *The Quarterly Journal of Economics*, 109(2).

Arestis, P. and Gonzalez, A. R. (2013). Modeling the house market in oecd countries. *Levy Economics Institute Working Paper*, (764).

Atkinson, A. B. (1997). Bringing income distribution in from the cold. *The Economic Journal*, 107.

Atkinson, A. B. (2009). *The Changing Distribution of Earnings in OECD Countries*. Oxford: Oxford University Press.

Atkinson, A. B. and Morelli, S. (2011). Economic crisis and inequality. *Human Development Research Paper*, (6).

Atkinson, A. B., Piketty, T., and Saez, E. (2011). Top incomes in the long run of history. *Journal of Economic Literature*, 49(1).

Bordo, M. D. and Meissner, C. M. (2012). Does inequality lead to a financial crisis? *Journal of International Money and Finance*, 31(8).

Bourguignon, F. (1996). Comment on "inequality, poverty, and growth: where do we stand?" by albert fishlow. In Bruno, M. and Pleskovic, B., editors, *Annual World Bank Conference on Development Economics*.

Carvalho, L. and Di Guilmi, C. (2014). Income inequality and macroeconomic instability: a stock-flow consistent approach with heterogeneous agents. *CAMA Working Paper*, (60).

Charpe, M. and Kuhn, S. (2012). Inequality, aggregate demand and crises. *Working paper*.

Cingano, F. (2014). Trends in income inequality and its impact on economic growth. *OECD Social, Employment and Migration Working Papers*, (163).

CJEC, U. (2010). Income inequality and the great recession. Technical report, U.S. Congress Joint Economic Committee.

Colombo, E. and Driffill, J. (2003). Financial markets and transition. In Colombo, E. and Driffill, J., editors, *The Role of Financial Markets in the Transition Process*. Springer-Verlag.

Creel, J. and Saraceno, F. (2010). The crisis, automatic stabilisation, and the stability pact. *Revista de Economia y Estadistica*, XLVIII(1).

Deininger, K. and Squire, L. (1996). A new data set measuring income inequality. *World Bank Economic Review*, 10(3).

Deininger, K. and Squire, L. (1998). New ways of looking at old issues: inequality and growth. *Journal of Development Economics*, 57(2).

Domar, E. (1946). Capital expansion, rate of growth and employment. *Econometrica*, 14.

Dosi, G., Fagiolo, G., Napoletano, M., and Roventini, A. (2013). Income distribution, credit and fiscal policies in an agent-based keynesian model. *Journal of Economic Dynamics and Control*, 37(8).

Ehrhart, C. (2009). The effects of inequality on growth: a survey of the theoretical and empirical literature. *ECINEQ WP Series*, 107.

Fazzari, S. M. and Cynamon, B. Z. (2013). Inequality and household finance during the consumer age. *Levy Economics Institute Working Paper*, (752).

FCIC (2011). Final report of the national commission on the causes of the financial and economic crisis in the united states. Technical report, Financial Crisis Inquiry Commission.

Fitoussi, J. P. (2013). *Le Théorème du Lampadaire*. Paris, FR: Les Liens Qui Liberent Editions.

Fitoussi, J. P. and Saraceno, F. (2010). How deep is a crisis? policy responses and structural factors behind diverging performances. *Journal of Globalization and Development*, 1.

Fitoussi, J. P. and Saraceno, F. (2010-2011). Inequality, the crisis and after. *Rivista di Politica Economica*, 100(I-III).

Frank, R. H., Levine, A. S., and Dijk, O. (2014). Expenditure cascades. *Review of Behavioral Economics*, 1.

Friedman, M. (1957). *A Theory of the Consumption Function*. Princeton, NJ: Princeton University Press.

Gaffard, J.-L. and Saraceno, F. (2014). Répartition, croissance et crise. *Economie et Management*, 151.

Galbraith, J. K. (2012). *Inequality and Instability: A Study of the World Economy Just Before the Great Crisis.* New York, NY: Oxford University Press.

Galor, O. and Tsiddon, D. (1996). Income distribution and growth: the kuznets hypothesis revisited. *Economica*, 63(250).

Galor, O. and Zeira, J. (1993). Income distribution and macroeconomics. *The Review of Eonomic Studies*, 60(1).

Garegnani, P. (1978). Notes on consumption, investment and effective demand: I. *Cambridge Journal of Economics*, 2(4).

Garegnani, P. (1979a). Notes on consumption, investment and effective demand: A reply to joan robinson. *Cambridge Journal of Economics*, 3(2).

Garegnani, P. (1979b). Notes on consumption, investment and effective demand: Ii. *Cambridge Journal of Economics*, 3(1).

Greenspan, A. (1996). Address: Job insecurity and technology. *Conference Series, Proceedings*.

Hacker, J. and Pierson, P. (2010). *Winner-Take-All Politics: How Washington Made the Rich Richer and Turned its Back on the Middle Class.* New York: Simon Schuster.

Harrod, R., F. (1939). An essay in dynamic theory. *The Economic Journal*, 49.

Harrod, R., F. (1948). *Towards a dynamic economics.* Macmillan.

Iacoviello, M. (2008). Household debt and income inequality, 1963-2003. *Journal of Money, Credit and Banking*, 40(5).

Kaldor, N. (1955). Alternative theories of distribution. *The Review of Eonomic Studies*, 23.

Kindleberger, C. P. and Aliber, R. (2005). *Manias, panics, and crashes: A history of financial crises.* Hoboken, NJ: Wiley.

Krueger, D. and Perri, F. (2006). Does income inequality lead to consumption inequality? evidence and theory. *Review of Economic Studies*, (73).

Krugman, P. (2009). *The return of depression economics and the crash of 2008.* New York, NY: W. W. Norton Company.

Kumhof, M., Lebarz, C., Rancière, R., Richter, W. A., and Throckmorton, N. A. (2012). Income inequality and current account imbalances. *IMF Working Paper*, (08).

Kumhof, M., Rancière, R., and Winant, P. (2015). Inequality, leverage and crises. *American Economic Review*, 105(3).

Kuznets, S. (1953). *Shares of Upper Income Groups in Income and Savings*. Boston: NBER.

Kuznets, S. (1955). Economic growth and income inequality. *The American Economic Review*, 65(1).

Lucas, R., E. (1973). Some international evidence on output-inflation trade-offs. *The American Economic Review*, 63(3).

Lucas, R., E. (1976). Econometric policy evaluation: A critique. *Carnegie-Rochester Conference Series on Public Policy*, 1.

Lucas, R., E. (2004). The industrial revolution: Past and future. *The Region - Banking and Policy Issues Magazine*.

Malinen, T. (2013). Is there a relationship between income inequality and leverage? *HEER Discussion Papers*, (362).

Mian, A. and Sufi, A. (2014). Why the income distribution matters for macroeconomics.

Mian, A. R. and Sufi, A. (2009). House prices, home equity-based borrowing, and the u.s. household leverage crisis. *National Bureau of Economic Research Working Paper*, (15283).

Milanovic, B. (2010). *The Haves and the Have-Nots: A Brief and Idiosyncratic History of Global Inequality*. New York, NY: Basic Books.

Moatsosm, M., Baten, J., Foldvari, P., van Leeuwen, B., and van Zanden, J. (2014). Income inequality since 1820. In van Zanden, J., Baten, J., Mira d'Ercole, M., Rijpma, A., Smith, C., and Timmer, M., editors, *How Was Life?: Global Well-being since 1820*, chapter 11. OECD Publications.

OECD (2011). *Divided we Stand: Why Inequality Keeps Rising*. OECD Publications.

Ortiz, I. and Cummins, M. (2011). Global inequality: Beyond the bottom line. *UNICEF Social and Economic Policy Working Paper*, April 2011.

Ostry, J. D., Berg, A., and Tsangarides, C. G. (2014). Redistribution, inequality and growth. *IMF Discussion Note*.

Pasinetti, L., L. (2000). Critique of the neoclassical theory of growth and distribution. *BNL Quarterly Review*, (215).

Perugini, C., Hölscher, J., and Collie, S. (2013). Inequality, credit expansion and financial crises. *MPRA Paper*, (51336).

Piketty, T. (1997). The dynamics of wealth distribution and the interest rate with credit rationing. *Review of Economic Studies*, 64.

Piketty, T. (2013). *Capital in the Twenty-First Century*. Harvard University Press.

Rajan, G. R. (2010). *Fault Lines: How Hidden Fractures Still Threaten the World Economy*. Princeton, NJ: Princeton University Press.

Reinhart, C. M. and Rogoff, K. S. (2009). *This time is different*. Princeton, NJ: Princeton University Press.

Robinson, J. (1979). Garegnani on effective demand. *Cambridge Journal of Economics*, 3(2).

Russo, A., Riccetti, L., and Gallegti, M. (2015). Increasing inequality, consumer credit and financial fragility in an agent based macroeconomic model. *Journal of Evolutionary Economics*.

Stern, N. (1991). The determinants of growth. *The Economic Journal*, 101(404).

Stiglitz, J. E. (2012). Macroeconomic fluctuations, inequality, and human development. *Journal of Human Development and Capabilities: A Multi-Disciplinary Journal for People-Centered Development*, 13(1).

Stiglitz, J. E. (2013). *The Price of Inequality*. New York, NY: W. W. Norton Company.

Tirelli, P. and Motta, G. (2012). Income inequality and macroeconomic stability in a new keynesian model with limited asset market participation. *University of Milan - Bicocca Workin Paper Series*, (219).

Van Treeck, T. (2012). Did inequality cause the u.s. financial crisis? *IMK Working Paper*, (91).

Van Treeck, T. (2013). Income distribution and current account imbalances. *IMK Working Paper*, (126).

Zezza, G. (2008). U.s. growth, the housing market, and the distribution of income. *Journal of Post Keynesian Economics*, 30(3).

Inequality, Household Debt and Financial Instability: An Agent-Based Perspective

Alberto Cardaci

Lombardy Advanced School of Economic Research, Milan

Abstract

Our paper contributes to the literature on the causes of the 2007-2008 financial crisis in the U.S.. By means of an Agent-Based Model, we argue that growing inequality and the resulting debt-financed consumption boom jeopardised the stability of the economic system, thus paving the way for the financial crisis as suggested by Cynamon and Fazzari (2013); Fitoussi and Saraceno (2010); Stiglitz (2012). Our model includes a behavioural rule for consumption based on expenditure cascades, a hierarchical structure of household finance, an articulated credit market with collateralised consumption loans and mortgages and a simple housing market. Results show that the model is able to capture the economic and social pressure of inequality on low and middle income households that pushes them to increase their consumption via home equity-based borrowing as described by Mian and Sufi (2009). Rising non-performing loans lead to higher bad debt on banks' balance sheets and, consequently, to the emergence of a crisis as an endogenous dynamic.

Keywords: Agent-Based Models, Equity Extraction, Household Debt, Inequality

JEL Classification: C63, D31, E21, G01

1 Introduction

There is a growing consensus in the literature that financial and economic stability in the U.S. was jeopardised not only by the development of bizarre financial instruments, but also by a more structural real factor, namely income inequality which could, and in fact did, play a role in boosting the risk of a crisis (Cynamon and Fazzari, 2013; Fitoussi, 2013; Fitoussi and Saraceno, 2011; Stiglitz, 2012, 2013).

In the period between 1983 and 2007, the income share of the top 5% in the U.S. increased from 22% to 34% (Kumhof and Rancière, 2010). Moreover, the top 1% of the population doubled its share in national income from around 8% in the mid-1970s to almost 16% in the early 2000s (Milanovic, 2010). This transfer of income from the bottom of the distribution to the top reproduced the same situation that existed prior to the 1929 crisis, when the share of the top 1% reached its previous high-water mark. One would expect the transfer of income from the bottom to the top to reduce overall consumer demand thus leading to unemployment and stagnation in general since the richest part of the population is assumed to have a lower propensity to consume (Kaldor, 1955). Still, in the years before the crisis, the U.S. economy performed well as American households, in the aggregate, increased their spending relative to income: using an adjusted measure of demand relative to adjusted disposable income of the household sector, Fazzari and Cynamon (2013) show that rising inequality, starting roughly in the early 1980s, corresponds unequivocally with a historic increase in American household demand relative to income from roughly 81% to almost 95%. The authors refer to this as a paradox and they wonder how consumption spending could rise so quickly in the face of stagnant growth over much of the income distribution. The answer is that "American households, outside of those in the top of the income distribution, went on an extended borrowing binge" (Fazzari and Cynamon, 2013): household debt increased from 48% of GDP in the early 1980s to 100% of GDP before the crisis (Milanovic, 2010). Hence, the observed drop in the propensity to save can be explained by the higher debt to income ratio and percentage of consumption financed by borrowing, as pointed out also by Zezza (2008).

Starting from these key facts, two major issues are worth analysing: one is about the reasons that pushed household debt to increase to such unsustainable levels; the other one is about the mechanisms that actually allowed households to borrow with virtually no constraints. The former can be traced back to the dramatic rise in income inequality in a context of peer effects in consumption, while the latter is explained by house price dynamics which made equity extraction a viable option for households (FCIC, 2011). Hence, we build a macro agent-based model (ABM) with the ultimate goal of assessing the impact of income inequality on household debt dynamics and financial stability in the presence of expenditure cascades (Frank et al., 2014)

and home-equity based borrowing (Mian and Sufi, 2014) by households.

1.1 Related Literature

In the period before (and during) the recent U.S. financial crisis, only a very few number of studies focused on the link between rising income inequality and the increase in household debt. Most of the studies, in particular, ignored the role these facts may have played in increasing the risk of financial instability. Galbraith (2012) argues that before the crisis the relationship between inequality and financial instability was not even thought of, as there was no study of the link between the two. Also Atkinson and Morelli (2011) stress that there have been few economic models showing how inequality can generate a greater risk of crisis.

In the aftermath of the crisis, however, some relevant contributions in this area have emerged. One of the key works is the paper by Kumhof et al. (2015) who build a dynamic stochastic general equilibrium (DSGE) model showing how greater inequality (modelled as a shock to the relative bargaining powers of the two income groups) results in asset price appreciation that eventually leads to the emergence of a financial bubble. Yet, the representative agent framework, a peculiarity of DSGE models, does not allow to capture either heterogeneity among agents or the existence of emerging credit networks. In addition, the model does not include a proper financial/banking sector, as all the borrowing-lending transactions occur between rich (lenders) and poor (borrowers) households. As a consequence, it is impossible to take into account the impact of household defaults on the balance sheets of the banking system and the possible resulting credit crunch.

Given the drawbacks of DSGE models, we explore the issue of inequality and financial instability by adopting a macroeconomic agent-based model, as in Dosi et al. (2013), Russo et al. (2015) and Erlingsson et al. (2013). Our paper, in fact, shares some similarities with such works, in particular with Russo et al. (2015) who focus on the impact of growing inequality on financial stability. Dosi et al. (2013) study the link between income inequality and monetary/fiscal policies in an agent-based model, which features "Keynesian mechanisms of demand generation, a Schumpeterian innovation-fueled process of growth and Minskian credit dynamics". Erlingsson et al. (2013), instead, do not focus on inequality. Rather, they model a credit economy where housing market bubbles and financial crises emerge endogenously as a result of agents' interactions. There is a clear common approach between such works and ours, in modelling the economy as a credit network in which agents, either firms or households, have access to bank loans. Yet, compared to the others, our model allows households to interact with heterogeneous banks in order to apply for both consumption loans and mortgages. Indeed, similar to Erlingsson et al. (2013), we introduce also a simple housing mar-

ket that allows for the endogenous dynamics of house prices (a feature that is present neither in Dosi et al., 2013, nor in Russo et al., 2015). This is a relevent element of our work since consumption loans and mortgages are collateralised and as such asset price formation is a key mechanism for the functioning of the credit market. Another distinctive feature of our work is the introduction of imitation and peer effects in household consumption through upward-looking comparisons, consistent with the behavioural literature (e.g. Frank et al., 2014 and Cynamon and Fazzari, 2013). None of the works mentioned above has a similar mechanism.

The paper is organised as follows: Section 2 introduces the theory linking inequality to higher household debt and house price dynamics; Section 3 describes our ABM; Section 4 reports simulation results; finally, Section 5 concludes.

2 Inequality, Equity Extraction and the Borrowing Binge

In the years before the crisis, as a result of increasing inequality, income growth outside the top quintile was stagnant (Cynamon and Fazzari, 2013; Fazzari and Cynamon, 2013). Yet, demand remained strong and contributed to the good performance of the American economy. This counterintuitive fact may be explained by looking at micro and macro aspects of economic theory, ranging from household imitative behaviour to house price dynamics.

Let us start from micro-foundations. As Cynamon and Fazzari (2013) point out, the literature on social psychology provides useful insights: "households learn consumption patterns from their social reference group". As such, they tend to compare their living standard, proxied by their level of consumption, with that of their neighbours or richer households. Hence, growing income disparities lead to the observed decline in the savings rates of American households through *expenditure cascades* (Frank et al., 2014): "a process whereby increased expenditure by some people leads others just below them on the income scale to spend more as well, in turn leading others just below the second group to spend more, and so on". In fact, following the rise in income inequality households at the bottom of the distribution looked for external resources to finance their growing desired consumption: they accessed credit markets to borrow.

Turning to macro dynamics, higher inequality contributed to booming household debt via the real estate market and equity extraction processes.

On the one hand, "a huge pool of available financial capital - the product of increased inequality - went in search of profitable opportunities in which to invest" (Milanovic, 2010). On the other hand, the expansionary policy implemented by the Federal Reserve in the 2000s successfully allowed low

and middle-income households to increase their private consumption faster than their disposable income by borrowing (Fitoussi and Saraceno, 2010). Lower interest rates in a deregulated environment contributed to strong house price appreciation, "fueled by the availability of mortgage credit to a riskier set of new home buyers" (Mian and Sufi, 2009). Banks and financial intermediaries, seeking profitable opportunities in the housing market, supplied mortgages not only to trustworthy new home buyers but also to risky ones, namely subprime borrowers. This resulted in growing demand for houses and therefore higher house prices. Also the Financial Crisis Inquiry Commission (2011) stresses that house prices grew markedly due to lower interest rates for mortgage borrowers and greater access to mortgage credit for households who had traditionally been left out (including subprime borrowers).

House price dynamics have "an important feedback effect on household leverage through existing homeowners" (Mian and Sufi, 2009), as higher house prices imply a greater value of home equity that can be extracted for consumption purposes. Mian and Sufi (2009) refer to this as home equity-based borrowing (HEBB), claiming that it allowed U.S. homeowners to increase their debt.[1] Since "credit standards and the cost of external finance are determined by considering the value of households collateral, which is influenced by housing prices" (Arestis and Gonzalez, 2013), as these rose, homeowners with greater equity felt more financially secure and, partly as a result, saved less and less. Many others went one step further, borrowing against their equity. The effect was unprecedented debt (FCIC, 2011).

As highlighted by Fitoussi and Saraceno (2010), higher house prices gave the false impression that high levels of debt were sustainable. Ultimately, the bubble exploded and net wealth returned to normal levels. The crisis revealed itself because the terms of credit were built upon the intrinsic instabilities involved in lending to those who cannot pay: "like any Ponzi scheme, or any bubble, it is a matter of timing: those who are in and out early do well and those who are not nimble always go bust" (Galbraith, 2012).

3   The Model

For the purpose of our work, we build an agent-based model where the economy is modelled as an ecology populated by heterogeneous agents whose interactions continuously change the structure of the system (Fagiolo and Roventini, 2012). At the micro level, agents repeatedly interact with each other based on adaptive and imitative behaviours thus giving rise to stable and predictable aggregate configurations at the macro level (Delli Gatti

---

[1]Notice that 65% of U.S. households already owned a house before house prices started to rise so fast in the late 1990s (Mian and Sufi, 2009). This stresses the importance of the HEBB channel.

et al., 2011; Tesfatsion, 2006).

The main goal of our model is to identify the effect of inequality on household debt and the stability of the economic system as a whole. To do so, we focus mostly on the household sector and its relationship with banks. Our economy is demand-driven, that is we assume the existence of a representative firm, owned by all households, which always satisfies demand: it supplies the required amount of goods and, as such, no rationing takes place in the goods market[2].

The structure of our model has some key features that allow to capture the dynamics described in the previous section of this paper. Such key features are:

- The introduction of a consumption behaviour based on an imitative behaviour as described by the Expenditure Cascades Hypothesis (Frank et al., 2014), so as to capture the economic and social pressure of inequality on low and middle income households;

- A hierarchical structure of household finance that leads households to demand credit only in the extreme case in which internal resources are not enough to finance desired consumption;

- An articulated credit market with collateralised consumption loans and mortgages;

- A simple housing market with price dynamics that allow for equity extraction behaviour by households.

Our model features two main categories of agents, namely households ($h = 1, ..., H$) and banks ($b = 1, ..., B$). It also includes an extremely simplified government and a central bank. Agents are heterogeneous, they have bounded rationality and follow behavioural rules based on adaptive expectations.

The sequence of events in each period t is as follows:

1. GDP at time $t - 1$ is distributed to households at the beginning of period t, based on exogenously set income shares. The government provides a subsidy to all households in the bottom 90% of the distribution, whose income is lower than a given threshold. The central bank endogenously sets the policy interest rate, targeting the change in GDP at time $t - 1$ with respect to the mean of the previous three periods.

---

[2]One can imagine that the firm is able to produce goods based on actual orders, so that the goods market is always in equilibrium. This strong assumption allows us to simplify a consistent part of the model as it does not represent the focus of our paper.

2. The pay back phase begins. Each household assesses whether she is able to pay back her debt by using her income and liquid wealth. Households that are not able to do so will have to sell their house and use the resulting liquidity to pay back their outstanding debt. For convenience, such households are labelled as "bankrupt". Banks use earned interests to increase the value of their net worth.

3. All households set their desired consumption based on adaptive and imitative behaviour and adjust their propensity to consume out of income and wealth accordingly. Households whose desired consumption is higher than the available internal resources have a positive consumption gap: they can apply for a consumption loan, provided that they own a house and have previously paid back their debt.

4. The credit market for consumption loans opens. Banks set their total available credit supply as a multiple of their equity and rank households based on their Total Debt Service Ratio[3] (TDS). Since houses serve as collateral, the amount of credit households can get depends on house prices. Households in the credit market for consumption loans can apply to one bank only in each period. After the market closes, households who get a lower amount of credit than asked, will not fill their consumption gap: credit rationing takes place.

5. The housing market opens. All households update their price; those who do not own a house are potential buyers. Supply of houses comes from all the households who are forced to sell their house to pay back their debt plus a random set of homeowners selected in each period. Sellers set their desired price equal to the value of their house, whereas buyers generally set their prices as a multiple of their liquid wealth. Buyers are sorted randomly, whereas sellers are sorted in ascending order based on their selling price, so that each buyer tries to buy from the seller asking for the lowest price. Households who have enough liquid wealth can buy a house directly. Those who have a deal with a seller but lack the internal resources to pay for the entire amount, enter the credit market for mortgages.

6. The credit market for mortgages opens. Individual demand for mortgages depends on the difference between the selling price and the liquid wealth of the buyer. Individual mortgage supply is based on the value of the house to be provided as collateral. Again, banks rank households based on their TDS. After the mortgage market closes, households who get the needed amount of credit get back to the seller to close the deal

---

[3]Total Debt Service Ratio (TDS) is defined as the ratio between household repayment schedule (the sum of consumption loan and mortgage principal plus interests) and household income.

and buy the house. Credit-rationed households, instead, will drop the deal and search for another house in the following period. The housing market closes and existing homeowners update the value of their real wealth based on the average market price.

7. If bankrupt households have managed to sell their house, they use the resulting liquidity to pay back their outstanding debt. Due to changes in house prices, each household's liquidity may be lower than the value of her outstanding debt: the bank will record a non performing loan and the resulting bad debt will slow down the accumulation of its net worth.

We now provide a detailed description of all the algorithms and rules of behaviour introduced in each section of the model.

3.1 Expenditure Cascades and Desired Consumption

At the beginning of each period t, households are divided in two income groups: the top 10% and the bottom 90%. Each of these is provided with a macro income share, $share_y$, which identifies the amount of GDP_{t-1} that the two groups receive. Each household is also assigned an exogenous and constant individual income share, $share_h$, such that $\sum share_h = 1$ within the group of reference. Therefore, household income is defined as $Y_{t,h} = GDP_{t-1} \cdot share_y \cdot share_h$.

Our model features a key mechanism in order to explain the reason why American households did not react to falling incomes and increased inequality by higher precautionary savings, like in Germany, but by borrowing more (Van Treeck, 2012). In particular, the specification of desired consumption in our model follows the expenditure cascades hypothesis introduced by Frank et al. (2014) (equation 1)[4].

$$C_{t,h}^d = k\,(1-a)(Y_{t,h} + M_{t-1,h}) + a\,C_{t-1,j} \tag{1}$$

Hence, h's desired consumption is a function of her income, $Y_{t,h}$, and liquid wealth, $M_{t-1,h}$, as well as j's actual consumption in the previous period, where j is the household who ranks just above h in the income scale, so that $j = h + 1$. Put it simply, h tries to replicate j's consumption in the past based on k, which is "a parameter unrelated to permanent income level or rank" (Frank et al., 2014) and a sensitivity parameter a, such that $0 \leq a \leq 1$: when $a = 1$, h fully mimics j's consumption; whereas when

---

[4]The inclusion of liquid wealth in the equation for desired consumption follows Russo et al. (2015)

$a = 0$, h does not consider j's consumption.[5]

Given the value of desired consumption, each household has to assess whether her internal financial resources are enough to pay for it. Such process is based on a hierarchical structure of household financing behaviour. That is, households finance their desired consumption by using, in hierarchical order, their income, liquid wealth and, eventually, consumption loans. A detailed description of this process is reported in Appendix A.

3.2   Credit Market for Consumption Loans

Demand for consumption loans, $L_{t,h}^d$, is defined as the difference between desired consumption and the sum of income and liquid wealth:

$$L_{t,h}^d = C_{t,h}^d - (Y_{t,h} + M_{t-1,h}) \qquad (2)$$

Note that loans are collateralised by houses so that only homeowners can enter the credit market.

Following Delli Gatti et al. (2011), the maximum allowable credit supply by bank b is defined as a fraction $\frac{1}{v}$ of its equity $E_{t,b}$, where v can be interpreted as a capital requirement coefficient. That is:

$$LS_{t,b} = \frac{E_{t,b}}{v} \qquad (3)$$

Each bank ranks households in ascending order based on their TDS, and supplies credit until $LS_{t,b} = 0$. Therefore, applicants with zero TDS are given priority and they are selected in random order. The formulation of credit supply follows the literature on collateral constraints spawned by Kiyotaki and Moore (1997) and recalled by more recent works in the DSGE literature (e.g. Justiniano et al., 2013).

Bank b offers individual single-period debt contracts, $LSH_{t,b,h}$, whose amount is based on the loan to value ratio, γ, the market value of h's real wealth, $RW_{t,h}$[6], the balance owed on the existing mortgage, $ZR_{t,h}$, and the interest rate on consumption loans, $r_{t,b,h}^L$:

$$LSH_{t,b,h} = \frac{\gamma RW_{t,h} - ZR_{t,h}}{1 + r_{t,b,h}^L} \qquad (4)$$

We assume the loan to value ratio to be the same for all banks. Following Russo et al. (2015), the interest rate on consumption loans is based on three elements:

---

[5]Our consumption mechanism implicitly assumes that (1) all households know how income is distributed so that each h can select the corresponding j; (2) households can observe j's consumption in the previous period.

[6]Real wealth is defined formally in section 3.3.

$$r^L_{t,b,h} = \overline{r_t} + \widehat{r_{b,t}} + r_{t,h} \qquad (5)$$

$\overline{r_t}$ is the policy rate set by the central bank at the beginning of each period (see subsection 3.6), $\widehat{r_{t,b}}$ is a bank specific component that reflects the sensitivity (measured by ρ) of each bank to its own leverage, $LB_{t,b}$. Hence, $\widehat{r_{t,b}} = \rho LB_{t,b}$, where bank leverage is the ratio between the total amount of loans and mortgages supplied by bank b and its equity. Finally, $r_{t,h}$ is a household specific component equal to $\mu TDS_{t,h}$, where μ is banks' sensitivity to household total debt service ratio. We also assume ρ and μ to be the same for all banks.

Note that our setting of the credit market for consumption loans implies banks have an information set that includes the amount of outstanding debt of each borrower. Hence, by looking at each borrower's TDS, the bank is able to apply an interest rate that takes into account the financial soundness of each borrower.

Each household searches for the bank applying the lowest interest rate.[7] Once found, household h accepts the offer, enters the credit network of bank b and gets $LOAN_{t,h} = L^d_{t,h}$ if $LSH_{t,b,h} \geq L^d_{t,h}$ or $LOAN_{t,h} = LSH_{t,b,h}$ otherwise. The debt contract corresponds to a repayment schedule defined as $RS^L_{t,h} = LOAN_{t,h}(1 + r^L_{t,b,h})$, to be paid back entirely in the following period.

The design of the credit market for consumption loans allows the model to capture the home-equity based borrowing mechanism as described by Mian and Sufi (2009). Indeed, when house prices increase, both existing and new homeowners can exploit the higher value of their real wealth to access credit market and borrow against their equity. The newly accumulated debt is then used to finance consumption expenditure.

3.3 Housing and Mortgage Market

The housing market features a fixed stock, $\overline{H}$, of houses, which is distributed to a constant number of households randomly selected at the beginning of period $t = 1$.[8] Each homeowner owns one house only and does not want to increase her stock. In other words, existing homeowners can enter the housing market on the supply side only: they never demand additional houses. As a result, the number (but not the identity) of homeowners, is fixed over time.

In period $t = 1$, each homeowner is also assigned a house price, $P^H_{t,h}$ drawn from a uniform distribution. Therefore, household real wealth, $RW_{t,h}$,

---

[7]If two or more banks set the same interest rate, households select one randomly.

[8]We do not include construction firms as we are not interested in quantity dynamics, but exclusively on housing price dynamics.

is defined as $RW_{t,h} = P^H_{t,h} H_{t,h}$, where $H_{t,h}$ is h's housing unit and it is equal to 1 for all households.

In every period, each homeowner updates the value of her house, by assessing whether the market is experiencing excess supply or excess demand using the number of unsold houses as a proxy. In particular, as shown in conditions 6 and 7, homeowners set the new value of their house at time t based on their price in the previous period ($P^H_{t-1,h}$) and a markdown ($-\xi_t$), if the number of unsold houses at the beginning of t is higher than at the beginning of $t-1$, or a markup ($+\xi_t$) otherwise. The price remains the same if the number of unsold houses does not change.

$$
P^H_{t,h} = \begin{cases}
P^H_{t-1,h}(1 - \xi_t) & \text{if } unsold_t - unsold_{t-1} > 0 \quad (6) \\
P^H_{t-1,h}(1 + \xi_t) & \text{if } unsold_t - unsold_{t-1} < 0 \quad (7) \\
P^H_{t-1,h} & \text{if } unsold_t - unsold_{t-1} = 0 \quad (8)
\end{cases}
$$

The magnitude of the change in the number of unsold houses reflects into the mark-up/down (9), so that the higher the difference between $unsold_t$ and $unsold_{t-1}$, the higher ξ_t.

$$
\xi_t = \xi_{min} + \frac{(\xi_{max} - \xi_{min})}{1 + \frac{1}{|X_t|}} \quad \text{where} \quad X_t = \frac{unsold_t - unsold_{t-1}}{unsold_{t-1}} \quad (9)
$$

ξ_{max} and ξ_{min} in equation 9 are parameters set in the initialisation phase, which are meant to limit the range of oscillation of the mark-up/down.

In every period, a number of randomly selected homeowners enters the housing market on the supply side. Similar to Erlingsson et al. (2013), we include random sellers in order to "address the trading activities driven not by speculative reasons but by different reasons, like family needs, migration", and so on.[9] In addition, all bankrupt households have to join the supply side of the market: since they have failed to meet their obligations with banks, they have to sell their house in order to get the liquidity to pay back their outstanding debt.

When entering the market, sellers set their selling price equal to their updated price at the beginning of each period, that is $PS_{t,h} = P^H_{t,h}$.

All households who do not own a house enter the housing market placing themselves on the demand side.[10] All buyers set a desired price, $PB_{t,h}$, as a multiple $\theta > 0$ of their liquid wealth (condition 10). If they have no

---

[9]This random set in each period t cannot include homeowners who use their house as a collateral for consumption loan in the same period. In addition, we also rule out the possibility of selecting homeowners who have bought the house in the previous "$rest_s$" periods, where "$rest_s$" is a parameter set in the initialisation phase of the model.

[10]The set of buyers does not include all households who have sold a house in the previous "$rest_b$" periods, where "$rest_b$" is a parameter set in the initialisation phase of the model.

liquid wealth, they will apply a mark-up to the average market price in the previous period (condition 11).

$$PB_{t,h} = \begin{cases} \theta M_{t-1,h} & \text{if } M_{t-1,h} > 0 & (10) \\ \overline{P_{t-1}^H}(1 + \xi_{t,h}) & \text{if } M_{t-1,h} = 0 & (11) \end{cases}$$

Transactions among households in the housing market are based on a search and matching mechanism: the main rule for buyers is to look for a seller such that $PS_{t,h} \leq PB_{t,h}$. All sellers are sorted in ascending order based on the selling price, whereas buyers are sorted randomly. The first buyer to enter the search and matching process assesses whether her price is higher than that of the first seller. If so, they set a deal; otherwise the buyer leaves the market and tries to buy a house in the following period. The second buyer steps in and searches for an available seller (i.e. a seller who does not have a deal with a buyer). The process keeps running until all buyers have had the chance to search for a seller.

When a deal is set up, the agreed price of the transaction is the price set by the seller. Buyers who have enough liquid wealth are allowed to buy the house directly: the seller transfers her real wealth to the buyer, who is now a new homeowner. In exchange, the seller gets an amount of liquidity equal to the selling price, so that $Liq_{t,h} = PS_{t,h}$. This will increase her liquid wealth.

Buyers who do not have enough liquid wealth to buy a house, enter the mortgage market. Demand for mortgages, $Z_{t,h}^d$, is equal to the selling price net of the downpayment, that is the whole amount of available (if any) liquid wealth:

$$Z_{t,h}^d = PS_{t,h} - M_{t-1,h} \tag{12}$$

By design, also households with no liquid wealth can apply for a mortgage. In other words, a downpayment is not necessary. Even though this might sound as an extreme assumption, in the years before the recent financial crisis "buyers could be given loans exceeding 80% of home price; or they could be given two loans, one for 80% of purchase price - making the loan potentially sellable to FNMA - and another (the down payment) for the other 20%" (Dimsky, 2010).

Bank behaviour in the credit market for mortgages follows the same rules as in the credit market for consumption loans: they rank households in ascending order based on their TDS and supply mortgages until $LS_{t,b} = 0$. Again, applicants with zero TDS are given priority. We assume all banks issue standard "plain-vanilla" mortgage contracts, $ZSH_{t,b,h}$, with fixed interest rates, the duration being T_z.

44

$$ZSH_{t,b,h} = \frac{\gamma RW_{t,h}}{1 + r^z_{t,b,h}} \tag{13}$$

Also in the mortgage market, the definition of the interest rate, $r^z_{t,b,h}$, is as follows:

$$r^z_{t,b,h} = \overline{r_t} + \widehat{r_{b,t}} + r_{t,h} \tag{14}$$

Each household searches for the banks whose individual supply is higher than her demand. Then, within the subset of selected banks, h selects the bank offering the lowest interest rate as shown in condition 15.[11]

$$\forall b \quad s.t. \quad ZSH_{t,b,h} \geq Z^d_{t,h}, \quad find \quad min(r^z_{t,b,h}) \tag{15}$$

If h finds a bank b satisfying condition 15, she accepts the offer of that bank, joins its credit network and gets a mortgage equal to $Z_{t,h} = ZSH_{t,b,h}$: from the following period until $t + T_z$, h will have a constant periodic payment which is based on the standardised calculations in the U.S. (as defined by Kohn, 1990):

$$ZP_{t,h} = Z_{t,h} \frac{r^z_{t,b,h} (1 + r^z_{t,b,h})^{T_z}}{(1 + r^z_{t,b,h}) - 1} \tag{16}$$

All households who do not find any bank willing to supply more than what they demand, leave the market without getting any mortgage. They drop the deal with the corresponding seller and search for a house and, eventually, a mortgage in the following period.

On the contrary, all the households who successfully found a mortgage get back to the corresponding seller to proceed with the transfer of real wealth. The buyer becomes the owner of the house, whereas the seller gets the corresponding liquidity equal to the selling price, thus increasing her liquid wealth.

Notice that the mechanisms included in the housing market allow to capture the impact that housing price dynamics have on existing homeowners and their home equity based borrowing behaviour. This is because the value of their equity reflects the changes in the number of unsold houses via house prices.

After mortgage and housing market close, each bank has a credit network made of all the households to which it has supplied consumption loans and

---

[11]Also in the mortgage market, if two or more banks set the same interest rate, each household selects one randomly.

mortgages. All banks update the value of their assets, $AB_{t,b}$, and their leverage ratio, that is $LB_{t,b} = AB_{t,b}/E_{t,b}$.

All borrowers update their debt and total debt service ratio as follows:

$$Debt_{t,h} = Debt_{t-1,h} + LOAN_{t,h} + Z_{t,h} \tag{17}$$

$$TDS_{t,h} = \frac{ZP_{t,h} + RS^L_{t-1,h}}{Y_{t,h}} \tag{18}$$

3.4 Pay Back Phase

As already pointed out, the pay back phase (PBP) starts at the beginning of each period t. In the PBP, some borrowers have to pay the repayment schedule of the consumption loan obtained in the previous period; others have to fulfill the recurring mortgage payment. Finally, a number of households has to do both. Each household is able to meet her obligations entirely if and only if $ZP_{t,h} + RS^L_{t-1,h} \leq Y_{t,h} + M_{t-1,h}$. If this condition is satisfied, household h pays $ZP_{t,h}$ and $RS^L_{t-1,h}$ in sequence, thus experiencing a reduction of her debt and the balance owed on the existing mortgage. Consequently, also her total debt service ratio decreases. In addition, each bank b earns profits equal to the sum of the interest payment of all the household in its credit network, CN, that is:

$$INT_{t,b} = \sum_{h \in CN} (r^L_{t,b,h} LOAN_{t-1,h} + int^Z_{t,h}) \tag{19}$$

Households who fail to meet their obligations, instead, try to pay back their outstanding debt only after selling their house. If they do not manage to sell it in period t, they will try to do so in any other following period. When bankrupt households sell their house, they assess whether the resulting liquidity, $Liq_{t,h}$, is higher than the entire repayment schedule: if $\sum_{ii=t^*}^{T_z} ZP_{ii,h} + RS^L_{t^*,h} \leq Liq_{t,h}$, their debt goes down to zero and they are not labelled as bankrupt anymore as they pay back both the entire principal and interests.[12] Moreover, they will keep the excess liquidity thus increasing their liquid wealth. On the contrary, if $\sum_{ii=t^*}^{T_z} ZP_{ii,h} + RS^L_{t^*,h} > Liq_{t,h}$, household h pays a lower amount than due. In this case, the non-performing loan results in bad debt on banks' balance sheets. The computation of bad debt is based on the composition of household debt. Indeed, if h belongs to

---

[12]Notice that t^* identifies the default period, namely the period at which household h failed to meet her obligation

the credit network of two banks at the same time[13], she splits the liquidity in two parts (equations 20 and 21): a part of it, $\delta_{t,h}^L$, will go to the bank that supplied the consumption loan, the remaining part, $\delta_{t,h}^Z$, being paid to the bank that issued the mortgage.

$$\delta_{t,h}^L = \frac{RS_{t^*,h}^L}{\sum_{ii=t^*}^{T_z} ZP_{ii,h} + RS_{t^*,h}^L} \tag{20}$$

$$\delta_{t,h}^Z = \frac{ZP_{t^*,h}}{\sum_{ii=t^*}^{T_z} ZP_{ii,h} + RS_{t^*,h}^L} \tag{21}$$

Hence, the amount of bad debt due to h's default is as follows:

$$bd_{t,h,b} = \begin{cases} RS_{t^*,h}^L - \delta_{t,h}^L Liq_{t,h} & (22) \\[2em] \sum_{ii=t^*}^{T_z} ZP_{ii,h} - \delta_{t,h}^Z Liq_{t,h} & (23) \end{cases}$$

As shown in equation 24, the overall amount of bad debt, $BD_{t,b}$, for each bank b is calculated as the sum of the entire bad debt coming from the bankrupt households who belong to its credit network.

$$BD_{t,b} = \sum_{h \in HB} bd_{t,h,b} \tag{24}$$

$HB \subset CN$ identifies the subset of all the bankrupt households in the credit network of bank b.

After the pay back phase, each bank updates its equity based on the following accumulation process:

$$E_{t,b} = E_{t-1,b} + INT_{t,b} - BD_{t,b} \tag{25}$$

Notice that, similar to Delli Gatti et al. (2010), the bankruptcy of a household creates a negative externality since the bad debt recorded on the bank's balance sheet results in a reduction of banks' equity and, therefore, a higher bank leverage which implies a higher interest rate and a reduction in the overall credit supply.

---

[13]Households can join two credit networks when they get a consumption loan from a bank and a mortgage from another one. Notice that since households cannot apply for more than one consumption loan and one mortgage, they cannot belong to more than two credit networks.

In addition, it may be the case that bad debt is high enough that $E_{t,b}$ is lower than zero, the bank has negative net worth and goes bankrupt. In this case, following Delli Gatti et al. (2011), we assume that whenever a bank records negative equity, "the government bails the bank out, replacing it with a random copy of surviving banks".

3.5 Goods Market, Consumption and Saving

After the housing and mortgage markets close, the goods market opens. We assume the representative firm always supplies the required amount of goods, so that no rationing takes place in the goods market.

All households make their consumption and saving decisions based on the level of desired consumption. Households who have enough internal resources, as well as those who managed to access the credit market and get a consumption loan, can close the gap between desired consumption and actual consumption expenditure, so that $C_{t,h} = C_{t,h}^d$, where $C_{t,h} \equiv \alpha_{t,h} Y_{t,h} + \beta_{t,h} M_{t-1,h} + L_{t,h}$.

All households save a portion $1 - \alpha_{t,h}$ of income that is converted into a zero interest rate deposit, $D_{t,h} = (1 - \alpha_{t,h}) Y_{t,h}$.

Household liquid wealth therefore becomes:

$$M_{t,h} = M_{t-1,h} + D_{t,h} + Liq_{t,h} \tag{26}$$

Finally, each household has an overall amount of wealth equal to:

$$A_{t,h} = M_{t,h} + RW_{t,h} - ZR_{t,h} \tag{27}$$

3.6 Policy Authorities

In our model the government serves the only purpose of smoothing income disparities by redistributing income from the top to the bottom.

To do so, we assume the government does deficit spending: it collects taxes on income based on the same tax rate for all households and spends a constant exceeding percentage of its earnings from taxes.

Government spending is entirely distributed to households at the bottom 90% of the distribution in the form government subsidies that increase their individual income. Subsidies are the same for all households. However, since the amount of taxes collected in each period t depends on income in the previous period (i.e. GDP_{t-1}), the amount of each subsidy depends on the performance of the economy.

On the other hand, the central bank has a countercyclical policy: at the beginning of each period it increases the policy rate if GDP at time $t-1$ is lower than the mean of GDP in previous three periods ($\overline{GDP_{t-2,t-4}}$).

However, it also looks at the one-to-one change in GDP between $t-1$ and $t-2$. That is:

$$\overline{r}_t = \begin{cases} \overline{r}_{t-1} \cdot (1-\tau_t) & \text{if } GDP_{t-1} \leq \overline{GDP_{t-2,t-4}} \text{ and } GDP_{t-1} \leq GDP_{t-2} \\ \overline{r}_{t-1} \cdot (1+\tau_t) & \text{if } GDP_{t-1} > \overline{GDP_{t-2,t-4}} \text{ and } GDP_{t-1} \geq GDP_{t-2} \end{cases}$$
$$(28)$$

Similar to house prices, τ_t is a mark-up/down that depends on the magnitude of the change in the key variable, that is GDP in this case (Equation 29).

$$\tau_t = \eta_{min} + \frac{(\eta_{max} - \eta_{min})}{1 + \frac{1}{|Q_t|}} \quad \text{where} \quad Q_t = \frac{GDP_{t-1} - \overline{GDP_{t-2,t-4}}}{\overline{GDP_{t-2,t-4}}} \quad (29)$$

η_{min} and η_{max} are set in the initialisation phase and are meant to limit the degree of oscillation of τ_t.

4 Model Results

We use our model to simulate two scenarios: a baseline scenario (BA) in which income shares at the beginning of each period t remain constant over time and a rising inequality scenario (RI) in which we shock income shares after a number of periods in order to simulate rising inequality. Model results are obtained by means of Monte Carlo (MC) analysis: given a parameter vector, we run 30 simulations for each of the two scenarios, selecting a different random seed at each run, similar to Delli Gatti et al. (2011) and Russo et al. (2015). Our parameter vector is set up mostly based on the literature as well as the need to rule out explosive dynamics and unrealistic patterns, similar to Delli Gatti et al. (2011), so that "no attempt has been made at this stage to calibrate the model for instance, by means of genetic algorithms in order to force the output of simulation to replicate some pre-selected empirical regularities". In addition, we also perform univariate sensitivity analysis by changing the values of some key parameters so as to asses the change in the outcome of simulations.

In order to run simulations we calibrate model parameters as shown in Table 1.

The choice of assigning a house to 260 randomly selected households follows Mian and Sufi (2009) who point out that "65% of U.S. households already owned their primary residence before the acceleration in house prices beginning in the late 1990s". The initial loan-to-value ratio for all banks is equal to 0.8 and it is in line with the data for 1990 reported in Duca et al. (2011) and retrieved from the American Housing Survey. v, which, as

Parameter		Value
T	Number of periods	2000
H	Number of households	400
B	Number of banks	20
HO	Number of homeowners	260
a	Sensitivity parameter to j's past consumption	0.5
k	Consumption parameter independent of income or rank	0.8
v	Capital requirement coefficient	0.08
μ	Bank sensitivity to TDS	0.005
ρ	Bank sensitivity to own leverage	0.005
γ	Loan to value ratio	0.8
θ	Multiple of liquid wealth	100
ξ_{min}	Minimum mark-up/down for house prices	0.01
ξ_{max}	Maximum mark-up/down for house prices	0.1
η_{min}	Minimum mark-up/down for the policy interest rate	0.01
η_{max}	Maximum mark-up/down for the policy interest rate	0.05
T_z	Duration of mortgages	120
$rest_s$	Number of "freezing" periods for sellers	16
$rest_b$	Number of "freezing" periods for buyers	4

Table 1: Model calibration

already pointed out, can be interpreted as a capital requirement coefficient is set to 0.08, following the standard value in the literature (see, for example, Benes et al., 2014). Finally, the values of a and k are taken from the original work on expenditure cascades by Frank et al. (2014).

4.1 Monte Carlo Analysis: Baseline Scenario vs. Rising Inequality

Starting from our parameter vector, we perform our MC simulations: for each scenario, we compute the cross-simulation mean of the key variables. For example, we calculate GDP at each time t as the average of GDP across the 30 MC simulations for each of the two scenarios.

In all simulations we drop the first 1100 periods in order to get rid of transients: graphs only show the last 900 periods for the purpose of simplicity.[14] In addition, we represent all data generated by our model as simple moving averages in order to smooth out the cyclical fluctuations of the key time series.[15]

In each scenario, the key time series show the same pattern across all MC simulations: cross-section time series in particular (e.g. total wealth share, consumption share, default rate, successful mortgage applicants) are all stationary at least in the last 500 periods in BA.

In both BA and RI, the model starts with unequal income shares for the top 10% and bottom 90%, with values respectively equal to 31.51% and 68.49%. These are retrieved from the World Top Income Database (Facundo et al., 2014) with reference to the United States for the year 1975. In RI we simulate a shock in the income shares that become equal 62.57% for the bottom 90%, 37.43% for the top 10% from period 100 until the end.[16]

Model results suggest our ABM fits the stylised facts described in section 2 of this paper. GDP, household debt and house prices follow the same pattern and are strictly correlated as shown in Figure 1, which collects the combined plots of such key time series in the two scenarios, together with their correlation values (see also Table 2 featuring a few key statistics for GDP and household debt).

Endogenous business cycles emerge in BA as a result of the agents' interactions that lead to small oscillations of house prices and household debt.[17]

---

[14]Hence, the description of the two scenarios refers to the last 900 periods and thus takes period 1101 as period 1.

[15]We choose a window size for our moving averages equal to 20.

[16]Such values are equal to the mean of the income shares for the groups in the period between 1971 and 2006.

[17]Note that house prices have a slightly decreasing trend. This is in contrast with the empirical evidence, particularly in the United States. Yet, this result is easily explained: as we want to keep the model as simple as possible, existing homeowners are allowed to enter the housing market on the supply side only, thereby resulting in a downward pressure
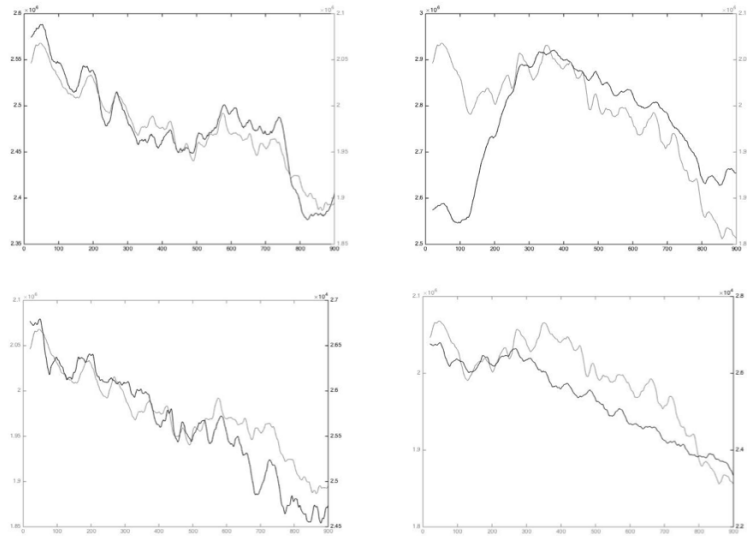
Figure 1: Left column, top: GDP (black) and household debt (gray) in BA (correlation: 0.99, significant at 5% level); bottom: household debt (gray) and average house prices (black) in BA (c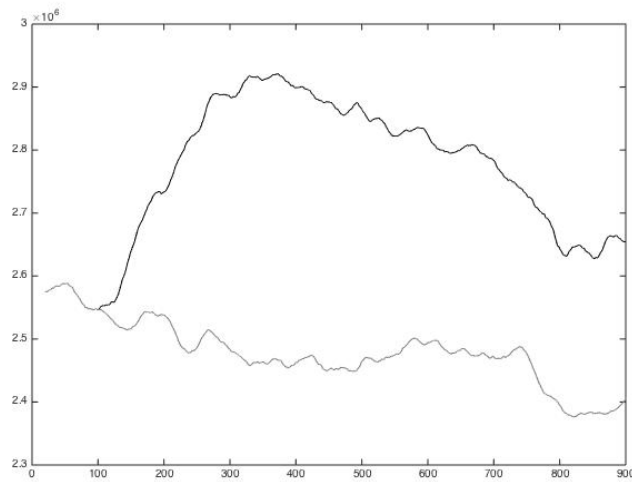orrelation: 0.85, significant at 5% level). Right column, top: GDP (black) and household debt (gray) in RI (correlation: 0.89, significant at 5% level); bottom: household debt (gray) and average house prices (black) in RI (correlation: 0.82, significant at 5% level).

Figure 2: GDP in BA (gray) and RI (black).
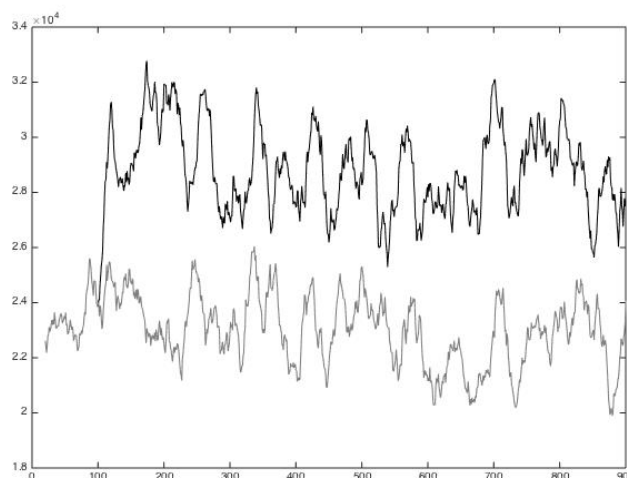
Figure 3: Amount of consumption loans supplied to households in each period t in BA (gray) and RI (black).

Scenario	Average growth rate (%)	Mean	Variance	Standard Deviation
GDP - BA	0.12	2478605.62	2718604888.14	52140.24
GDP - RI	0.2	2759851.12	13561870075.59	116455.44
Household Debt - BA	0.29	1974999.09	1997990747.62	44698.89
Household Debt - RI	0.9	1991219.39	3546517787.83	59552.65

Table 2: Key statistics for crosse section GDP and household debt in the two scenarios.

However, when income shares change and inequality rises, GDP increases substantially, as shown in Figure 2. The inequality shock has various consequences.

First, Figure 3 compares the amount of consumption loans households actually get in each period in the two scenarios. Clearly, with higher inequality, households' demand for consumption loans increases as income at the bottom of the distribution is stagnating and households need external resources to finance their desired consumption. However, also note that house prices do not change significantly for a number of periods as shown in Figure 4. Hence how can households increase their debt?

The answer to this question comes by looking at the behaviour of households at the top of the distribution: they exploit the newly accumulated amount of income to buy more houses whereas households in the bottom 90% lower the number of houses being bought. Indeed, as shown in Figure

_____

on house prices.
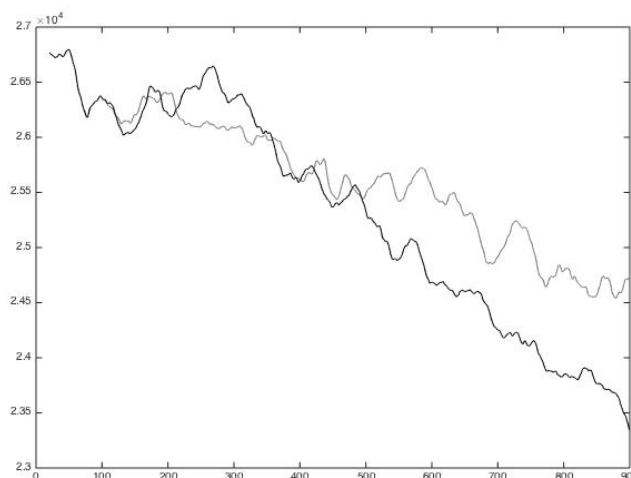
Figure 4: Average house price in BA (gray) and RI (black).

5, the real wealth of the top 10% rises right after the shock.

This results in a greater number of direct buys and, consequently, in a reduction of mortgages (Figure 6).

The impact on the banking sector is relevant: lower mortgages imply lower bad debt and therefore higher net worth. Hence, banks increase the maximum allowable credit supply: a greater number of households is now able to get the desired amount of consumption loans. This is the reason why, right after the shock, the overall amount of consumption loans increases even though house prices remain roughly stable for a while. We might call this a "supply effect": more households can borrow because of greater availability of credit, not because of changes in house prices. The increased amount of debt for consumption loans results immediately in higher household spending thus pushing GDP upwards, as seen in Figure 2.

After a number of periods, house prices increase smoothly. Indeed, as these rise, the value of mortgages being issued increase as well: people at the bottom of the distribution borrow to buy a house as well. Higher house prices also result in greater consumption loans. The overall consequence is booming household debt (Figure 7). This sustains consumption and GDP for a while, thereby giving the false impression that the economy is performing well.

Nonetheless, when households start defaulting on their obligations, a dramatically large amount of bad debt is accumulated by the banking system that reacts by cutting credit supply and increasing interest rates. Given the existence of interconnected credit networks among households and banks, the consequence of a growing number of non-performing loans is a credit
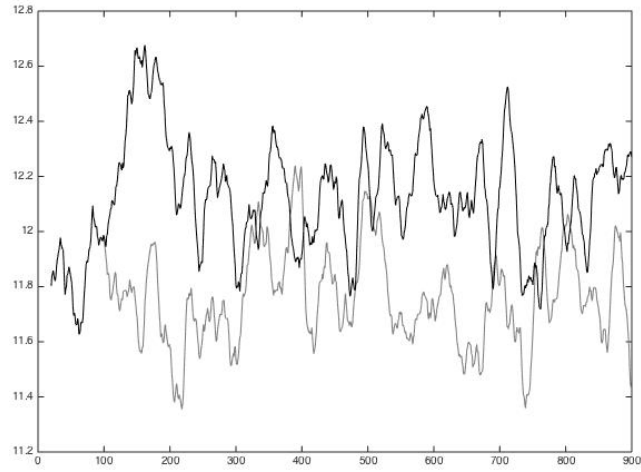
54

Figure 5: Share of real wealth held by the top 10% in BA (gray) and RI (black).
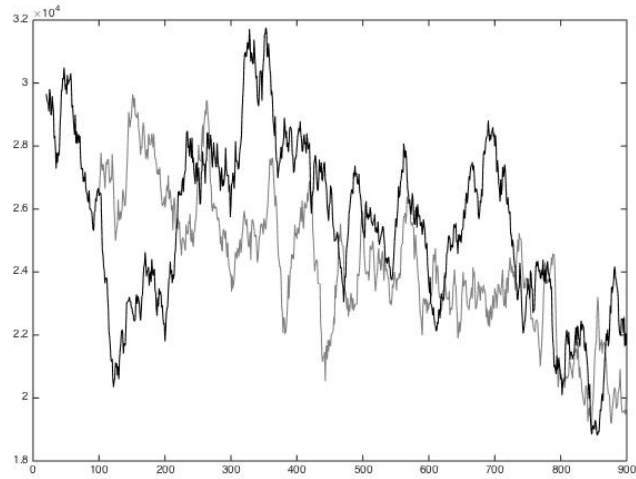

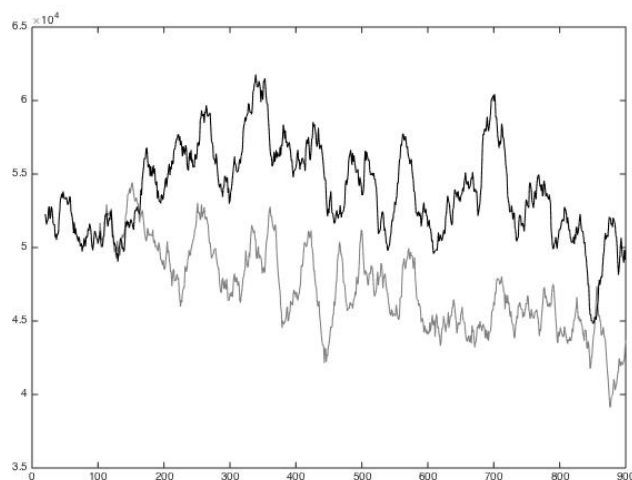Figure 6: Amount of mortgages in BA (gray) and RI (black).

Figure 7: Household debt in BA (gray) and RI (black).

crunch that affects future borrowers and their ability to finance desired consumption. Therefore, the crisis emerges as a balance sheet recession: households fail to meet their debt obligations and banks record a substantial value of bad debt. Figure 8 shows this is the case in RI: as households take on more debt, both in the form of consumption loans and mortgages, they lack the internal resources to pay it back due to rising income inequality and bad debt rises. Note that the correlation between GDP and bad debt of the banking sector is 0.89, which are statistically significant at 5% level: this suggests that the expansion of the economy goes together with the amount of non-performing loans.

Due to the emerging credit crunch, households are forced to consume less than desired, thus leading to falling actual consumption and GDP. After entering a recession, household debt and bad debt decline as well: this is mostly due to lower mortgages. In fact, the amount of consumption loans remains roughly stable even though this is not enough to keep consumption up to its previous levels. The reason is that the number of households who is able to get the desired amount of consumption loans drops: in other words, less people are getting more loans but a wider number of households is forced to cut their consumption as a consequence of bankruptcy.

4.2 Sensitivity Analysis

We now show the results of our sensitivity analysis with the aim of showing how model output changes when we explore the parameter space. In particular, following Delli Gatti et al. (2011), we perform univariate sensitivity analysis for the baseline scenario, "according to which the model
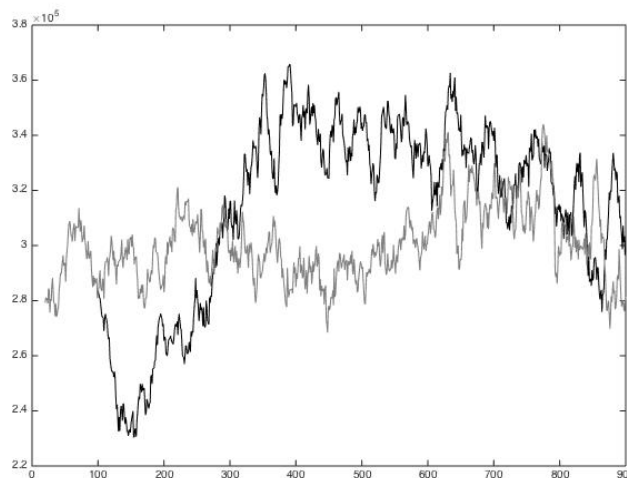
Figure 8: Bad debt for the banking sector in AB (gray) and RI (black).

outcomes are analyzed with respect to the variation of one parameter at a time, whereas all the other parameters of the system remain constant". We act on five different parameters, namely a, k, μ, ρ and θ which are the sensitivity parameters of our model. We find that for three of these parameters, that is a, k and ρ, model results change in line with our intuitions. On the contrary, changes in μ and θ do not seem to affect the dynamics of our artificial economy in any relevant manner.

Let us summarise our main findings.

Sensitivity parameter to j's past consumption: a. We run 30 MC simulations for the baseline scenario, for 4 different values of a: 0.2, 0.4, 0.6 and 0.8. Results show that the lower the value of a, the higher the (stationary) trend along which GDP oscillates. In particular, lower levels of a imply a less imitative behaviour by households: since desired consumption is set mostly based on internal resources, a larger number of households is able to finance it without accessing credit markets for consumption loans. Indeed, the lower a, the lower the amount of consumption loans. This also results in smaller debt-to-GDP ratios and total debt service by households. Consequently, less households default on their obligations and banks record a fewer number of non-performing loans.

Consumption parameter: k. We run 30 MC simulations for the baseline scenario, for 3 different values of k: 0.2, 0.4, 0.6. Remember that in all these experiments, a is equal to its original value of 0.5. Changing the value of k does not imply a different sensitivity to j's consumption for household h. Rather, it means each household is targeting a different amount of internal resources to set her desired consumption. Results suggest

57

that lower values of k go along together with business cycles along lower trends: GDP and consumption loans have smaller values. With less GDP to be distributed, households have lower internal resources to pay back their debt: non-performing loans and bad debt have higher values, thus resulting in higher debt-to-GDP ratios.

Bank sensitivity to TDS: μ. In this experiment we run 30 MC simulations for the baseline scenario, for 3 different values of μ: 0.001, 0.01, 0.05. In this case we find that modifications in banks' sensitivity to households' total debt service ratios do not imply any significant change in the model results and the overall dynamics of the economy. Results are in line with those reported for the baseline scenario using the parameter vector described above.

Bank sensitivity to own leverage: ρ. In this experiment we run 30 MC simulations for the baseline scenario, for 3 different values of ρ: 0.001, 0.01, 0.05. When banks are more sensitive to their own leverage, interest rates are higher. This results in higher total debt service ratio and a rise in the number of defaults and the value of bad debt. On the other hand, households are less willing to take on more debt so that household debt falls as well as debt-to-GDP ratios.

Multiple of liquid wealth: θ. In this experiment we run 30 MC simulations for the baseline scenario, for 4 different values of θ: 50, 80, 120, 150. We find that modifications in the value of θ do not result in significant changes in model outcome: all the key time series follow the same pattern as in our baseline, thus suggesting that θ is not a key parameter in affecting output and model dynamics.

5 Concluding Remarks

By means of an agent-based model we create an artificial economy with heterogenous agents whose interactions result in mutual feedbacks and emerging macroeconomic dynamics resembling the ones that took place before and during the recent financial crisis in the United States. By including some key elements regarding household consumption behaviour and the functioning of credit and housing markets, the data generating process built in our model captures the impact of increasing inequality on household debt and the overall stability of the economy.

On the one hand, growing income disparities force low and middle income households to enter credit markets so as to find the external resources that are needed to satisfy consumption needs. This captures the pressure of inequality on the lower segments of society. On the other hand, higher house prices, fueled by mortgage credit and the accumulation of wealth at the top of the distribution, allow for relaxed collateral constraints thus impacting households' ability to borrow.

The combination of these elements gives rise to an extended borrowing binge, as described by Fazzari and Cynamon (2013). This undermines the stability of the system: when household debt skyrockets, a growing number of households default on their obligations. Non-performing loans affect banks' balance sheets and their willingness to lend. Hence, the credit bubble created by higher inequality and household debt collapses and the structural vulnerability of the economy emerges. Therefore, as highlighted by Galbraith (2012), the link between radical inequality and financial crisis runs precisely through private debt. However, "the problem with the trick of generating prosperity through inequality is simply that it cannot be continually repeated" (Galbraith, 2012).

From a policy perspective, our results seem to go in the direction of a redistributive policy in favour of the poorer segments of society, as a less unequal society seems to benefit from smoother and more stable oscillations of GDP, whereas a more unequal society suffers from dramatic booms and busts for the reasons explained above. In other words, our findings support the work carried out at the International Monetary Fund by Ostry et al. (2014) who find that lower inequality has a positive impact of growth both in terms of speed and stability.

Even though the current setting of our model proves useful in studying the dynamics described above, further improvements could be made in order to assess a broader set of issues. For example, similar to Delli Gatti et al. (2011, 2010), we could include heterogenous firms that can hire and fire workers, or access credit markets, based on their financial conditions. This would allow us to include bargain processes in wage setting mechanisms and to study unemployment dynamics in periods of expansion and recession.

Another possible extension is the inclusion of construction firms in the housing market so as to drop the assumption of a fixed stock of houses and number of homeowners. This might change house price dynamics and investment mechanisms by richer households.

Finally, another interesting aspect deals with the international dimension of the crisis. Indeed, by extending our model to a multi-country setting we could capture the dynamics of business cycles and external imbalances in the presence of rising income disparities. As a matter of fact, the higher inequality results in different economic patterns across countries: on the one hand, households in debt-led economies increase consumption by borrowing, thus leading to a borrowing binge or capital inflows; on the other hand, households in export-led countries lower their consumption thereby leading to excessive savings and depressed growth.

References

Arestis, P. and Gonzalez, A. R. (2013). Modeling the house market in oecd countries. *Levy Economics Institute Working Paper*, (764).

Atkinson, A. B. and Morelli, S. (2011). Economic crisis and inequality. *Human Development Research Paper*, (6).

Benes, J., Kumhof, M., and Laxton, D. (2014). Financial crises in dsge models: Selected applications of mapmod. *IMF Working Paper*, (56).

Cynamon, B. Z. and Fazzari, S. M. (2013). The end of the consumer age. In Cynamon, B. Z., Fazzari, S. M., and Setterfield, M., editors, *After the Great Recession: The Struggle for Economic Recovery and Growth*. New York, NY: Cambridge University Press.

Delli Gatti, D., Desiderio, S., Gaffeo, E., Cirillo, P., and Gallegati, M. (2011). *Macroeconomics from the Bottom-Up*. Milano, IT: Springer.

Delli Gatti, D., Gallegati, M., Greenwald, B., Russo, A., and Stiglitz, J. E. (2010). The financial accelerator in an evolving credit network. *Journal of Economic Dynamics and Control*, 34.

Dimsky, G. A. (2010). Why the subprime crisis is different: a minskyian approach. *Cambridge Journal of Economics*, 34.

Dosi, G., Fagiolo, G., Napoletano, M., and Roventini, A. (2013). Income distribution, credit and fiscal policies in an agent-based keynesian model. *Journal of Economic Dynamics and Control*, 37(8).

Duca, J. V., Muellbauer, J., and Murphy, A. (2011). House prices and credit constraints: Making sense of the us experience. *The Economic Journal*, (121).

Erlingsson, E. J., Cincotti, S., Stefansson, H., Sturlusson, J. T., Teglio, A., and Raberto, M. (2013). Housing market bubbles and business cycles in an agent-based credit economy. *Economics Discussion Papers*, 32.

Fagiolo, G. and Roventini, A. (2012). Macroeconomic policy in dsge and agent-based models. *Revue de l'OFCE / Debates and Policies*, (124).

Fazzari, S. M. and Cynamon, B. Z. (2013). Inequality and household finance during the consumer age. *Levy Economics Institute Working Paper*, (752).

FCIC (2011). Final report of the national commission on the causes of the financial and economic crisis in the united states. Technical report, Financial Crisis Inquiry Commission.

Fitoussi, J. P. (2013). *Le Théorème du Lampadaire*. Paris, FR: Les Liens Qui Liberent Editions.

Fitoussi, J. P. and Saraceno, F. (2010). How deep is a crisis? policy responses and structural factors behind diverging performances. *Journal of Globalization and Development*, 1.

Fitoussi, J. P. and Saraceno, F. (2010-2011). Inequality, the crisis and after. *Rivista di Politica Economica*, 100(I-III).

Frank, R. H., Levine, A. S., and Dijk, O. (2014). Expenditure cascades. *Review of Behavioral Economics*, 1.

Galbraith, J. K. (2012). *Inequality and Instability: A Study of the World Economy Just Before the Great Crisis*. New York, NY: Oxford University Press.

Justiniano, A., Primicieri, G. E., and Tambalotti, A. (2013). Household leveraging and deleveraging. *Federal Reserve Bank of New York Staff Reports*, (602).

Kaldor, N. (1955). Alternative theories of distribution. *The Review of Eonomic Studies*, 23.

Kiyotaki, N. and Moore, L. (1997). Credit cycles. *Journal of Political Economy*, 105(2).

Kohn, R. E. (1990). A capital budgeting model of the supply and demand for loanable funds. *Journal of Macroeconomics*, 12(3).

Kumhof, M. and Rancière, R. (2010). Leveraging inequality. *Finance and Development*, 47(4).

Kumhof, M., Rancière, R., and Winant, P. (2015). Inequality, leverage and crises. *American Economic Review*, 105(3).

Mian, A. and Sufi, A. (2014). Why the income distribution matters for macroeconomics.

Mian, A. R. and Sufi, A. (2009). House prices, home equity-based borrowing, and the u.s. household leverage crisis. *National Bureau of Economic Research Working Paper*, (15283).

Milanovic, B. (2010). *The Haves and the Have-Nots: A Brief and Idiosyncratic History of Global Inequality*. New York, NY: Basic Books.

Ostry, J. D., Berg, A., and Tsangarides, C. G. (2014). Redistribution, inequality and growth. *IMF Discussion Note*.

Russo, A., Riccetti, L., and Gallegti, M. (2015). Increasing inequality, consumer credit and financial fragility in an agent based macroeconomic model. *Journal of Evolutionary Economics*.

Stiglitz, J. E. (2012). Macroeconomic fluctuations, inequality, and human development. *Journal of Human Development and Capabilities: A Multi-Disciplinary Journal for People-Centered Development*, 13(1).

Stiglitz, J. E. (2013). *The Price of Inequality.* New York, NY: W. W. Norton Company.

Tesfatsion, L. (2006). Agent-based computational economics: A constructive approach to economic theory. *Computing in Economics and Finance*, (527).

Van Treeck, T. (2012). Did inequality cause the u.s. financial crisis? *IMK Working Paper*, (91).

Zezza, G. (2008). U.s. growth, the housing market, and the distribution of income. *Journal of Post Keynesian Economics*, 30(3).

A Appendix - Hierarchical Structure of Household Finance
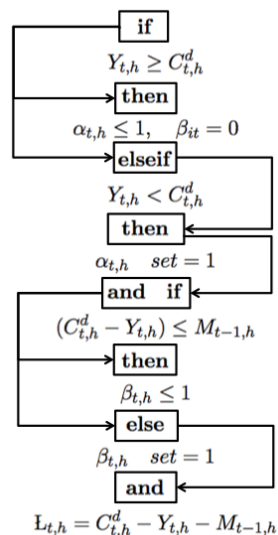
Figure 9: Hierarchical structure of household finance.

The functioning of the hierarchical structure of household finance is shown in Figure 9.

In general, households finance their desired consumption by using a portion $0 < \alpha_{t,h} \leq 1$ of their income, a portion $0 \leq \beta_{t,h} \leq 1$ of liquid wealth and, eventually, consumption loans, $L_{t,h}$. More specifically, h adjusts her propensity to consume out of income so that $\alpha_{t,h} = C_{t,h}^d / Y_{t,h}$. If $C_{t,h}^d \leq Y_{t,h}$, then $\alpha_{t,h} \leq 1$ and h is able to finance her desired consumption by using her income only: no wealth wears away and in this case $\beta_{t,h} = 0$ and $L_{t,h} = 0$. On the contrary, if $C_{t,h}^d > Y_{t,h}$, then $\alpha_{t,h} > 1$ thus violating its domain. As such, we impose $\alpha_{t,h} = 1$, so that h consumes her income entirely. Yet, this is not enough to finance desired consumption and consequently h needs to use her liquid wealth as well: $\beta_{t,h}$ becomes positive and equal to $(C_{t,h}^d - Y_{t,h})/M_{t,h}$, provided that h has a positive amount of liquid wealth[18]. If $(C_{t,h}^d - Y_{t,h}) \leq M_{t,h}$, $\beta_{t,h} \leq 1$ and h has enough internal resources to pay for her desired consumption. If $(C_{t,h}^d - Y_{t,h}) > M_{t,h}$, then $\beta_{t,h}$ is greater than one, thereby violating its domain. In this case we impose $\beta_{t,h} = 1$: h also consumes her liquid wealth entirely but has to apply for a consumption loan in order to close the gap between her desired consumption and the resources needed to finance it.

---

[18]It may be the case that h has no liquid wealth: if she is a homeowner, then she can enter the credit market directly to ask for a consumption loan. If h does not own a house, she will be forced to consume less than her desired consumption.

Inequality, Financialisation and Economic Crises: an Agent-Based Macro Model[*]

Alberto Cardaci[1] and Francesco Saraceno[2]

[1]Lombardy Advanced School of Economic Research, Milan
[2]OFCE-SciencesPo, Paris and LUISS-SEP, Rome

Abstract

By means of a macroeconomic model with an agent-based household sector and a stock-flow consistent structure, we analyse the impact of rising income inequality on the likelihood of a crisis for different institutional settings. In particular, we study how economic crises emerge in the presence of different credit conditions and policy reactions to rising income disparities. Our simulations show the relevance of the degree of financialisation of an economy. In fact, when inequality grows, a Scylla and Charybdis kind of dilemma seems to arise: on the one hand, low credit availability implies a drop in aggregate demand and output; on the other hand, relaxed credit constraints and a higher willingness to lend result in greater financial instability and a debt-driven boom and bust cycle. We also point out that policy reactions play a key role: a real structural reform that tackles inequality, by means of a more progressive tax system, actually compensates for the rise in income disparities thereby stabilising the economy. Results also show that this is a better solution compared to a stronger fiscal policy reaction, which, instead, only leads to a larger duration of the boom and bust cycle.

Keywords: Inequality, Household Debt, Credit Markets, Agent-Based Models, Stock-Flow Consistency

JEL Classification: C63, D31, E21, E62, G01

1 Introduction: Inequality, Institutions and Financialisation

It is widely established that inequality increased substantially, both in developed and in emerging economies, starting from the late 1970s (Atkinson et al., 2011; IMF, 2007; Milanovic, 2010; OECD, 2008; Piketty and Saez, 2013). In particular, in Europe and in the United States those who have lost ground belong to the middle class, while in other areas of the world, such as China, the rise of inequality has hit the very poor. Nonetheless, in all cases the redistribution has benefited mainly the rich and the very rich (the top one percent of the population, see Figure 1), giving birth to what Dew-Becker and Gordon (2005) define as the "Superstar Economy".
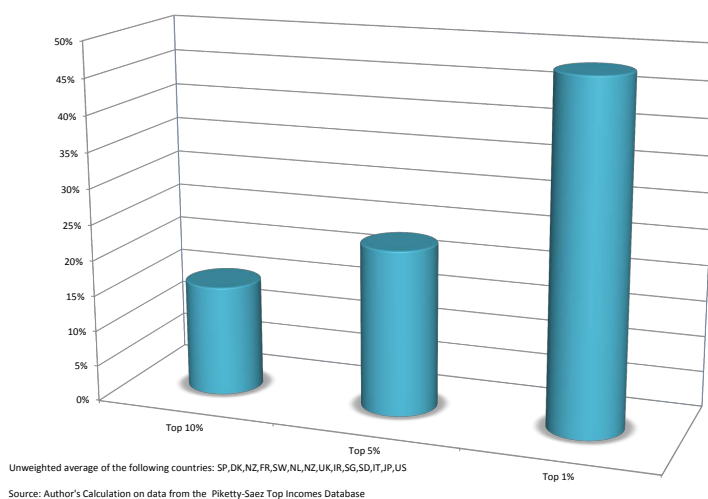

Figure 1: Average Change in Income Shares for Different Percentiles - 1980-2007.

Even though widening income inequality seems to be a widespread phenomenon (Table 1) in the recent years, cross-country differences have emerged in terms of economic performance[1].

The American economy, for example, performed reasonably well with an average annual growth rate of 3.16% between 1981 and 2007. In particular, the United States have experienced an excess of demand over domestic production that resulted in an increasingly important trade deficit, which in 2006 peaked at almost 6% of GDP. This deficit was financed by the excess savings that, with different causes, characterised other regions of the world for more than a decade.

In China and in other East Asian countries, due to the lack of a proper

---

[1]Among the selected countries, France is the only one where the Gini index has decreased in the selected time-span.

Country	oldest	latest
China	27.69 (1984)	42.06 (2010)
France	33.00 (1989)	31.69 (2005)
Germany	28.61 (1984)	31.83 (2007)
Italy	32.52 (1986)	35.52 (2010)
Spain	32.33 (1990)	35.75 (2010)
United Kingdom	36.21 (1991)	38.04 (2010)
United States	36.96 (1986)	41.12 (2010)

Table 1: Gini index in selected countries. Source: FRED

welfare state and of a reliable financial system, higher inequality yielded an excess of precautionary savings for businesses and households.[2]

Following growing income disparities, continental Europe (Germany in particular) experienced excess savings as well, even though, in our view, they were caused by the inertia of economic policy and by low investment rates, which depressed demand and income. As such, this part of the region relied on export-led growth alone.

These opposite imbalances compensated each other for almost two decades, resulting in an overall balance that the recent crisis proved to be fragile. The reason why increased inequality has led to excess savings in some areas, while resulting in excesses demand in others, lies in the interaction of the trend in income distribution, common to all countries, with institutional differences - most notably, the degree of financialisation - and the policy responses that have taken very different forms.

As a matter of fact, the development of financial markets seems to be a key factor that explains such differences among countries. As pointed out by Kumhof et al. (2012), the increase in income inequality in the United States and, in general, in more advanced economies, has not been tackled by means of political interventions to support the living standards of those who suffer from stagnating incomes. Rather, policy authorities have temporarily alleviated its consequences "through access to cheap borrowing, in other words through financial liberalization" (Kumhof et al., 2012). Krueger and Perri (2006) argue that the rise in inequality in the United States led to a change in the development of financial markets, which have allowed households to better insure against fluctuations of income. Therefore, in the United States, the reduction in income has been offset by private borrowing, made easier by a less regulated financial system, but also by a widespread perception of "end of history" which led to believe that all constraints to the unlimited growth of some sectors (financial, real estate) had been permanently

---

[2]In addition, after the 1997 crisis, authorities in these countries started a policy of reserve accumulation to deal with possible sudden stops.

removed. Consequently, aggregate demand has remained high, even if it has been debt-driven rather than income-driven.

Hence, as claimed by Van Treeck (2013), "in advanced economies with highly developed financial markets, including most notably the United States and the United Kingdom, rising inequality has led to a deterioration of national saving-investment balances, as the poor and middle classes borrowed from the rich and from foreign lenders to finance consumption".

However growing inequality in other regions of the world, such as China, led to a different outcome because "financial markets are less developed and hence do not allow the lower and middle classes to respond to lower incomes by borrowing" (Van Treeck, 2013). The implication is a weaker domestic demand and the emergence of an export-oriented growth model, where richer creditors lend to foreign rather than domestic borrowers. Also continental Europe has developed an export-oriented growth model, as stricter regulation of financial markets and less accommodating monetary policies have made borrowing for households and firms more difficult and expensive. Peripheral Europe also experienced a rise in top income shares in the recent decades (Atkinson et al., 2011). However, in contrast with the rest of the continent, these countries recorded growing level of household indebtedness as well as current account deficits (Kumhof et al., 2012).

Some authors point out that also policies have played a role in amplifying the imbalances among countries. For example, Rajan (2010) argues that monetary authorities in the United States fostered the speculative boom by implementing an expansionary policy in order to stimulate the economy, thus facilitating household access to credit markets and sustaining consumption for a while, albeit at the price of booming household debt. Rajan emphasises in particular the role of government failures: "the political response to rising inequality whether carefully planned or an unpremeditated reaction to constituent demands was to expand lending to households, especially low-income ones", so as to end up with rising household debt. While Rajan may be right in pointing at excessively lax monetary policy, the role of the central bank has only led to the amplification of a structural phenomenon, namely widening income disparities (Fitoussi and Saraceno, 2011).

One might also wonder why monetary policy has been the main policy instrument. Stiglitz (2012) suggests that political reasons matter in this case:

> High inequality is often accompanied by a demand for a smaller government and more fiscal restraint. (...) Policies are often affected by lobbying, campaign contributions, and revolving doors, so that the wealthy have disproportionate influence. Thus, as inequality grows, at least in many countries, so too do constraints on the government's fiscal space (Stiglitz, 2012, p.33).

The paper is organised as follows: Section 2 introduces our macroeco-

nomic model; Section 3 provides an analysis of model results obtained by means of Monte Carlo ripetitions; we also check for the robustness of our results through sensitivity analysis. Finally, Section 4 concludes.

2 The Model

In the light of the considerations above, we build a macroeconomic model with an agent-based household sector. Our goal is to show how the institutional setting and credit conditions interact with the impact of rising inequality on the performance of the economy and the accumulation of household debt. Our work follows part of the literature on macro agent-based models. In particular, Cardaci (2014) analyses the consequence of rising inequality in a context of peer effects in consumption and equity extraction processes. The paper shows that widening income disparities result in a debt-financed consumption boom that jeopardises the stability of the economic system (a similar result is found in Russo et al., 2015). Our paper represents a step forward. In fact, not only we include an analysis of the impact of inequality for different degrees of financialisation, but we also assess the effectiveness of different fiscal policy reactions. This is in line with the contribution by Dosi et al. (2013) that focuses on the effect of inequality under different monetary and fiscal policies. They show that more unequal societies suffer from more severe business cycles oscillations and higher unemployment rates thus increasing the likelihood of economic crises. Yet, their model allows for the accumulation of private debt by firms only. On the contrary, we apply our analysis on household loans since, in our opinion, the link between inequality and financial instability in the recent years ran precisely through household debt (Cardaci, 2014; Fazzari and Cynamon, 2013). On the other hand, this might allow for a generalisation of the policy implications of our findings.

Our model is also stock-flow consistent (SFC). The SFC approach is commonly used in the Post-Keynesian literature and dates back to the contributions by Tobin (1969, 1982) and, more recently, Godley and Lavoie (2007). The idea behind this methodology is that transactions in asset stocks imply the existence of an interlocked system of balance sheets, as Godley and Lavoie (2007) point out. As such, SFC models are built upon an accounting framework whose goal is to coherently integrate all stocks and flows of an economy, so that "every monetary flow, in accordance with the double-entry book keeping logic, is recorded as a payment for one sector and a receipt for another sector, and every financial stock is recorded as an asset for a sector and a liability for another sector" (Caiani et al., 2014).

Let us now go through the details of the modelling structure.

Our model follows the "KISS" (keep it simple, stupid!) principle. As such, we devote our effort to the development of the household sector, while

simplifying all the others as much as possible. Hence, the distinctive features of our economy are as follows:

- There is only one representative firm which is owned by all households and distributes all its earnings thus retaining zero profits.

- There is no investment in capital goods.

- Households' desired consumption is based on imitative behaviour and, more precisely, on the Expenditure Cascades hypothesis (Frank et al., 2014)

- There is a credit market for non-collateralised loans to households.

- There is a public sector with a government that can issue bonds to finance its deficit (if any).

The model has a sequential structure regarding decisions about flows and actual balance-sheet transactions. The entire sequence of events in each period t can be summarised as follows:

1. Production takes place. The firm produces homogenous perishable goods using labour as the only input.

2. The firm distributes wages to all households. This process is based on individual income shares drawn from a Pareto distribution.

3. If the commercial bank has a positive net worth, it distributes the entire amount of profits to households based on the same income shares as in the previous point. However, in case of a negative net worth, the commercial bank is bailed out by the central bank via a transfer of assets (i.e. reserves). Note that, in any case, the commercial bank has zero net worth at the end of this phase.

4. Households pay taxes. Tax payment is based on a progressive system of taxation on income. Tax rates are computed endogenously in period t and they remain constant for all the remaining periods. Collected taxes add up to the government deposit account held by the central bank.

5. The government then pays back its principal and interest on bonds to each household, based on the repayment schedule set in the previous period.

6. Households compute their desired consumption based on imitative behaviour and assess their own financial position. This latter may be

positive, if their internal resources are higher than their desired consumption and due debt, or negative, otherwise. Households with a positive financial position use the exceeding amount of internal resources to demand government bonds, whereas households with a negative financial position ask for a loan. Note that, as such, households can demand loans in order to finance desired consumption as well as to perform debt rollover, that is, to pay back the debt from the previous period.

7. Policy institutions decide their targets: the central bank sets the policy interest rate while the government sets its desired public expenditure. Both decisions are based on the value of the "demand gap" in the previous period and follow an anti-cyclical rule.

8. The bond market opens: if desired public expenditure exceeds collected taxes and past deposits, the government needs to borrow from households, thereby computing its supply of bonds. Total bond demand simply equals the sum of individual bond demand by each household, as mentioned in point 6. Note that the bond market may be in disequilibrium since total supply and demand are the result of independent decisions.

9. The pay-back phase (PBP) begins: households pay back the loan (principal plus interest) from the previous period. This does not include borrowers who need to perform debt rollover, as they do not have the internal resources to meet their debt obligations entirely. Hence, they will enter the credit market trying to get a new loan and, afterwards, they will go through a second PBP in order to repay the old one.

10. The credit market opens: the bank sets its total available credit supply as a fraction of total credit demand and ranks households in ascending order based on their financial soundness. Loan applications, computed by households at step 6, are satisfied until the bank runs out of total credit supply. This implies that credit-rationing may occur in the market: more financially fragile households may not get any loan from the commercial bank. Credit-rationed households will not be able to finance their desired consumption entirely and to perform debt rollover. Hence they go bankrupt and as such they are not allowed to apply for a new loan for a number of periods.

11. A second PBP opens: households who needed debt rollover and successfully got a new loan in the credit market, can now pay back the loan from the previous period.

12. The goods market opens: government and households buy goods based on their desired level of consumption. If the output produced by the

firm at step 1 is lower than overall desired consumption, rationing takes place. On the contrary, in case of excess supply, we assume the firm gets rid of the unsold amount of its perishable goods at no cost.

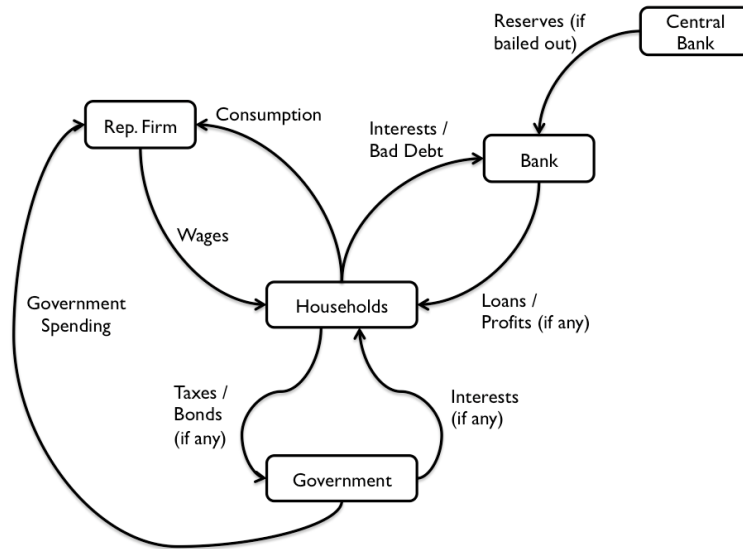13. Finally, all macroeconomic variables (e.g. GDP, Public Debt, Private Debt) are updated.

Figure 2: Transaction flows in our economy.

Figure 2 provides a graphical representation of all the transactions taking place in our artificial economy, based on the sequence reported above. These are represented as flows from a typology of agents to the others. In order to make sure that our model is stock-flow consistent so that no flow "leaks out" of the system, each agent is provided with a balance sheet that allows us to track and measure the levels of all stock variables at any point in time. Figure 3 shows the balance sheets of all the agents in the economy at the end of each period.[3]

Stock-flow consistency implies that any transaction that takes place in the economy is matched by an identical change in the stocks held in the balance sheets of the agents involved. For example, when the firm pays the wage bill, it transfers all of its deposits to the household sector through the commercial bank. Figure 4 provides a numerical example: firm deposits lower by their entire amount, whereas household deposits increase accordingly. This transaction is reported also on the liability side of the balance

---

[3]For simplicity, households are represented as an aggregate sector. Note, however, that the generic household h holds the same typology of assets and liabilities as the aggregate sector.

Households	
Assets	Liabilities
Household Deposits Bonds	Loans
	Net Worth

Firm	
Assets	Liabilities
Firm Deposits	
	Net Worth

Bank	
Assets	Liabilities
Loans Reserves	Household Deposits Firm Deposits
	Net Worth

Government	
Assets	Liabilities
Government Deposits	Bonds
	Net Worth

Central Bank	
Assets	Liabilities
	Reserves Government Deposits
	Net Worth

Figure 3: Agents' balance sheets in our economy.

73

sheet of the bank. Yet, the net worth of the bank does not change since a transfer of deposits does not modify the overall amount of liabilities it holds.[4] In general, at the end of each period, agents may have positive or negative individual net worth, depending on the difference between assets and liabilities. However, stock-flow consistency in our model implies that the overall value of the net worth in the economy must always be zero, not only at the end of each period t but also right after any transaction.

Let us now introduce the rules of behaviour for each category of agent and sector of the economy.

2.1 Production

The representative firm has a limited role to play in our model: it distributes wages and reacts to disequilibria in the goods market by changing total production. The firm is owned by the entire population of households, H, who all work for it. As shown in Equations 1 and 2, current production (Q_t) and prices (P_t) depend on their level in the previous period and on a sensitivity parameter (ϕ_Q and ϕ_P respectively) multiplied by the demand gap. This latter is defined as the previous period difference between aggregate demand and production, divided by production itself, that is $gap_{t-1} = \frac{AD_{t-1} - Q_{t-1}}{Q_{t-1}}$. In other words, the demand gap represents a measure of the real term excess demand or supply in the past.

$$Q_t = Q_{t-1}\left(1 + \phi_Q \cdot gap_{t-1}\right) \tag{1}$$

$$P_t = P_{t-1}\left(1 + \phi_P \cdot gap_{t-1}\right) \tag{2}$$

At the beginning of each period, the firm distributes its entire revenues, collected at the end of $t-1$, to the population in the form of wages. The distribution process is based on constant individual income shares that are drawn from a Pareto distribution. This is consistent with empirical evidence suggesting that income is generally distributed according to a power-law distribution and, more specifically, to a Pareto, particularly at top of the income scale (Clementi and Gallegati, 2005; Jones, 2015).

2.2 Expenditure Cascades and Financial Assessment

Individual household income (Equation 3) is defined as the sum of wages ($w_{t,h}$), profits from the bank ($\pi_{t,h}$, if any) and the repayment schedule on government bonds from the previous period ($RSG_{t-1,h}$, if any).

---

[4]In principle, such transfer of liabilities takes place among different banks and, as such, it has to be matched by an equal transfer of reserves on the asset side of their balance sheets. Nonetheless, this change does not occur in our case because our simplified framework features a single representative bank.

Households	
Assets	Liabilities
$D_h = 100$ $B_h = 20$	$L_h = 70$
	$NW_h = 50$

Firm	
Assets	Liabilities
$D_f = 80$	
	$NW_f = 80$

Bank	
Assets	Liabilities
$L_b = 70$ $R = 110$	$D_h = 100$ $D_f = 80$
	$NW_b = 0$

Households	
Assets	Liabilities
$D_h = 180$ $B_h = 20$	$L_h = 70$
	$NW_h = 130$

Firm	
Assets	Liabilities
$D_f = 0$	
	$NW_f = 0$

Bank	
Assets	Liabilities
$L_b = 70$ $R = 110$	$D_h = 180$ $D_f = 0$
	$NW_b = 0$

Figure 4: Numerical example of a wage payment. The firm transfers all of its revenues to the household sector as wages. This implies a transfer of deposits from the balance sheet of the former to that of the latter. This modifies their net worth. Also the bank records this change on the liability side of its balance sheet, even though its overall net worth remains the same.

$$y_{t,h} = w_{t,h} + \pi_{t,h} + RSG_{t-1,h} \tag{3}$$

After receiving income, households pay taxes based on a progressive tax system, with constant tax rates set in period 1. Hence, individual disposable income $(yd_{t,h})$ is given by income net of the due amount of taxes $(T_{t,h})$, as defined in Equation 4.

$$yd_{t,h} = y_{t,h} - T_{t,h} \tag{4}$$

Consumption behaviour in our model is based on peer effects and imitation. This is consistent with the empirical literature on behavioural economics, as reported in Cardaci (2014), Fazzari and Cynamon (2013) and Frank et al. (2014). In particular, similar to Cardaci (2014), the formulation of desired consumption in our model follows the Expenditure Cascades (EC) hypothesis introduced by Frank et al. (2014), with a slightly amended formulation (Equation 5).

$$C_{t,h}^d = k \cdot yd_{t,h} + a \cdot C_{t-1,j} \tag{5}$$

Therefore, h's desired consumption is a function of her disposable income $(yd_{t,h})$ as well as j's actual consumption in the previous period, where j is the household who ranks just above h in the income scale, so that $j = h+1$. k is "a parameter unrelated to permanent income level or rank" (Frank et al., 2014), while the sensitivity parameter a is such that $0 \le a \le 1$: "when $a = 1$, h fully mimics j's consumption; whereas when $a = 0$, h does not consider j's consumption" (Cardaci, 2014).

As already mentioned, households carry out an assessment of their financial position, by comparing their expected expenditures with their internal resources. That is, if the sum of desired consumption and the repayment schedule on loans from the previous period $(RS_{t-1,h}{}^{[5]})$ is higher than the sum of their disposable income and past deposits $(D_{t-1,h})$, households have a negative financial position and apply for a loan $(L_{t,h}^d)$ to the banking sector. That is:

$$\begin{aligned} if \quad & C_{t,h}^d + RS_{t-1,h} > yd_{t,h} + D_{t-1,h} \\ then \quad & L_{t,h}^d = C_{t,h}^d + RS_{t-1,h} - yd_{t,h} - D_{t-1,h} \end{aligned} \tag{6}$$

On the contrary, households with enough internal resources to finance desired consumption and repayment schedule, ask for government bonds $(B_{t,h}^d)$. Hence:

---

[5]The repayment schedule on loans is defined in section 2.4.

$$if \qquad C_{t,h}^d + RS_{t-1,h} \leq yd_{t,h} + D_{t-1,h}$$
$$then \quad B_{t,h}^d = yd_{t,h} + D_{t-1,h} - C_{t,h}^d - RS_{t-1,h} \qquad (7)$$

2.3 Bond Market

At the beginning of each period, the government sets its (G_t^d) as a percentage of GDP. As already pointed out, this decision follows an anti-cyclical rule. In particular, the government adjusts the initial value of such ratio ($\overline{\frac{G^d}{GDP}}$, computed in period 1) based on its sensitivity (ϕ_G) to the demand gap in the previous period.

$$\frac{G_t^d}{GDP_{t-1}} = \overline{\frac{G^d}{GDP}} - \phi_G \cdot gap_{t-1} \qquad (8)$$

Afterwards, the government carries out its own financial assessment by computing the difference between its expected expenditure (the sum of desired public expenditure and the repayment schedule on public bonds issued in the previous period, RSG_{t-1}) and its available internal resources (the sum of past deposits, $D_{t-1,g}$, and the amount of taxes collected, T_t). If this is negative, the government has enough resources to finance the expected expenditure. On the contrary, if the difference is positive, the government has to finance its expenditure by issuing new public bonds. The overall supply of bonds is defined in Equation 9.

$$BS_t = G_t^d + RSG_t - D_{t,g} \qquad (9)$$

Note that government deposits at time t are defined as the sum between past deposits and tax revenues, so that $D_{t,g} = D_{t-1,g} + T_t$. We assume that bonds are one period debt contracts between households and the government. Hence, in the following period, the government will pay back RSG_{t-1}, which includes both principal and interests. We also make the assumption that the interest rate on bonds is equal to the policy rate set by the central bank (see Section 2.4).

It is wort noting that there is no mechanism that guarantees that the bond market is in equilibrium. In other words, as the formulation of bond demand and supply are based on independent decisions by households and the government, rationing may take place in the bond market. Indeed, if total bond supply is higher than demand, all households asking for bonds get the desired amount. Still, in the opposite case, all applicants are rationed so that the amount each h gets is equal to $B_{t,h}^d \frac{BS_t}{BD_t}$, where BD_t is total bond demand (i.e. $BD_t = \sum_h B_{t,h}^d$).

2.4 Pay Back Phase and Credit Market

As pointed out in Section 2.2, only households with a negative financial position enter the credit market. Note, however, that we distinguish two types of borrowers: consumption borrowers (CB) and borrowers in financial distress (FDB). CB are all households whose own resources are enough to pay back their repayment schedule on the loan from the previous period[6]. Hence, they enter the market in order to get a loan to finance their desired consumption only. On the contrary, FDB ask for a new loan not only to finance consumption but also to perform debt rollover. In other words, FDB use the new loan to pay back the previous one.

The commercial bank sets a maximum allowable credit supply as a fraction of total credit demand (Equation 10).

$$LS_t = v_t \sum_h L_{t,h}^d \tag{10}$$

Note that $v_t \in [v_{min}, v_{max}]$. That is, the commercial bank endogenously changes the value of v_t within two boundaries (v_{min} and v_{max}) that are exogenously set in the initialisation phase of the model (Conditions 11 and 12). In particular, v_t evolves as a function of systemic risk which is proxied by the household debt-to-GDP ratio in the previous period, $\frac{debt_{t-1}}{GDP_{t-1}}$. In fact, we introduce an exogenous parameter (*threshold*) that represents the sensitivity threshold to the level of the household debt-to-GDP ratio, so that if the ratio is higher (lower) than the threshold, the bank decreases (increases) v_t.

$$if \quad \frac{debt_{t-1}}{GDP_{t-1}} > threshold \quad then \quad v_t = v_{t-1} - \phi_v(v_{min} - v_{t-1}) \tag{11}$$

$$if \quad \frac{debt_{t-1}}{GDP_{t-1}} < threshold \quad then \quad v_t = v_{t-1} + \phi_v(v_{max} - v_{t-1}) \tag{12}$$

The sensitivity threshold, as well as the two boundaries for v_t, represent our key parameters in the simulation phase of the model as they act on the willingness to lend of the commercial bank and on its reaction to systemic risk. Hence, a more financialised economy is one in which both *threshold* and v_{max} are set to high values.

The commercial bank ranks households in ascending order based on a measure of their financial soundness - namely the total debt service ratio (TDS)[7] - and supplies credit by matching each individual demand until $LS_t = 0$. As a consequence, if $v_t < 1$, less financially sound applicants

---

[6]CB also includes households with zero repayment schedule, that is, those who did not take any loan in $t - 1$.

[7]Following Cardaci (2014), TDS is defined as the ratio between household repayment schedule and disposable income.

(namely, households with a higher TDS) will be rationed on the credit market thus getting no loans at all. Borrowers who are credit-rationed cannot pay back their previous loan and, in some cases, finance their desired consumption entirely. Therefore, they will go bankrupt and as such they are not allowed to apply for another loan for a limited period of time.

Similar to bonds, we assume each loan is a one-period debt contract corresponding to a repayment schedule defined as $RS_{t,h} = L_{t,h}(1 + r^L_{t,h})$, to be paid back entirely in the following period. Similar to Russo et al. (2015) and Cardaci (2014), the interest rate on loans is made up of three components, as described by Equation 13.

$$r^L_{t,h} = \overline{r_t} + \widehat{r_t} + r_{t,h} \tag{13}$$

$\widehat{r_t}$ is a system-specific component that reflects the sensitivity of the bank to the household debt-to-GDP ratio of the economy, so that $\widehat{r_t} = \rho \frac{debt_{t-1}}{GDP_{t-1}}$, while $r_{t,h}$ is a household-specific component equal to $\mu\,TDS_{t,h}$, where μ is the bank sensitivity to household total debt service ratio. Finally, $\overline{r_t}$ is the policy rate set by the central bank at the beginning of each period (Equation 14). Similar to desired public expenditure, the central bank reacts to changes in the demand gap.[8]

$$\overline{r}_t = \overline{r}_{t-1} + \phi_{CB} \cdot gap_{t-1} \tag{14}$$

Once transactions in the credit market are over, a new PBP begins: all FDB who successfully got a loan now pay back their due debt $RS_{t-1,h}$.

2.5   Goods Market

Both the government and households interact with the firm in order to buy goods. Note that each agent on the demand side may have an actual capacity of spending that differs from the desired one. As a matter of fact, even though the government is willing to spend an amount equal to G^d_t, it is possible that its liquidity does not allow to do so and its actual spending capacity is constrained by its current deposits ($D_{t,g}$), which include collected taxes, issued bonds and past deposits. Hence actual maximum government expenditure is defined as $min(G^d_t, D_{t,g})$. Similarly, some households might not be able to finance their desired consumption entirely due to credit rationing, as already pointed out. As a consequence, actual maximum expenditure for each household is equal to $min(C^d_{t,h}, D_{t,h})$.

Before transactions take place, the firm compares aggregate demand in real terms (Equation 15) with the amount of quantities produced.

---

[8] As quantities and prices move in the same direction, the central bank is implicitly targeting inflation as well.

$$AD_t = \frac{min(G_t^d, D_{t,g}) + \sum_h min(C_{t,h}^d, D_{t,h})}{P_t} \qquad (15)$$

If the former is lower than the latter, each buyer will obtain the demanded amount of goods, while the firm will get rid of excess supply at no cost. In the opposite case, instead, all buyers in the goods market will be rationed. If such a circumstance occurs, the firm computes a "rationing ratio" equal to $\frac{Q_t}{AD_t}$. This applies equally to the government as well as each household, so that all buyers are rationed in the same way and actual household consumption and government spending are defined as $C_{t,h} = min(C_{t,h}^d, D_{t,h})\frac{Q_t}{AD_t}$ and $G_t = min(G_t^d, D_{t,g})\frac{Q_t}{AD_t}$.

3 Model Results

Model results are obtained by means of computer simulations. We start by replicating the following three scenarios:

- a baseline (BS) scenario with income shares that are fixed at the beginning of the first period and remain constant over time;

- a rising-inequality (RS) scenario in which we change the value of individual income shares over time to simulate increasing income disparities;

- finally, a credit-inequality (CS) scenario in which the maximum propensity to lend of the bank rises along with the same rise of inequality simulated in RS.

We also run some additional experiments to assess different model dynamics when financial conditions, as well as policy implementations, change.

For each scenario we perform 20 Monte Carlo (MC) repetitions selecting a different random seed at each run, similar to Delli Gatti et al. (2011) and Russo et al. (2015). The choice of our parameter vector, shown in Table 2, is based on the need to rule out explosive dynamics and unrealistic patterns. In addition, we also perform both univariate and multivariate sensitivity analysis in order to test the robustness of model results to changes in parameter values.

3.1 Monte Carlo Analysis of the Three Scenarios

For each scenario, we compute the cross-simulation mean of the key variables. For example, we calculate GDP at each time t as the average of GDP across the 20 MC ripetitions for each of the three scenarios. Moreover, we

Parameter		Value
T	Number of periods	1000
H	Number of households	200
k	Propensity to consume for $h = 1 : H - 1$	0.8
k_H	Propensity to consume for $h = H$	0.6
a	Sensitivity parameter to j's past consumption	0.6
v_{max}	Maximum propensity to lend	0.4
v_{min}	Minimum propensity to lend	0.1
ρ	Bank sensitivity to debt/gdp ratio	0.005
μ	Bank sensitivity to TDS	0.005
ϕ_Q	Output sensitivity to output gap	0.01
ϕ_P	Price sensitivity to output gap	0.01
ϕ_G	Government sensitivity to output gap	0.05
ϕ_{CB}	Central bank sensitivity to output gap	0.05
ϕ_v	Speed of adjustment for credit supply	0.05
$freeze$	Number of "freezing" periods for bankrupt borrowers	5
$threshold$	Bank threshold for debt-to-GDP ratio	0.5

Table 2: Model calibration

drop the first 200 periods in order to get rid of transients, that is the stabilisation phase of the model. Graphs only show the last 800 periods for this reason. Furthermore, following Cardaci (2014), all data generated by our model are represented as simple moving averages in order to smooth out the cyclical fluctuations of the time series.

BS is based on the calibration shown in Table 2, while in the other two scenarios we implement the following shocks:

- RS: the income share of the top 10% increases gradually (from period 401 to period 600) from 22% to 37%.

- CS: we perform the same inequality shock as in RS, together with a sudden rise in v_{max} which increases from 0.4 to 0.8 in period 401.

All the key time series obtained by means of MC repetitions show smooth and minor oscillations along a stationary trend in the baseline scenario (as confirmed by Table 3, which reports also the average growth rates of GDP in all the 20 MC simulations for the baseline scenario). In particular, the model seems to stabilise along a quasi-steady state. As shown in Figure 5, GDP in BS is rather flat over time.

Let us provide a narrative for the other two scenarios.

- **RS**. Figure 5 shows quite distinctly that a rise in income disparities results in falling GDP. As a matter of fact, when income moves from
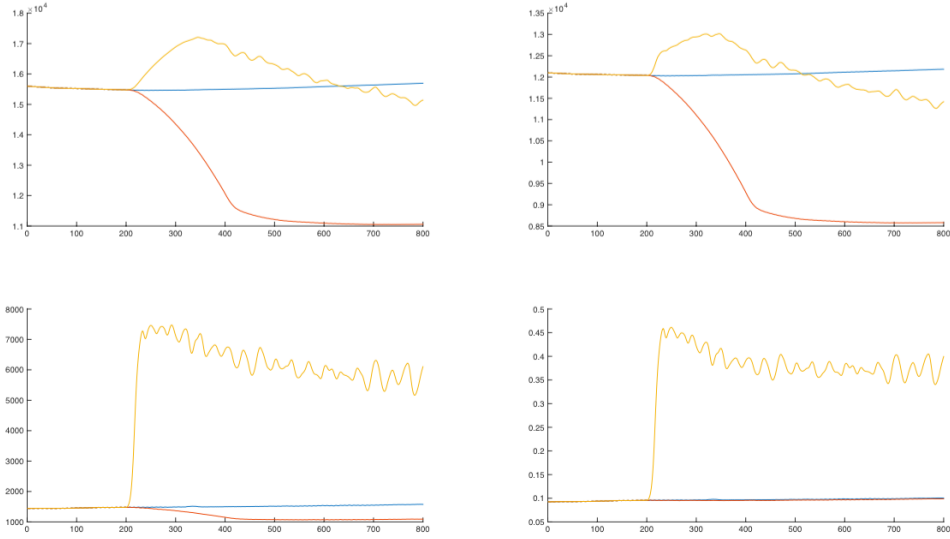
Figure 5: GDP (top left), aggregate desired consumption (top right), household debt (bottom left) and household debt-to-GDP (bottom right) in BS (blue), RS (red), CS (yellow).

the bottom to the top of the distribution, overall desired consumption rises for a very small number of periods due to stronger expenditure cascades. However, financial parameters (v_{max}, $threshold$ and ϕ_v) in RS do not change compared to their baseline values and the economy remains poorly financialised as it is in BS. As a consequence, households do not find enough credit supply to finance their increased desired expenditure and demand for loans. Indeed, in the baseline the household debt-to-GDP ratio is well below the bank sensitivity threshold and, consequently, v_t rises endogenously up to $v_t = v_{max}$, $\forall t$. That is, in BS the banking system endogenously increases its willingness to lend up to its maximum value as it detects low systemic risk. Yet, as v_{max} is calibrated at a low value in BS and RS (see Table 2), the result of increasing inequality in our economy with a low degree of financialisation and credit availability is a recession with falling debt and desired consumption.

- **CS**. Similar to RS, as soon as income inequality starts to increase, household desired consumption grows because of stronger imitation effects. However, the degree of financialisation is different in CS, as the commercial bank has a higher maximum willingness to supply credit. That is, a greater value of v_{max} allows v_t to rise endogenously so that a broader number of borrowers actually finds the necessary external resources to finance their desired spending. In fact, even if income

82

Simulation	Average growth rate (%)	Mean	Variance	Standard Deviation
1	1.51	15443.80	2848.26	53.37
2	1.31	15685.65	8572.67	92.59
3	1.11	15382.01	3138.18	56.02
4	0.17	15636.93	4992.87	70.66
5	0.61	15593.71	3554.80	59.62
6	1.47	15639.42	8035.21	89.63
7	1.03	15416.06	5673.53	75.32
8	0.89	15428.54	3084.45	55.54
9	0.97	15415.67	2321.31	48.18
10	1.09	15518.28	5624.1	74.99
11	1.07	15606.42	4321.62	65.74
12	0.3	15200.34	2895.02	53.8
13	0.76	15752.72	3546.91	59.55
14	1.39	15536.94	5783.84	76.05
15	0.19	15516.43	2847.19	53.36
16	0.35	15491.02	4382.62	66.2
17	1.1	15574.72	9465.53	97.29
18	0.72	15592.42	3043.92	55.17
19	1.16	15484.07	2836.83	53.36
20	0.36	15471.21	2838.9	53.28

Table 3: Key statistics for BS-GDP in the 20 MC simulations.

disparities become wider, GDP rises in CS as a result of debt-financed consumption. Also note that the default rate of borrowers actually goes down. This is not surprising: higher credit availability results in a greater number of households who successfully perform debt-rollover and as such more borrowers are actually able to pay back their older loans. Nonetheless, this also implies that household debt grows faster than GDP: the debt-to-GDP ratio increases as well, going beyond the threshold level set by the commercial bank. This is the turning point: the bank starts decreasing its willingness to lend and, as a consequence the portion of overall credit demand that is actually matched by credit supply drops thus triggering the recession. Two aspects are worth stressing: (1) the fall in GDP is slower than that of desired consumption and (2) credit demand and supply remain substantially higher compared to their baseline level, even though they both experience much wider oscillations along a roughly decreasing trend. The first point can be explained by the impact of public spending which decreases but at a fairly slower rate than private spending. The second point, instead is explained by looking at the number of households who need debt rollover, which remains stable at around 60% after the peak of GDP and debt. This entails a change in the nature of credit: the higher demand for credit after the recession comes from FDB and it is, as such, for debt rollover purposes rather than for consumption

financing.

3.2 Financialisation and Institutional Setting

The results of our three main scenarios suggest that where credit constraints are relaxed, higher loan demand can be matched by a wider availability of credit thereby resulting in higher household debt that sustains aggregate demand at the price of greater instability; whereas, if access to credit is harder and its availability is subject to tighter regulation, widening income disparities are not compensated by increased borrowing and, as such, the economy performs badly.

We now want to provide a deeper analysis of the impact of growing inequality on household debt and the performance of the economy under different degrees of financialisation. To do so, we run two more sets of simulations by randomly drawing 20 different values for v_{max} and $threshold$. For each of these values, we also perform 20 MC repetitions, each with a different random seed (for a total of 400 simulations).

In the first case we reproduce a multitude of scenarios where the bank has a different maximum willingness to lend, while in the second case we test how greater credit availability interacts with different sensitivities to the household debt-to-GDP ratio by the bank.

Let us start from changes in v_{max}. When inequality rises, we increase the maximum willingness to lend of the bank without changing the value of $threshold$ or any other parameter in the model. Figure 6 reports our key results for selected values of v_{max}. The graphs show that a higher value of v_{max} corresponds to a greater boom and bust cycle, as expected. That is, a stronger degree of financialisation allows for more debt-financed consumption by households, while a lower amount of credit availability forces the economy into the recession since the downward pressure on the aggregate demand is not compensated by higher household debt.

Next we investigate the case of a different $threshold$ in CS. That is, when inequality increases, the bank is willing to supply more credit, since v_{max} jumps from 0.4 to 0.8 in CS, but it also has different sensitivities to the household debt-to-GDP ratio (starting from period 1 and letting the other parameters unchanged). Our results for selected values of $threhsold$ are shown in Figure 7. Clearly, $threshold$ is a key parameter in determining model dynamics. As a matter of fact, lower values of $threshold$ imply a worse performance of the economy, regardless of the increased willingness to lend of the bank. In particular when $threshold$ is less or equal to 0.1, the economy in CS performs even worse than in the RS scenario where $threshold = 0.5$ and $v_{max} = 0.4$. In general, our findings seem to bring about further evidence that the degree of financialisation matters, even when we look at another dimension, namely the sensitivity of the commercial bank to systemic risk.
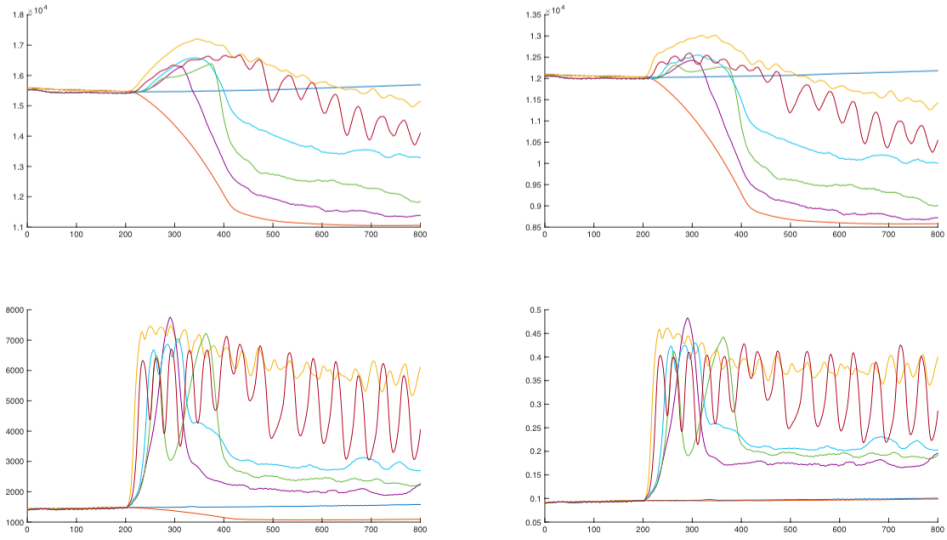
Figure 6: GDP (top left), aggregate desired consumption (top right), household debt (bottom left) and household debt-to-GDP (bottom right) for v_{max} equal to 0.5724 (purple), 0.5846 (green), 0.6023 (light blue), 0.6894 (dark red), compared to baseline (blue), RS (red) and CS (yellow).
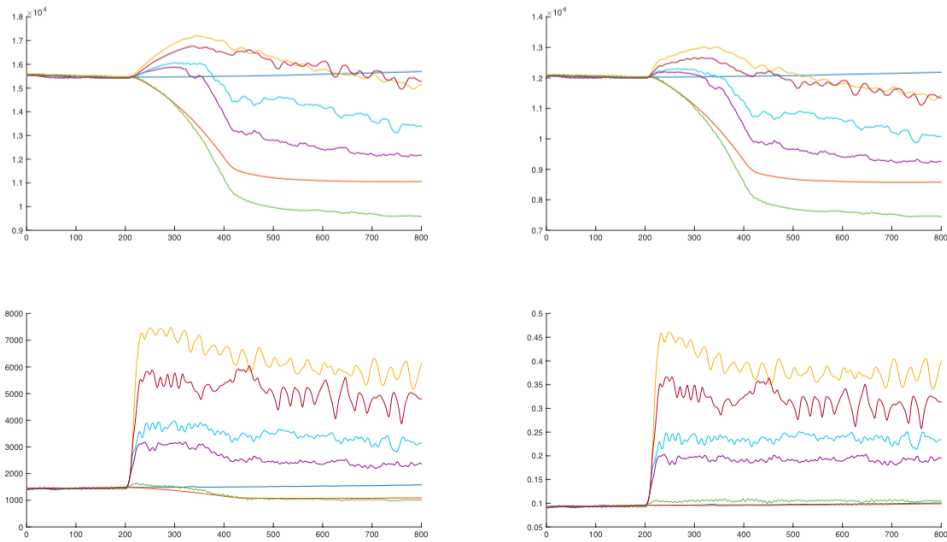

Figure 7: GDP (top left), aggregate desired consumption (top right), household debt (bottom left) and household debt-to-GDP (bottom right) for *threshold* equal to 0.1048 (green), 0.2041 (purple), 0.2533 (light blue), 0.3705 (dark red) compared to baseline (blue), RS (red) and CS (yellow).

3.3 Policy Responses

We now move on to the analysis of different policy interventions. In particular, we compare a "Keynesian" type of policy - consisting in a bolder reaction of desired government expenditure to the demand gap[9] - with an increase in "progressivity" of the tax system that tackles inequality by redistributing income from the top to the bottom of the population. Our results suggest that the second type of policy has a clearer and stronger effect on the overall economy with respect to an intervention of the first type.

Simulations are carried out following the same procedure introduced above: we randomly draw 20 different values for ϕ_G and for each of them we also perform 20 MC repetitions in each of the three scenarios (hence, we perform 1200 computer simulations in total). We find that, a greater value of ϕ_G does not avoid the recession that results from rising inequality in the RS scenario. Moreover, in the CS scenario, that is when inequality rises together with the maximum willingness to lend of the banking system, the impact of the Keynesian policy reaction is non tangible. That is, the time series for the key variables do not show any significant difference (in terms of magnitude, duration and volatility of the boom and bust cycle) compared to the standard time series obtained in the CS scenario with ϕ_G equal to its baseline value.

What happens if, instead, the government reacts to rising inequality by changing the tax rates such that it redistributes income from households at the top of the distribution to those at the bottom? In this case, the impact on the economy is strong and positive. Note that we analyse the fiscal reform in RS so that all model parameters, including the financial ones, do not change.

Selected simulations are reported in Figure 8. They all show that more progressive systems manage to counterbalance the (exogenous) change in the Pareto distribution that alters the original distribution of income. Regardless of the degree of progressivity, the economy has a higher and more stable GDP compared to the baseline, as well as a similar level of household debt. This latter is also much lower than in CS. In any case, a more progressive tax system results in a dramatic boom in GDP followed by a prolonged period of stability. This is not surprising: by counterbalancing the rising trend in inequality, the government provides poorer households with the necessary internal resources to finance their desired consumption. As a consequence, the household sector relies much less on debt accumulation so that both household debt and household debt-to-GDP stabilise around the baseline level after a certain number of periods.

As far as our result seem to push in favour of a structural reform with a more progressive tax system, for the sake of completeness it is worth

---

[9]Notice that, consistently with the first part of the *General Theory*, we interpret as Keynesian a proactive government, rather than a large government.
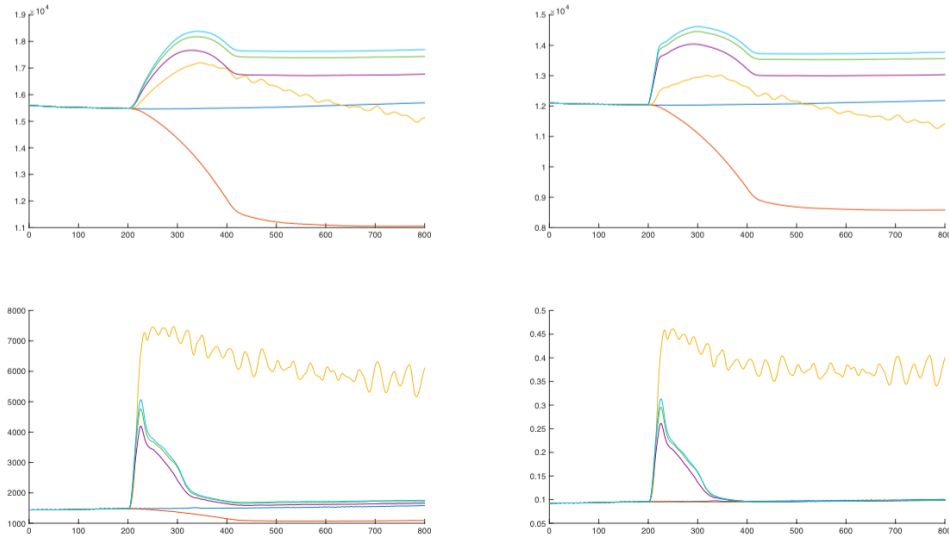
Figure 8: GDP (top left), aggregate desired consumption (top right), household debt (bottom left) and household debt-to-GDP (bottom right) for different levels of progressive tax system (purple, green and light blue) compared to baseline (blue), RS (red) and CS (yellow).

pointing out that we do not take into account any consideration regarding the distortionary effect that greater progressivity may have on other aspects of the economy, such as the functioning of labour markets or firm profits and investment decisions. The interpretation of our results should therefore be limited to considering that an increase in progressiveness is more efficient than macroeconomic policies in tackling the expenditure cascades that follow an rise in inequality. Any further interpretation would be unwarranted given the simplified structure of our model.

3.4   Sensitivity Analysis

In order to check whether our model results are biased by the specific combination of parameter values, we perform both univariate and multivariate sensitivity analysis. This allows us to test the robustness of the model following changes in the parameter vector.

Univariate analysis consists in assessing variations in model outcome while performing changes in one parameter at a time, leaving all the others constant. As Delli Gatti et al. (2011) point out, "the model is then believed to be good if the output values of interest do not vary significantly despite significant changes in the input values".

In the univariate case, we select 12 parameters of our model and we randomly draw 20 values within a reasonable *min-max* interval for each

individual parameter at a time, leaving all the other ones unchanged. Then, for each of the 20 values, we perform 20 MC repetitions, each with a different random seed, in the 3 scenarios (BS, RS and CS). Therefore, the univariate analysis of a single parameter implies 1200 simulations. Since we explore 12 parameters, we run 14400 simulations in total.

As a general comment, we highlight that for most variables the resulting variations in output are smaller than the variations in the parameters. This indicates that results are indeed quite robust with respect to univariate changes in model parameters.

Table 4 reports the variation for each parameter between its minimum and maximum value in the sensitivity analysis and the corresponding cross-series variation in GDP at time 500 for BS and at time 1000 for RS and CS[10]. With the only exception of a and k, output variations in the baseline scenario are consistently small for a very wide range of values for each individual parameter. Notice that variations in two parameters, namely v_{max} and ϕ_v, do not determine any change in output in BS. Univariate analysis also shows that individual changes in a wide range of model parameters have no significant effect on the dynamics of the model in the RS scenario either, even though $freeze$ has a slightly more relevant role than in BS. Finally, as expected, all parameters have a more distinctive impact on model dynamics in CS: our analysis confirms the primary role of the consumption parameters, a and k, as well as of the financial parameters related to the behaviour of the banking system, namely $threshold$ and v_{max}.

Parameter	Variation in parameter (%)	Variation in GDP-BS at t 500 (%)	Variation in GDP-RS at t 1000 (%)	Variation in GDP-CS at t 1000 (%)
k	65.1	12.68	25.60	102.18
a	302.64	28.4	60.37	231.22
v_{max}	103.56	0	0	53.69
ρ	355.25	1.3	2.15	14.38
μ	2505.26	0.39	1.59	19.39
ϕ_Q	1369.17	0.98	3.47	22.05
ϕ_P	1817.82	1.73	3.69	14.36
ϕ_G	274.37	2.38	1.59	9.71
ϕ_{CB}	288.55	1.22	1.39	14.08
ϕ_v	747.62	0	0	34.72
$freeze$	350	3.42	10.02	30.9
$threshold$	660.69	0.45	0.54	59. 44

Table 4: *Min-max* variations in parameter values for univariate sensitivity analysis, together with corresponding cross-series variation in GDP at time 500 in BS and at time 1000 in RS and CS.

---

[10]For the sake of simplicity, we report values for GDP only since our results show that variations in the other key time series are in line with those for GDP.
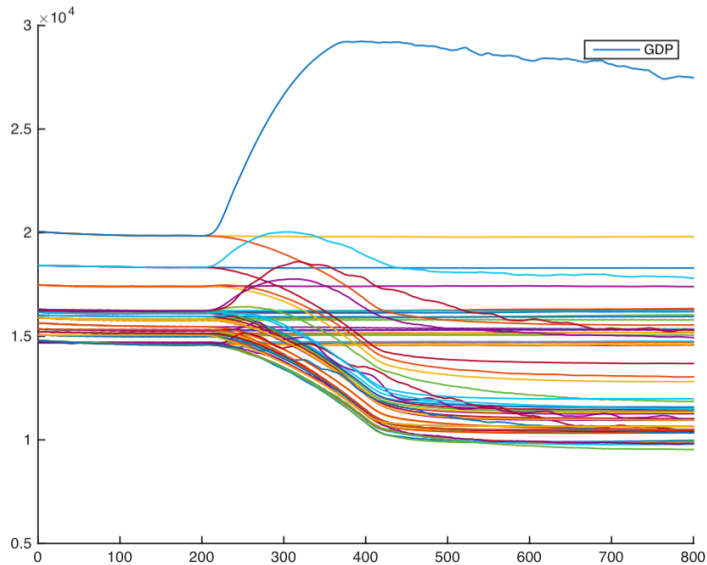
Figure 9: GDP in the multivariate sensitivity analysis.

The univariate analysis for the CS scenario shows that values of a between 0.4 and 0.6 result in shorter boom and longer busts, whereas $a > 0.6$ implies a wider duration of the expanding phase of the economy. In addition, values of k lower than 0.5 seem to counterbalance the impact of a higher willingness to lend, as the CS scenario collapses to the RS in this case. a and k are not the only relevant parameters in CS. As a matter of fact, our results suggest that ϕ_Q, ϕ_P, ϕ_v, $threshold$ and $freeze$ have an impact on model dynamics in this scenario as well. In particular, higher values of ϕ_Q and ϕ_P imply greater booms and faster recessions. Higher values of ϕ_v and $freeze$ result in faster and stronger booms and longer busts over time, whereas the higher $threshold$, the greater and longer the boom before the bust.

Multivariate analysis tests changes in model results with different calibrations of model parameters. In this case, we build 20 parameter vectors for our model parameters. Each value in the vector is randomly draw within a reasonable interval. Then, for each of the 20 vectors, we perform 20 MC repetitions, each with a different random seed, in the three scenarios. Hence, in the multivariate sensitivity analysis, we run 1200 simulations in total.

The multivariate analysis shows that the behaviour of the model is robust to parameter changes. Figure 9, which shows GDP for each of the parameter vectors, proves that almost any combination of parameters leads to the same dynamics from a purely qualitative point of view. The only exception to this is represented by the highest blue line in the graph (Figure 9): in CS, for this specific combination of parameters, GDP booms in the expansion phase of the economy while falling at a dramatically slow pace during the

89

recession. By looking at the calibration for this particular case, one may have an intuition about such dynamics: this scenario features a value of a and k close to 1, a very low value of $freeze$ (equal to 2), as well as a higher $threshold$ (around 0.6) and a much greater value for v_{max} (around 0.8). We believe that the explanation for the entity of the boom, as well as its sensationally slow negative growth in the recession, is to be found precisely in the extremely high values of a, k and v_{max} that allow the model to follow the same dynamics as in the standard CS with more pronounced values. In other words, GDP booms as a consequence of stronger expenditure cascades and greater availability of credit. However, after peaking, the economy enters a recession and GDP starts to fall. Its remarkably small negative growth rate might be the consequence of very low value of $freeze$ as it implies easier access to credit markets for both consumption and debt-rollover purposes. In other words, even though the bank lowers its endogenous willingness to lend, households who go bankrupt can still access the credit market after a very few periods and, as such, debt-financed consumption keeps going on during the recession (even though at a lower speed compared to the boom).

With the exception of the above mentioned case, we can generally conclude that results from our simulations are in line with those for the univariate case. That is, our multivariate sensitivity analysis confirms the primary role of just a few model parameters, namely a and k in determining model dynamics in BS and RS. It also highlights the importance of v_{max} and $threshold$ in the CS case, thus proving the importance of reproducing alternative financial and policy scenarios by changing the values of such parameters.

4 Conclusion

Through an agent-based macroeconomic model with a stock-flow consistent structure, we showed how different institutional settings and levels of financialisation affect the dynamics of an economy hit by an increase of inequality. In fact, when income disparities become wider, a dilemma arises. That is, when the degree of financialisation is poor and financial institutions are less willing to lend, increasing inequality implies a drop in aggregate demand and output. On the contrary, when credit constraints are relaxed and the financial sector is prone to lend, a short term positive effect on growth comes at the price of greater financial instability: a debt-driven boom and bust cycle emerges. We then carried out an extensive sensitivity analysis, both univariate and multivariate, that confirms the robustness of our main findings.

Our results are in line with insights provided by Kumhof et al. (2012) and Russo et al. (2015). The latter, in particular, build an agent-based macroeconomic model showing that consumer credit has, on the one hand,

a positive effect on aggregate demand even though, on the other hand, it accelerates the tendency of the economic system towards a crisis. However, our work also focuses on policy reactions to rising inequality. As a matter of fact, our results show that tackling inequality, by means of a more progressive tax system, can compensate for the rise in income disparities thereby stabilising the economy. Our findings also show that this is a better solution compared to a proactive (Keynesian) fiscal policy reaction, as the latter has no tangible counterbalancing effect with respect to increasing income inequality. Therefore, in order to avoid being caught in between the *Scyilla* of stagnant growth and the *Charybdis* of instability, it seems necessary to act on the structure of the economy and act on the problem of inequality at its roots.

References

Atkinson, A. B., Piketty, T., and Saez, E. (2011). Top incomes in the long run of history. *Journal of Economic Literature*, 49(1).

Caiani, A., Godin, A., and Lucarelli, S. (2014). Innovation and finance: a stock flow consistent analysis of great surges of development. *Journal of Evolutionary Economics*, 24(2).

Cardaci, A. (2014). Inequality, household debt and financial instability: an agent-based perspective. *Working paper*.

Clementi, F. and Gallegati, M. (2005). Pareto's law of income distribution: Evidence for germany, the united kingdom, and the united states. In Chatterjee, A., Sudhakar, Y., and Chakrabarti, B. K., editors, *Econophysics of Wealth Distributions*. Springer Milan.

Delli Gatti, D., Desiderio, S., Gaffeo, E., Cirillo, P., and Gallegati, M. (2011). *Macroeconomics from the Bottom-Up*. Milano, IT: Springer.

Dew-Becker, I. and Gordon, R. J. (2005). Where did the productivity growth go? inflation dynamics and the distribution of income. *Brookings Papers on Economic Activity*.

Dosi, G., Fagiolo, G., Napoletano, M., and Roventini, A. (2013). Income distribution, credit and fiscal policies in an agent-based keynesian model. *Journal of Economic Dynamics and Control*, 37(8).

Fazzari, S. M. and Cynamon, B. Z. (2013). Inequality and household finance during the consumer age. *Levy Economics Institute Working Paper*, (752).

Fitoussi, J. P. and Saraceno, F. (2010-2011). Inequality, the crisis and after. *Rivista di Politica Economica*, 100(I-III).

Frank, R. H., Levine, A. S., and Dijk, O. (2014). Expenditure cascades. *Review of Behavioral Economics*, 1.

Godley, W. and Lavoie, M. (2007). *Monetary Economics*. Palgrave Macmillan.

IMF (2007). *World Economic Outlook - Globalization and Inequality*. IMF Publications.

Jones, C. (2015). Pareto and piketty: The macroeconomics of top income and wealth inequality. *Journal of Economic Perspectives*, 29(1).

Krueger, D. and Perri, F. (2006). Does income inequality lead to consumption inequality? evidence and theory. *Review of Economic Studies*, (73).

Kumhof, M., Lebarz, C., Rancière, R., Richter, W. A., and Throckmorton, N. A. (2012). Income inequality and current account imbalances. *IMF Working Paper*, (08).

Milanovic, B. (2010). *The Haves and the Have-Nots: A Brief and Idiosyncratic History of Global Inequality*. New York, NY: Basic Books.

OECD (2008). *Growing Unequal?: Income Distribution and Poverty in OECD Countries*. OECD Publications.

Piketty, T. and Saez, E. (2013). Top incomes and the great recession: Recent evolutions and policy implications. *IMF Economic Review*, 61.

Rajan, G. R. (2010). *Fault Lines: How Hidden Fractures Still Threaten the World Economy*. Princeton, NJ: Princeton University Press.

Russo, A., Riccetti, L., and Gallegti, M. (2015). Increasing inequality, consumer credit and financial fragility in an agent based macroeconomic model. *Journal of Evolutionary Economics*.

Stiglitz, J. E. (2012). Macroeconomic fluctuations, inequality, and human development. *Journal of Human Development and Capabilities: A Multi-Disciplinary Journal for People-Centered Development*, 13(1).

Tobin, J. (1969). A general equilibrium approach to monetary theory. *Journal of Money, Credit and Banking*, 1(1).

Tobin, J. (1982). Money and finance in the macroeconomic process. *Journal of Money, Credit and Banking*, 2(14).

Van Treeck, T. (2013). Income distribution and current account imbalances. *IMK Working Paper*, (126).

Acknowledgments