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

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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 Scyilla 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 stabylising 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

*We are particularly grateful to Alessandro Caiani and Alberto Russo (*Università Politecnica delle Marche, Ancona*) as well as to the participants at the seminar held in Università Milano Bicocca, the EEA New York conference and the Bordeaux-Milano Joint Workshop on Agent-Based Models. This paper benefited from funding by the European Community's Seventh Framework Programme (FP7/2007-2013) under Socio-economic Sciences and Humanities, grant agreement no. 320278 (RASTANEWS).

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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 (IMF, 2007; Milanovic, 2010; OECD, 2008; Piketty and Saez, 2013; Piketty et al., 2011). 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".

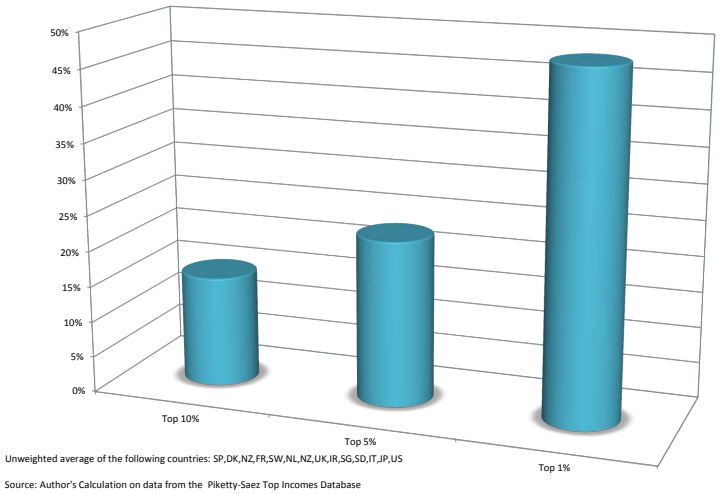

Figure 1: Average Change in Income Shares for Different Percentiles - 1980-2007

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 non-existence of a proper welfare state and of a reliable financial system,

[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

higher inequality yielded an excess of precautionary savings for businesses and households[2]. Following growing income disparities, Europe experienced excess savings as well, even though, in our view, they have been caused by the inertia of economic policy and by low investment rates, which have depressed demand and income. As such, Europe has 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 removed. Consequently, aggregate demand has remained high, even if it has

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

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 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. Fiscal policy have also been generally more restrictive in European countries, constrained by the Maastricht Treaty and the Stability Pact.

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).

In the light of these considerations, we build a macroeconomic model with an agent-based household sector. Our goal is to analyse the impact of rising income inequality on household debt dynamics and the likelihood of a crisis, given different institutional settings. In particular, compared

to other existing macroeconomic agent-based model dealing with inequality, such as Russo et al. (2015) and Dosi et al. (2013), we focus on how economic crises emerge in the presence of different credit conditions and policy reactions to growing income disparities. 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).

The paper is organised as follows: Section 2 introduces our macroeconomic 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

Our objective is to highlight the relationship between income distribution and household debt accumulation. Therefore, we have chosen to develop the household sector, while simplifying all the others as much as possible. Our model has the following distinctive features:

- There is only one representative firm which is owned by all households and distributes all its earnings thus retaining zero profits.
- Households' desired consumption is based on imitative behaviour and, more precisely, on the Expenditure Cascades hypothesis (Frank et al., 2014)
- The government can issue public bonds to finance its deficit (if any). We assume bonds can be bought by households only.
- There is no investment in capital goods.
- There is a credit market for non-collateralised consumption loans.

In describing the narrative of the model we distinguish between decisions about flows and actual balance-sheet transactions. Hence, the entire sequence of events in each period t can be summarised as follows:

1. Production takes place. The firm produces homogenous 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. The commercial bank distributes the entire amount of profits (if any) to households based on the same income shares as in the previous point. On the contrary, if it has losses on its balance sheet such that its net worth is negative, the central bank bails out the bank by providing it with assets (i.e. reserves) to compensate the loss in order to make its net worth equal to zero. 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.

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 set their desired consumption based on imitative behaviour. Afterwards, they assess their own financial position. In particular, they compare their internal resources with their expected expenditure, which is the sum of desired consumption and the repayment schedule on consumption loans from the previous period. Households who have a positive financial position use the exceeding amount of internal resources to demand government bonds. Instead, households with a negative financial account, ask for a loan. Hence, households can demand loans not only in order to finance desired consumption but also to perform debt rollover.

7. Policy institutions set 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 output gap in the previous period and follow an anti-cyclical rule.

8. The bond market opens: the government supplies the desired amount of bonds equal to the difference between expected expenditures net of collected taxes and past deposits.

9. The pay-back phase (PBP) begins: households who have taken a loan in $t-1$ pay it back. Based on the financial assessment carried out before, some households are not be able to meet their debt obligations entirely. As such, they try to perform debt rollover thus asking for a new loan in order to pay back the previous one.

10. The credit market opens: banks set their total available credit supply as a fraction of total credit demand and rank households in ascending order based on their financial soundness. Loan applications are satisfied until the bank runs out of total credit supply. A second PBP opens for households who perform debt rollover: they pay back the remaining part of their previous loan entirely, right after the credit market closes.

11. The goods market opens: government and households buy goods based on their desired level of consumption. Rationing may take place whenever production is lower than overall desired consumption.

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

In order to make sure that our model is stock-flow consistent and nothing "leaks out" of the system, each agent in the model is provided with a balance sheet that describes and measures the levels of all stock variables at any point of time.

Figure 2 shows the balance sheets of all the agents in the economy at the end of each period based on the sequence of events reported above.[3]

Stock-flow consistency implies that any flow transaction that takes place in the economy, shown in Figure 3, is matched by an identical change in the stocks held in the balance sheets of the agents involved. For example (Figure 4), whenever the firm pays the wage to household h, the amount of deposits in the balance sheet of the firm decreases and that of household h increases by the same amount.

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 within each period t.

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 changinng total production. The firm is owned by the entire population of households, H, who all work for it. Production and prices are set according to the two following rules of behaviour:

[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 2: Agents' balance sheets in our economy.

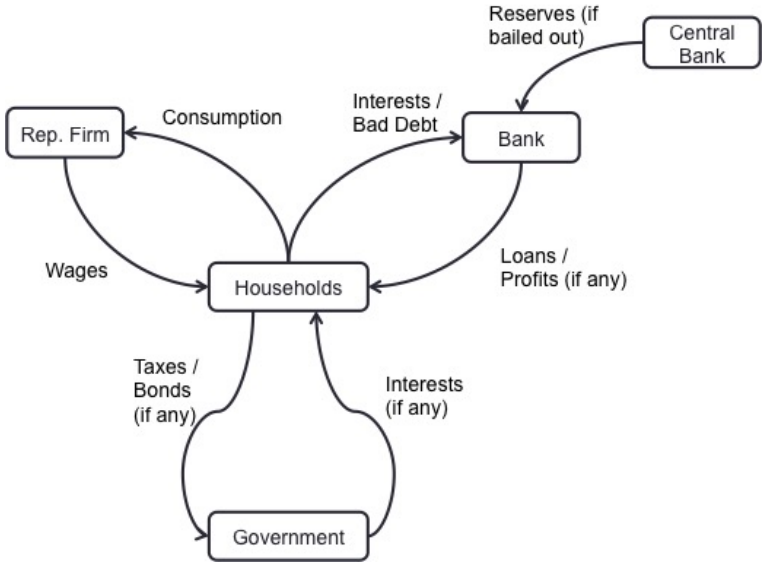

Figure 3: Graphic representation of all the flow transactions in our economy

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

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

where $gap_{t-1} = \frac{AD_{t-1} - Q_{t-1}}{Q_{t-1}}$ is the output gap. That is, the firm sets production, Q_t, and prices, P_t, based on their level in the previous and a sensitivity parameter multiplied by the output gap.

At the beginning of each period, the firm distributes its revenues from the previous period to the entire population in the form of wages. The distribution process is based on constant individual income shares that are drawn from a Pareto distribution.

2.2 Expenditure Cascades and Financial Assessment

Individual household income is defined as follows:

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

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

Households then 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, $T_{t,h}$.

$$yd_{t,h} = y_{t,h} - T_{t,h} \quad (4)$$

Household h	
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
$L_b = 70$ $R = 110$	$D_h = 100$ $D_f = 80$
	$NW_b = 0$

Household h	
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 balance sheet transaction between the firm and the household sector. 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 and, consequently, also the net worth of the agents changes. Note, however, that the net worth of the bank does not change as a transfer of deposits does not change the amount of stocks held on the liability side of its balance sheet.

Following Cardaci (2014), all households in our model set desired consumption based on a the Expenditure Cascades (EC) hypothesis introduced by Frank et al. (2014).

$$C^d_{t,h} = k(1-a)yd_{t,h} + aC_{t-1,j} \tag{5}$$

Therefore, h's desired consumption is a function of her disposable income ($y_{t,h}$) 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), whereas the sensitivity parameter a is such that $0 \leq a \leq 1$: "when $a = 1$, h fully mimics j's consumption; whereas when $a = 0$, h does not consider j's consumption" (Cardaci, 2014).

The difference between disposable income and desired consumption defines desired savings, $Sd_{t,h}$.

$$Sd_{t,h} = yd_{t,h} - C^d_{t,h} \tag{6}$$

Households then assess their financial position: those who have an amount of internal resources - namely the sum of disposable income and past deposits, $D_{t-1,h}$ - that is lower than expected expenditures - that is, the sum of desired consumption and the repayment schedule on loans from the previous period, $RS_{t-1,h}$[4] - apply for a consumption loan, $L^d_{t,h}$, to the banking sector. That is:

$$\begin{aligned} &if \qquad C^d_{t,h} + RS_{t-1,h} > yd_{t,h} + D_{t-1,h} \\ &then \quad L^d_{t,h} = C^d_{t,h} + RS_{t-1,h} - yd_{t,h} - D_{t-1,h} \end{aligned} \tag{7}$$

On the contrary, households with enough internal resources to finance desired consumption and the repayment schedule, set a positive demand for government bonds, $B^d_{t,h}$:

$$\begin{aligned} &if \qquad C^d_{t,h} + RS_{t-1,h} \leq yd_{t,h} + D_{t-1,h} \\ &then \quad B^d_{t,h} = yd_{t,h} + D_{t-1,h} - C^d_{t,h} - RS_{t-1,h} \end{aligned} \tag{8}$$

2.3 Bond Market

At the beginning of each period, the government sets its desired public expenditure, G^d_t as a percentage of GDP, based on the initial value of such ratio, $\overline{\frac{G^d}{GDP}}$, as well as the output gap multiplied by a sensitivity parameter ϕ_G.

$$\frac{G^d_t}{GDP_{t-1}} = \overline{\frac{G^d}{GDP}} - \phi_G \cdot gap_{t-1} \tag{9}$$

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

Based on G_t^d, the repayment schedule on public bonds issued in the previous period, RSG_{t-1}, the amount of past deposits, $D_{t-1,g}$, and the amount of taxes collected in each period, T_t, the government assesses whether it has to finance public expenditure by issuing new public bonds. If so, the government supplies an amount of bonds defined as follows:

$$BS_t = G_t^d + RSG_t - D_{t,g} \tag{10}$$

Where government deposits at time t are defined as the sum between past deposits and tax revenues, so that $D_{t,g} = D_{t-1,g} + T_t$.

2.4 Pay Back Phase and Credit Market

There are two types of borrowers in the credit market: financial sound borrowers (FSB) and borrowers in financial distress (FDB). FSB are all households who have enough income and past deposits to pay back their repayment schedule. On the contrary, FDB need to ask for a new loan in order to pay back the previous one. In other words, FDB perform debt rollover.

In the credit market, the commercial bank sets a maximum allowable credit supply as a fraction of total credit demand.

$$LS_t = v_t \sum_h L_{t,h}^d \tag{11}$$

Note that $v_t \in [v_{min}, v_{max}]$. That is, the commercial bank endogenously changes the value of v_t within two boundaries that are exogenously set in the initialisation phase of the model. The evolution of v_t is 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 particular we introduce an exogenous parameter 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.

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

$$if \quad \frac{debt_{t-1}}{GDP_{t-1}} < threshold \quad then \quad v_t = v_{t-1} + \phi_v(v_{max} - v_{t-1}) \tag{13}$$

After setting the maximum supply of credit, the bank ranks households in ascending order based on a measure of their financial soundness - namely the total debt service ratio[5] - and supplies credit by matching each individual demand until $LS_{t,b} = 0$. As a consequence, if $v_t < 1$ some applicants will be rationed on the credit market thus getting no loans at all.

[5]Following Cardaci (2014), Total Debt Service Ratio (TDS) is defined as the ratio between household repayment schedule and household disposable income.

We assume each loan is a one-period debt contract which corresponds 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:

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

$\widehat{r_t}$ is a system-specific component that reflects the sensitivity (measured by ρ) of the bank to the hosuehold debt to GDP ratio of the economy, 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. Similar to desired public expenditure, the central bank reacts to changes in the output gap, that is:

$$\overline{r}_t = \overline{r}_{t-1} + \phi_{CB} \cdot gap_{t-1} \tag{15}$$

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

After getting the loan, FDB perform debt rollover immediately thus entirely paying back the repayment schedule of the loan from the previous period. Borrowers who are credit-rationed go bankrupt and as such they are not allowed to apply for a loan for a limited period of time.

2.5 Goods Market

Both the government and households enter the goods market to buy products from the firm. The government is willing to spend an amount equal to G^d_t but if its liquidity - that is the sum of collected taxes, issued bonds and past deposits - is not enough, the government then can only spend an amount equal to its current deposits, $D_{t,g}$. Hence, its actual maximum expenditure is defined as $min(G^d_t, D_{t,g})$.

A similar criterion applies to each household. Indeed, households who are rationed in the credit market are not able to finance their desired consumption entirely. As such, their actual maximum expenditure is equal to $min(C^d_{t,h}, D_{t,h})$.

The firm then computes aggregate demand in real terms: if this is higher than the amount of quantities produced, rationing takes place on the market. In this case, the firm computes a "rationing ratio" equal to $\frac{Q_t}{AD_t}$, where AD_t is equal to:

$$AD_t = \frac{min(G^d_t, D_{t,g}) + \sum_h min(C^d_{t,h}, D_{t,h})}{P_t} \tag{16}$$

If the rationing ratio is greater than 1, no rationing takes place as production is enough to satisfy aggregate demand. If, on the contrary, production is lower than AD_t, the ratio applies equally to the government as well as each households, so that each buyer is rationed in the same way.

3 Model Results

We run different simulations to replicate three key scenarios:

- a baseline (BS) with income shares that are fixed at the beginning of the first period 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 rise of inequality.

In addition to this, we also run some 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, as shown in Table 2, is based on the need to rule out explosive dynamics and unrealistic patterns; 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 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 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 key time series.

All the key time series obtained by means of MC analysis show smooth and minor oscillations along a stationary trend in the baseline scenario.

In the other two scenarios we implement the following shocks:

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

- 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 the baseline scenario, the model stabilises along a quasi-steady state. As shown in Figure 5, GDP in the baseline is rather flat over time.

- **RS**. When income disparities become wider, GDP falls. As a matter of fact, when income moves from the bottom to the top of the distribution, overall desired consumption rises for a very small number of periods as a result of stronger expenditure cascades due to imitation effects. However, as the economy is poorly financialised, households do not find enough credit supply to finance their increased desired expenditure. Indeed, in the baseline the household debt-to-GDP ratio is well below the bank threshold and, consequently, v_t evolves endogenously up to $v_t = v_0$, $\forall t$. In other words, the bank already provides the maximum amount of credit it is willing to supply. The result of increasing inequality in our economy with low credit availability is a recession that leads to falling debt and desired consumption.
- **CS**. If the commercial bank is willing to supply more credit whenever income disparities increase, the higher amount of desired consumption

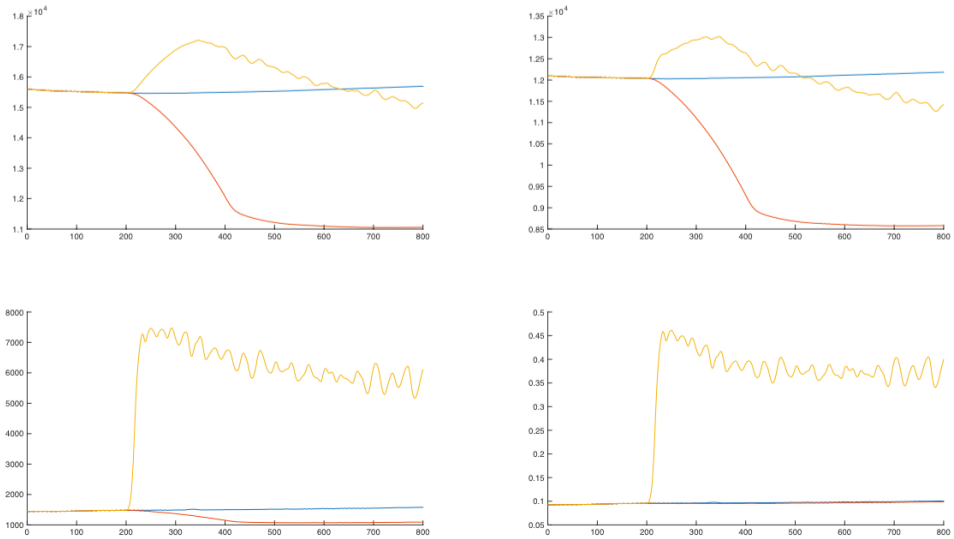

Figure 5: GDP (top left), aggregate desired consumption (top right), household debt (bottom left) and household debt-to-GDP (bottom right) in BS (blue), RS (red), CS (yellow).

can actually be financed by a greater amount of loans (even though not entirely as $v_t < 1$, $\forall t$). Indeed GDP rises even if income stagnates over much of the distribution. Notice that even though such growth is purely debt-financed, the default rate of borrowers actually goes down. This is not surprising: higher credit availability results in a grater number of households who successfully perform debt-rollover. Nonetheless since 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. In fact, after the peak of GDP and debt, the number of households who need debt rollover remains stable around 60%. That is, 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

As already pointed out, the goal of our work is to analyse the impact of growing inequality on household debt and the performance of the economy in the presence of different institutional settings. Indeed, higher inequality can lead to different outcomes depending on the degree of financialisation of an economy: where credit constraints are relaxed higher credit demand for consumption purposes can be matched by greater credit availability resulting in higher household debt that sustains aggregate demand at the price of higher instability; whereas, if access to credit is harder and credit availability is subject to tighter regulation, widening income disparities are not compensated by the increased borrowing and, as such, the economy performs badly.

Based on this, we run two more set of simulations: we randomly draw 20 different values for v_{max} and *threshold*. For each of these values, we also perform 20 MC repetitions.

In the first case we reproduce different 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 the maximum willingness to lend. We run the simulations for the CS scenario. That is, when inequality rises, we increase the maximum willingness to lend of the bank, without changing the value of *threshold* (or any other parameter). Our results (Figure 6) show that the higher the value of v_{max}, the greater the boom and bust cycle, as expected. In particular, with a small increase of v_{max}, the rise of inequality is not compensated by higher household debt and the economy enters a recession as in the RS scenario.

Next we investigate the case of a different *threshold*. That is, when inequality increases the bank is willing to supply more credit but it has different sensitivities to the household debt-to-GDP ratio (starting from period 1 and letting the other parameters unchanged). Our results (Figure 7) show that the *threshold* parameter is a key element in determining model dynamics. As a matter of fact, the lower the value of *threshold*, the worse the 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 the CS scenario, with $v_{max} = 0.8$, performs even worse than in the RS scenario with $threshold = 0.5$ and $v_{max} = 0.4$.

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

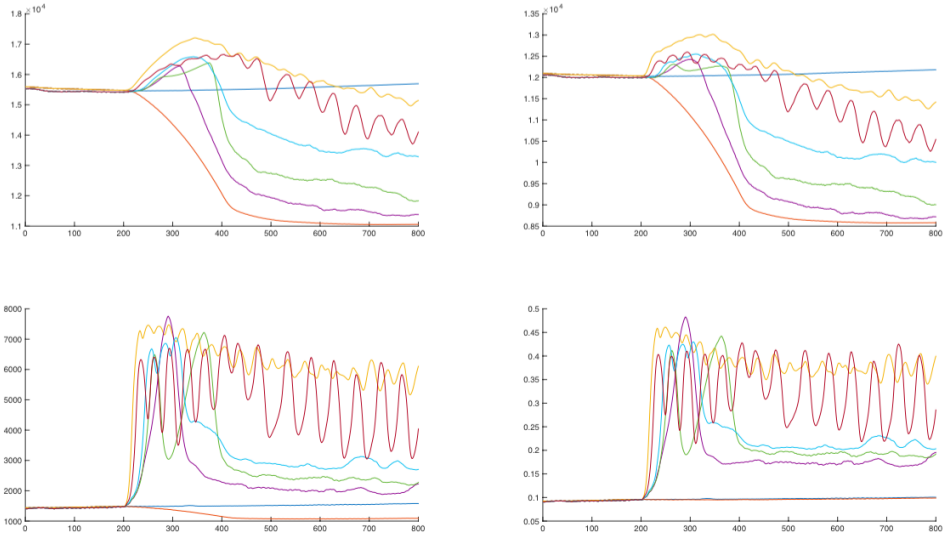

Figure 6: GDP (left) and aggregate desired consumption (right) for v_{max} equal to 0.5724 (purple), 0.5846 (green), 0.6023 (light blue), 0.6894 (dark red), compared to baseline (blue), RS (red) and CS (yellow)

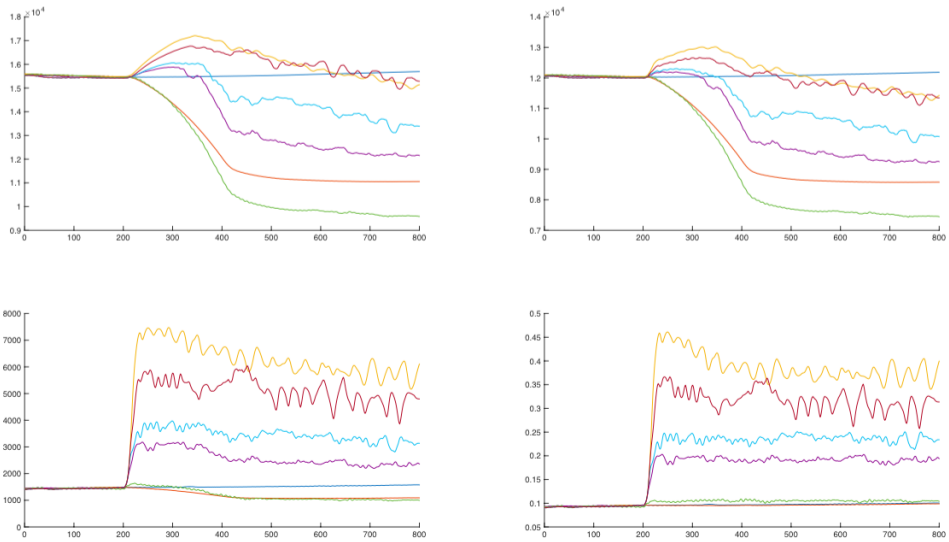

Figure 7: GDP (left) and aggregate desired consumption (right) for *threshold* equal to 0.1048 (green), 0.2041 (purple), 0.2533 (light blue), 0.3705 (dark red) compared to baseline (blue), RS (red) and CS (yellow)

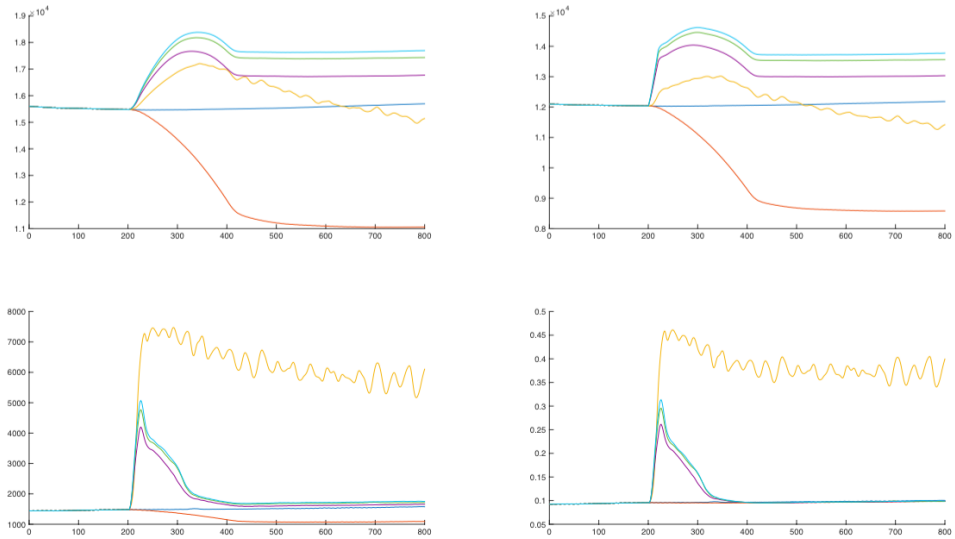

Figure 8: GDP (left) and aggregate desired consumption (right) for different levels of progressive tax system (purple, green and light blue) compared to baseline (blue), RS (red) and CS (yellow)

reaction of desired government expenditure to the output gap[6] - 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.

In order to simulate a Keynesian intervention, firs we randomly draw 20 different values for ϕ_G and then we select those that are higher than its baseline value. Again, for each of these values, we also perform 20 MC repetitions. 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 and duration 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 to those at the bottom? In this case, the impact on the economy is positive. Indeed, in the RS scenario, the structural reform tackles

[6]Notice that, consistently with the first part of the *General Theory*, we interpret as Keynesian a proactive government, rather than a large government.

inequality at the very origin and as such, it manages to counterbalance the (exogenous) change in the Pareto distribution that alters the original distribution of income. Depending on 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 which is also much lower than in the CS scenario (Figure 8). In addition, if the government makes the tax system more progressive in the CS scenario, the consequence is a dramatic boom in GDP, followed by a prolonged period of stability. Notice, however, that we do not take into account any consideration regarding the distortionary effect that a more progressive tax system may have on other aspects of the economy, such as the functioning of labour markets. 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 increase in inequality. Any further interpretation would be unwarranted given the simplified structure of our model.

3.4 Sensitivity Analysis

We perform both univariate and multivariate sensitivity analysis 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). That is, a univariate analysis of a single parameter implies 1200 simulations ($20 * 20 * 3$). Since we explore 12 parameter, we have a total of 14400 simulations.

Table 3 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[7]. 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 model in the RS scenario either,

[7]For the sake of simplicity, we report values for GDP only. Indeed, our results show that variations in the other key time series are in line with those for GDP.

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 3: *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.

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 higher booms and faster recessions. Higher values of ϕ_v and $freeze$ result in faster and greater 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 3 scenarios (BS, RS and CS). Hence, in the multivariate sensitivity analysis, we have 1200 simulations in total.

The multivariate sensitivity analysis shows that the model's behaviour is robust to parameter changes. Figure 9, which shows GDP for each of the

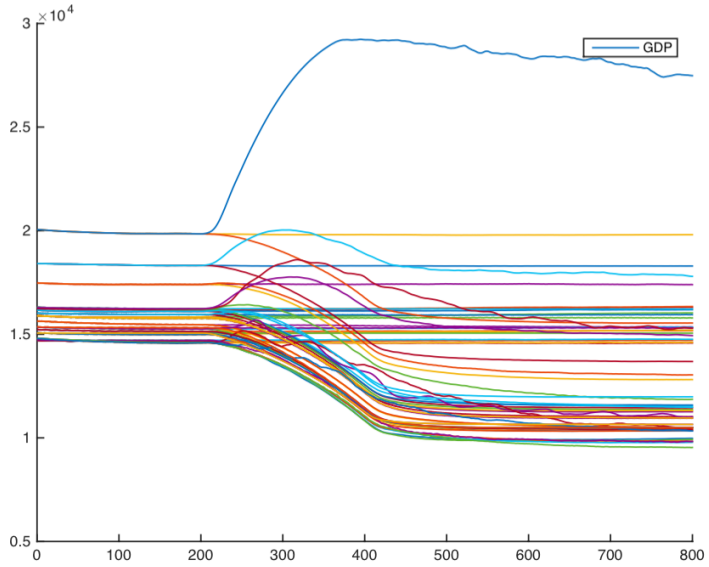

Figure 9: GDP in the multivariate sensitivity analysis

parameter vectors, proves that any combination of parameters leads to the same dynamics from a purely qualitative point of view[8].

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 policy scenarios by changing the values of such parameters.

4 Conclusion

Through an agent-based macroeconomic model, we showed how different institutional settings and level 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

[8] An exception exists. This is represented by the highest blue line in the graph (Figure 9): for this specific combination of parameters, GDP booms in the CS scenario and has a dramatically slow negative growth in the recession phase.

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) andRusso 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 thus tackling at its root the problem of inequality.

References

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*.

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).

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.

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.

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

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).