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Abstract

We study how income inequality affects monetary policy through the inequality-household debt channel. We design a minimal macro Agent-Based model that replicates several stylized facts, including two novel ones: falling aggregate saving rate and decreasing bankruptcies during the household's debt boom phase. When inequality meets financial liberalization, a leaning against-the-wind strategy can preserve financial stability at the cost of high unemployment, whereas an accommodative strategy can dampen the fall of aggregate demand at the cost of larger leverage. We conclude that inequality may constrain the central bank, even when it is not explicitly targeted.

Keywords: Inequality, Financial Fragility, Monetary Policy, Agent-Based Model.

JEL classification codes: E21, E25, E31, E52, G51

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1 Introduction

The aim of this paper is to investigate the relationship between income inequality and monetary policy. While most of the literature focuses on how central banks shape income distribution, we explore how ensuing income inequality affects the conduct of monetary policy. Our intuition is that inequality influences variables that are usually targeted by the central bank, which therefore might react to inequality even when inequality is not directly included in its decision rule. In other words, can monetary policy become endogenously constrained with respect to income and wealth distribution, as conjectured by Fitoussi and Stiglitz (2009)?

Reading the 1980-2008 period through these lenses highlights several persistent trends characterizing the US economy prior to the financial crisis:

a A significant fall of the wage share (fig. 1a).

b A steady increase in the top 10% income share (fig. 1b).

c An increase in households' debt-to-income ratio (fig. 1b).

d A slow down of inflation (fig. 1c).

e A drop of the interest rates, both the Fed funds rate and the interest rate on loans (fig. 1d).

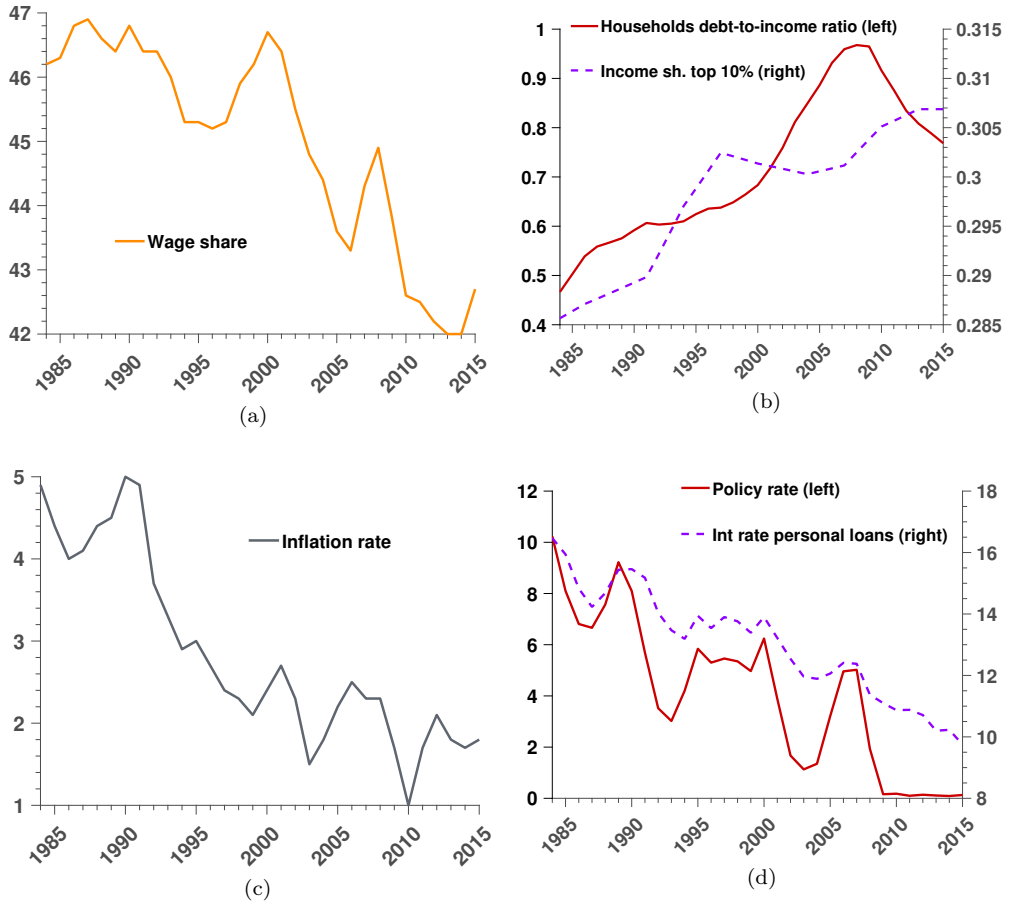


Figure 1: Wage share (panel a), households debt-to-income ratio and top 10% income share (panel b), inflation rate (panel c), policy rate and interest rate on loans (panel d), 1985-2015, US economy. Data are taken from BIS and FRED.

To investigate the inequality/monetary policy nexus, we develop a model able to jointly explain the aforementioned dynamics and provide policy insights for the conduct of monetary policy in a high and rising inequality environment. We build a parsimonious Agent-Based Model (henceforth ABM) endowed with a large number of heterogeneous households[1]. Our key assumptions are the presence of heterogeneous saving rates across households belonging to different income classes (Dynan et al., 2004; Mian et al., 2021b) and imitative consumption *a lá* "keeping up with the Joneses" (Frank, 2005). This is very much in the spirit of Duesenberry (1949) classic *"Income, Saving, and the Theory of Consumer Behavior"*, which entails two empirically relevant properties of the saving rate: cross-sectional heterogeneity and aggregate scale invariance.

Our main results suggest that increasing income inequality causes both a slowdown of inflation and a credit boom. The central bank is then compelled to reduce the policy rate in response to low inflation, whereas its reaction to the credit boom depends on the policy regime chosen: accommodative vs leaning against the wind. In any case, the monetary authority must face a trade-off between sustaining real economic activity in the short run at the cost of financial instability in the long run (accommodative regime) or achieving financial stability at the cost of a more severe output loss in the aftermath of an inequality shock (leaning against the wind regime).

Our analysis builds upon three main pillars. First and foremost, we interpret rising income inequality as a credit demand shock trigger. From an empirical standpoint, income inequality and households' leverage have been robustly found to exhibit a long-run relationship across a wide spectrum of countries (Klein, 2015; Malinen, 2016; Yamarik et al., 2016). The behavioral rationale behind this aggregate relationship was provided by Rajan (2011) in his influential book *Fault Lines*, where it is argued that rising income inequality widens the edge between desired consumption and available resources for households far from the top income distribution. Van Treeck (2014) provides further empirical support for such a hypothesis, in particular stressing the importance of imitative social pressures. As noticed by Marx: *Our wants and pleasures have their origin in society; we, therefore, measure them in relation to society; we do not measure them in relation to the objects which serve for their gratification. Since they are of a social nature, they are of a relative nature*[2]. If this is correct, the more unequal the income distribution is, the more misaligned wants and resources became, specifically, for the part of society falling behind the top income distribution. What is peculiar to a modern and financialized economy is that credit is a way out of this trade-off, insofar as it allows to close the gap between desired and affordable consumption. This is the channel that we are going to integrate into our model.

To the attentive reader, the reasoning laid down so far might appear plausible as a pure theoretical elaboration, but difficult to reconcile with the observed data. Indeed, in the aftermath of a demand shock, we should expect quantities and prices moving in the same direction implying that households' debt and the interest rate move hand in hand. The reason for this apparent inconsistency is that focusing exclusively on inequality and credit demand gives only a partial account of the relevant dynamics of interest. In particular, two additional forces might have exerted downward pressure on the interest rate. One of these forces is the financial liberalization that occurred in the US starting from the '70s (De Cecco, 1999), which can be seen as a credit supply shock, therefore counteracting the upward pressure on the interest rate. The other one is monetary policy, which plays a key role in steering the interest rate.

The role played by financial liberalization in fueling the credit bubble is extensively analyzed in Rajan (2011). He argued that the increase in US inequality from the 1980s on has led to political pressure for redistribution. In response to that, American politicians allowed an expansion of credit, especially housing finance, by lowering the credit standards for low-income households. Credit booms

[1] An incomplete and tentative list of macro ABMs is: Delli Gatti et al. (2003), Russo et al. (2007), Deissenberg et al. (2008), Dosi et al. (2010), Riccetti et al. (2015), Caiani et al. (2016). For interested readers, we suggest two comprehensive review papers: Di Guilmi (2017) and Dawid and Delli Gatti (2018)

[2] Karl Marx, *Wage, Labor, and Capital*, 1847.

have been indicated as robust predictors of crises (Schularick and Taylor, 2012). Moreover, recessions preceded by credit booms tend to be more severe (Jordà et al., 2013; Mian and Sufi, 2018). According to Mian and Sufi (2018), the 'credit-driven household demand channel' is characterized by three moments: (i) the expansion in credit supply is the key force enhancing the growth of economic activity, which is reminiscent of the fundamental contributions by Kindleberger and Minsky; (ii) the expansionary phase of the credit supply affects the "real economy" through boosting household demand, highlighting a central role of the aggregate demand as opposed to aggregate supply (Dutt, 2006); (iii) the contraction of credit supply (often associated with a banking crisis) induces a sharp drop in spending of the indebted households.

Therefore, inequality can cause a credit boom through its effect on credit demand and at the same time its effect on credit supply (due to the availability of accumulated financial resources on the part of the rich who want to reinvest them in highly profitable activities). In such a scenario, the creation of new loans, through securitization, produces structured products for satisfying the demand for assets (with high return and allegedly low risk). Commercial banks have then an incentive to create more loans (by lowering credit standards) and to sell them to Special Purpose Vehicles (SPV) to comply with regulatory constraints. In a sense, loans created by commercial banks represent the "raw material" for producing complex financial commodities (e.g. MBS, CDO) demanded by the rich (Botta et al., 2021), according to a process of financial commodification (Lysandrou, 2005).

The combination of easy credit for the poor and financial innovations for the rich reflected the polarization of income and wealth. The expansion of finance may (at least temporarily) counteract the lack of aggregate demand which would result from the deceleration of consumption of middle-to-low income classes (those with a higher propensity to consume). This is more likely to happen in a deregulated financial system in which obstacles to easy credit and financial innovations are removed, as gradually happened from the 1970s-1980s, when the Golden Age that characterized the post-WWII economic expansion came to an end. Referring in particular to the US, these changes contributed to making the financial system very fragile and required the availability of the FED, as the lender of last resort (LLR), to provide a steady flow of liquidity to face the frequent emergencies erupting in financial markets: in a sense, the LLR has been transformed in a "lender of first resort" (De Cecco, 1999). This is the first channel through which financial fragility, magnified by rising inequality, may influence the conduct of monetary policy.

The last aspect of our analysis concerns the role of the central bank, in which sense it is constrained by inequality, and which are the available ammunition against it. After the "dotcom bubble" and the attack on the Twin Towers in September 2001, monetary policy turned to be expansionary until 2004 (the so-called Greenspan put), with a policy rate below the level implied by the standard Taylor rule (Taylor, 2009). Then, the resurgence of inflation brought about a raise of the Fed funds rate, from around 1% to 5.25% in a couple of years. This resulted in an increase in the delinquency rate in the subprime mortgage market. Financial contagion and a widespread confidence crisis – particularly after the Lehman Brothers collapse – led to the largest disaster after the Great Depression. One reason which might have persuaded the FED to keep the policy rate close to the Zero Lower Bound (ZLB) is the low and decreasing inflation rate observed until the early 2000s. We conjecture that also in this respect inequality might have played a role: since rich households display larger saving rates (Dynan et al., 2004; Mian et al., 2021b) with respect to poorer ones, shifting income from poorer to richer households conceivably led to a lack of aggregate demand (Stiglitz, 2016) with obvious implications for inflation.

On the other hand, financial fragility may also have influenced monetary policy through the huge negative impact that a policy rate hike conceivably has on an unstable economy, by triggering a financial collapse followed by a severe recession. In this situation, the central bank might adopt an accommodative regime, according to which the policy rate is kept at low levels in order to avoid, or more likely postpone

a financial meltdown.

Differently from the 1930s, monetary policy reacted promptly by reaching the ZLB and implementing a Quantitative Easing (QE). After more than a decade of the eruption of the Global Financial Crisis (GFC) and the following Great Recession (GR), some countries have not fully recovered and the US economy still presents fundamental imbalances like unsustainable inequality and worrying financial fragility. Will the US economy continue to grow even under raising interest rates and inflationary pressures? Specifically, we wonder if central banks can return to set the policy rate to control inflation without causing again financial turmoil with recessionary effects, which is instead a likely event under chronic fragility in a financially deregulated and unequal economic system. To sum up, monetary policy can help the system to alleviate the problems associated with inequality and financial fragility by (i) providing all the liquidity required by financial institutions and (ii) keeping the policy rate at a low level (even at the ZLB) as long as possible (Giri et al., 2019).

The financial burden can be kept sustainable for a while until the inevitable policy rate hike in response to raising inflation arrives and the crisis-prone system collapses. In fact, the central bank sometimes can trigger recessions to reduce financial fragility, as shown by Gorton and He (2021): when the ratio of privately produced "safe debt" (e.g. ABM, MBS, etc.) to government bonds (i.e. Treasuries) is high (i.e. there is a shortage of government produced safe debt), a financial crisis is more likely (because private "safe debt" is not riskless in every state of the world); a particular purpose of macroprudential policy could then be to address the quality of the collateral, because financial fragility (i.e. the likelihood of a crisis) is increasing in the ABS/MBS-to-Treasuries ratio, and this reduces welfare. According to Gorton and He (2021), the central bank can incorporate financial fragility in its policy and pursue (this kind of) macroprudential policy. This would imply even triggering a recession if the welfare costs associated with a recession are smaller than the gain associated with reduced financial fragility. From the perspective of our research project, if financial fragility continues raising due to growing inequality, monetary policy alone seems to be an insufficient tool for this purpose.

The rest of the paper is organized as follows: In section 2 we survey the relevant literature. In section 3 we discuss our contribution, how it differs from the existing literature, and which novelties it introduces. In section 4 we lay down the theoretical model. In section 5 we present the main model dynamics and show two sensitivity exercises, in order to clarify and disentangle the role of inequality and financial liberalization. In section 6 we present our policy experiment. Section 7 concludes.

2 Literature Review

Our paper contributes to the literature investigating the debt-inequality nexus and more in general how inequality undermines financial and macroeconomic stability. The empirical literature on the subject is rich and has produced robust results. For example, cointegration between top income shares and private debt ratios has been established in a large number of developed economies (Klein, 2015; Malinen, 2016; Yamarik et al., 2016; Fasianos et al., 2017). The pioneering study of Bordo and Meissner (2012) is the first to explicitly put the so-called Rajan hypothesis to a formal empirical test using time series. Their results partially reject the Rajan hypothesis, insofar as they confirm a positive relationship between credit booms and financial instability, but reject inequality as a root cause of credit growth. However, Bordo and Meissner (2012) inspired a bulk of empirical research which, instead, estimated a positive role for inequality in the building up of private debt (Perugini et al., 2016; Bartscher et al., 2020; Chang et al., 2020). The relationship between inequality and crises as envisaged by Atkinson and Morelli (2011) has also been empirically investigated, delivering unambiguous results: inequality increases the probability of financial crises, even when private debt is netted out, suggesting that inequality undermines financial

stability within and beyond its direct leveraging effect (Kirschenmann et al., 2016; Bellettini et al., 2019; Bartscher et al., 2020; Paul, 2022).

The theoretical literature analyzing causes and consequences of the debt-inequality nexuses can be divided into two different strands: the first one provides a credit supply-based (CSB) explanation (Kumhof et al., 2015; Mian et al., 2021a; Cairó and Sim, 2020), whereas the second provides a credit demand based (CDB) explanation (Cynamon and Fazzari, 2008; Ryoo and Kim, 2014; Van Treeck, 2014; Cardaci, 2018). Models belonging to the first strands are usually characterized by a loanable fund approach, heterogenous saving rates, absence of banking, and absence of a policy rate (with the exception of Cairó and Sim, 2018). The main mechanism works as follows: shifting resources from low to high-income households increases the aggregate level of savings, as the latter display larger saving rates than the former. Those savings are then lent to low-income households, which results in a credit supply shock and a consequently new equilibrium defined by larger debt levels and lower natural interest rate.

The CDB approach is generally rooted in the post-Keynesian tradition and it stresses that an inequality shock should be interpreted as a credit demand trigger. The main channel considered runs through consumption imitation: as the differences between rich and poor households are exacerbated, the latter find it increasingly difficult to keep up with the former by exclusively resorting to income and therefore demand more credit. Another distinctive feature of this approach is the departure from the loanable funds theory and the central role played by endogenous money (Arestis and Sawyer, 2006; Lavoie, 2022). Indeed, in the CDB framework saving accumulation does not need to precede credit, for all it takes is banks to be willing to meet the credit demand by means of money creation. It follows that in the CDB framework, financial liberalization is usually a necessary condition for credit growth.

Although the CSB and CDB approaches stem from very different theoretical foundations, they share some common traits. The first one is that in both frameworks the policy rate is effectively missing, although considerations on the policy rate itself and more in general on the monetary stance are drawn. Both approaches highlight a generally negative impact of inequality on the macroeconomic dynamics, in particular for what concerns financial stability and long-run growth. On the policy side, both approaches suggest reducing inequality and to engage in macro-prudential policies.

We also contribute to the growing literature on inequality and monetary policy. Most of the research so far has focused on how monetary policy reshapes income distribution. We do not attempt to provide a full account of the relevant literature, since excellent review papers have already dealt with this endeavor (Colciago et al., 2019; Kappes, 2022). However, we want to highlight a finding which seems to robustly emerge from this literature: at least in recent times, a contractionary monetary policy has been associated with an increase in income inequality (Coibion et al., 2017; Mumtaz and Theophilopoulou, 2017; Furceri et al., 2018), whereas to an expansionary monetary policy is associated a reduction of income inequality (Samarina and Nguyen, 2019; Broer et al., 2021). We shall however mention that departures from these general findings exist, for example, Amberg et al. (2022) find that expansionary policies tend to polarize the income distribution, i.e. middle incomes losing relative to both low and high incomes, or Davtyan (2016) who actually finds that contractionary monetary policies in the US reduce inequality.

Although not many, there are some contributions analyzing the opposite relationship, that is how inequality affects monetary policy. Ma (2019) studies the relationship between income inequality and the effectiveness of the monetary policy, focusing on the aggregate labor supply elasticity. According to Ma (2019), a less dispersed income distribution is associated with a larger aggregate labor supply elasticity, therefore the monetary policy can more effectively stabilize output when operating in low inequality economies. Cairó and Sim (2018) argue that income inequality influences two traditional FED targets: inflation and financial fragility. According to them, income inequality can result in a lack of aggregate demand and therefore exert deflationary pressures. On the other hand, income inequality can spur a wave of private debt following the CSB logic described above, therefore undermining financial

stability. The contribution closer to our paper is Mian et al. (2021a) which extends the CSB framework to explicitly draw monetary policy implications. According to them, an inequality shock triggers a credit supply shock, which in turn reduces the natural rate of interest. It is therefore the natural rate dragging the policy rate down, leaving no room for maneuver for the central bank, which is indeed bound to behave like a *driver on a highway who must adapt her speed to road conditions*[3].

3 Inequality constraint(s)

In this paper, we study how inequality constrains monetary policy. We adhere to the CDB approach and we systematically compare it against the *indebted demand* framework (ID) proposed by Mian et al. (2021a). As extensively discussed by Servaas Storm[4], the ID framework suffers from some theoretical weaknesses, which we try to overcome in this contribution. First of all, the ID framework is rooted in the loanable fund approach, meaning that credit for one economic agent is always financed by a corresponding amount of savings accumulated by another agent. It follows that the secular decrease of the interest rates should be at least partially attributed to the increase of savings by richer households, which is then channeled by commercial banks to finance the indebted demand of low-income households. However, what really matters in such context are *total* savings, which despite increasing savings accruing to the top 1% (see figure 3 from Mian et al., 2020), remained nearly constant for the US economy. Instead of building our analysis on the loanable funds framework, our model relies on endogenous money. This assumption allows us to decouple the credit supply from savings accumulation and to reconcile our model with many relevant stylized facts, some of which are currently unaddressed by the literature.

Another weakness of the ID framework is the absence of a motive for credit demand. Indeed, credit demand in the ID framework coincides with the credit constraint, which is in turn exclusively defined by the interest rate (the endogenous variable) and the value of collaterals (the exogenous variable). On the contrary, we argue that the demand for credit is fundamentally determined by the difference between desired consumption and available resources at the household level (Rajan, 2011). Therefore, understanding the drivers of this difference is of paramount importance and it calls for a more elaborated definition of the credit demand. We believe that there are at least two, possibly complementary, ways to link rising inequality to credit demand: one is to assume consumption norms based on habit formation. In a nutshell, rising inequality implies income losses for low and middle-income households, who in order to preserve their consumption levels resort to credit (Stockhammer, 2015). The other way is to incorporate some sort of consumption cascade through consumption imitation. As it is common in the CDS framework, we rely on the second option.

In the ID framework, the aggregate saving rate adjustment following an inequality shock is not straightforward. Given the type of non-homothetic preferences employed by Mian et al. (2021a), the saving rate of rich households must increase in the aftermath of an inequality shock. Obviously, redistributing resources from poor households, characterized by low saving rates, to high-income households, characterized by high saving rates, unambiguously lifts the aggregate saving rate up. It is quite likely, however, that in the ID framework an inequality shock reduces the low-income households' saving rate, rendering the sign of the change in the aggregate saving rate unknown. From empirical data, however, two facts emerge: (i) the saving rate of the top 10% has been remarkably stable in the last forty years (see again Storm as referenced in footnote 4); (ii) the aggregate saving rate has been constantly decreasing (fig. 2). Our model is able to replicate the falling aggregate saving rate, consistently with a stable saving rate for rich households. As we will see, the former fact is a direct consequence of imitative social

[3]The quote is from the NYT columnist Neil Irwin: https://www.nytimes.com/2021/08/28/upshot/low-interest-rates.html

[4] https://www.ineteconomics.org/perspectives/blog/why-the-rich-get-richer-and-interest-rates-go-down

pressures, which tend to lower the saving rate of the bottom 90%, whereas the latter fact is obtained by design.

Schularick and Taylor (2012) show that large households' leverage levels are associated with large probabilities of financial crises, a relevant empirical fact that the theoretical literature has been able to replicate (Kumhof et al., 2015). We would argue, however, that this observation should be complemented with another one shown in fig. 2: during the building up of the credit boom, we observe a persistent decrease in non-performing loans, which is apparently contradictory, insofar as the system becomes more and more leveraged, bankruptcies become rarer and rarer. As we will see, our model is able to qualitatively replicate such dynamics, which is due to financial liberalization and the low policy rate set by the central bank. The latter allows households' debt to be rolled over even if its sustainability is impaired, whereas low-interest rates allow interest payments to be met, even for comparatively high debt-income ratios.

The last departure we take from the existing literature concerns the narrative used to justify the progressively increasing income and/or wealth inequality. For example, Kumhof et al. (2015) assume heterogeneous discount rates across households: patient - *therefore* rich/lender - households, versus impatient - *therefore* poor/borrower - households. Mian et al. (2021a) assume exogenous shocks hitting the endowments distribution coupled with non-homothetic preferences, which - more realistically - implies rich - *therefore* lender - households, versus poor - *therefore* borrower - households. We are instead much closer to Cairó and Sim (2020) in explicitly linking personal and functional income distribution. We assume that households hold stocks and are therefore entitled to dividends proportionally to their accumulated wealth. It follows that a markup shock reverberates along the personal income distribution by depressing real wages and magnifying dividends. We deem this approach more accurate from a descriptive point of view. Indeed, it allows us to match an additional stylized fact: the wage share fall going hand in hand with the rise of the top 10% income share.

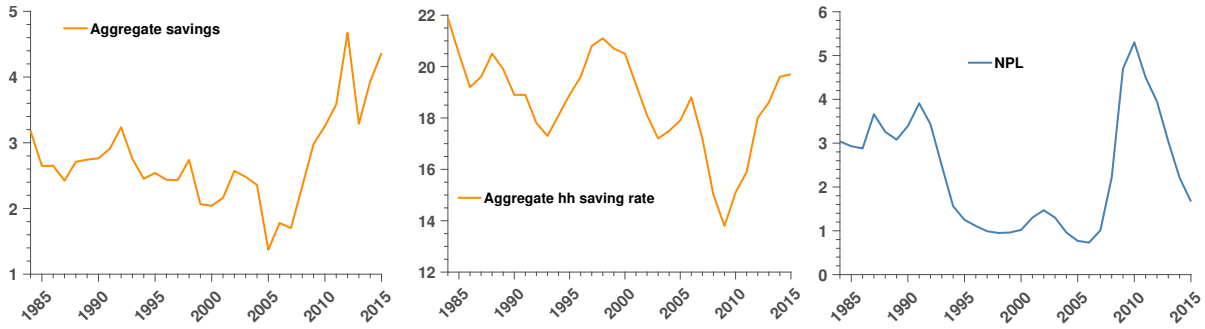


Figure 2: Aggregate savings (panel a), aggregate household savings (panel b), non performing loans (panel c), 1985-2015, US economy. Data are taken from FRED.

4 The model

We propose a minimal ABM describing an economy composed of heterogeneous households, a non-financial firm sector, a banking system, the government, and the central bank. Accordingly, the only sector in which heterogeneous agents are present is the household sector. Initial conditions are set such that all variables are zero but for the ones necessary to activate the economy (for example, firm's expected demand). Moreover, we set the exogenous distribution of individual wage quotas based on a log-normal distribution (which remains fixed during the whole simulation). The model works according to the following sequence of events (more details on single events are provided in following subsections):

- interest on loans and (firm and bank) dividends are paid;
- the firm sets its expected demand and, based on a fixed labour productivity, demands labour (which is the only productive input);
- if the firm's labour demand is less or equal to the labour supply (considering that a fraction of workers is hired by the government), the employment level corresponds to the labour demand; otherwise, it is constrained by the availability of workers;
- when the labour demand is smaller than the labour supply (net of public workers), a number of households (corresponding to the realized unemployment rate, which is set at the aggregate level) are picked at random as unemployed;
- wage inflation is determined based on an inverse relation with the unemployment rate in a Phillips curve fashion;
- the total wage bill is set and assigned to the employed workers according to the log-normal distribution of individual wage quotas; unemployed workers receive a dole;
- the firm produces homogeneous goods based on a linear technology;
- the price of goods is set according to a mark-up over unit production and financial cost;
- households' disposable income is given by the net wage (or the dole), plus interest on deposit and dividends, minus interest on loan (if any);
- households choose desired consumption based on both heterogeneous propensities to consume and an imitation mechanism;
- households set desired (precautionary) deposit and desired loan (to cover desired consumption in excess with respect to disposable income and the available stock of deposit net of desired deposit);
- the bank grants loans to creditworthy households; the interest rate depends on both the policy rate and a risk premium;
- affordable consumption is equal to desired consumption for creditworthy households (as well as for non-indebted households), whereas it can be lower for rationed households for which the available stock of deposit is insufficient to cover the entire expenditures implied by desired consumption;
- in case the sum of affordable consumption plus programmed public purchases in real terms is greater than firms' production, both consumption and public purchases are rescaled to meet the total supply of goods (this implies that households' effective consumption can be lower than the affordable level; the difference gives rise to forced saving);
- households' savings are set and stored in the form of deposits;
- firm's and bank's profit is determined; while firm's profit is fully distributed to households, the bank retains a fraction of profit if this is necessary to meet the capital requirement; if household's liquidity is not enough to pay back the principal to the bank, a non-performing loan is set implying a loss for bank's capital;
- if firm's internal resources do not fully cover production and financial costs, the firm asks for a bank loan; the interest rate depends on both the policy rate and a risk premium;

- the government determines the public deficit (public purchases, wages to public workers and dole minus collected taxes) and issues bonds which are bought by both the banking sector and the central bank;
- the central bank sets the policy rate.

4.1 Households

The household sector is composed of H=5000 heterogeneous households ($h = 1, 2, ..., H$). Each employed worker earns a wage $w_{h,t}$ which is a fraction of the total wage bill W_t paid by the firm. The individual wage quota is determined by an exogenous (and time-invariant) log-normal distribution initially set with a standard deviation κ.[5] Unemployed workers receive a dole from the government which is a fraction ν of the lowest net wage paid to employed workers (in the previous period). The total wage bill W_t is determined at the aggregate level by the following equation:

$$W_t = W_{t-1}(1 + \dot{w}_t + \dot{N}_t) \tag{1}$$

where $\dot{w}_t$ is the wage inflation and $\dot{N}_t$ is the percentage change of employment. In particular, wage inflation linearly depends on the unemployment rate u_t:

$$\dot{w}_t = \alpha_0 - \alpha_1 u_t \tag{2}$$

where α_0 and α_1 are positive parameters.

The disposable income of the h-th household is given by:

$$yd_{h,t} = w'_{h,t} + d_{h,t} - i^L_{h,t} l_{h,t-1} \tag{3}$$

where $w'_{h,t}$ is the net wage (households pay a flat tax τ on labour incomes),[6] $d_{h,t}$ the dividends distributed by the firm and the bank (proportionally to each households' wealth),[7] $i^l_{h,t}$ the interest rate on loan charged by the bank to household h, and $l_{h,t-1}$ the loan stock inherited from the previous period.

Each household sets a level of desired consumption as a weighted average between normal and imitated consumption. Normal consumption is tied to disposable income $yd_{h,t}$ and net worth $nw_{h,t}$, whereas imitated consumption reflects social pressures according to a "keep up with the Joneses" mechanism:

$$c^d_{h,t} = (1 - \xi)c^n_{h,t} + \xi c^i_{h,t} \tag{4}$$

where $c^n_{h,t}$ is "normal consumption", $c^i_{h,t}$ is "imitated consumption", and $\xi \in (0, 1)$ is an "imitation intensity" parameter. Normal consumption is given by:

$$c^n_{h,t} = c^h_{yd} \cdot max(0, yd_{h,t}) + c_{nw} \cdot max(0, nw_{h,t}) \tag{5}$$

where c^h_{yd} and c_{nw} are the propensity to consume out of disposable income and net worth, respectively. The propensity c^h_{yd} is heterogeneous across households' deciles, in particular we assume that c^h_{yd} is decreasing in income.

Imitated consumption (which is set to zero for unemployed workers) follows an "expenditure cascade" scheme: each household imitates the average consumption of the decile immediately above her own decile,

[5] The mean of log values is 1. This is not reported as a model parameter due to the fact that once random log values are created, we divide each number by their total in order to obtain individual quotas summing to unity.

[6] In the case of an unemployed worker, in eq. 3 there will be the dole rather than the net wage.

[7] In order to keep the model as simple as possible, we do not consider firm and bank shares and assume that dividends are distributed to households according to their relative wealth – namely deposits, which represent the only asset in the households' balance sheet.

i.e. households belonging to the 10^{th} decile imitate the average consumption of households belonging to the 9^{th} decile and so on (households belonging to the first decile do not imitate at all).

Households set a desired deposit $\Delta d^d_{h,t}$ for precautionary purposes which is equal to past consumption[8]. If the available resources, namely the disposable income plus the deposit stock inherited from the past period, are not enough to cover desired consumption plus desired deposit, then the household asks for a bank loan:

$$\Delta l^d_{h,t} = \begin{cases} c^d_{h,t} + \Delta d^d_{h,t} - (yd_{h,t} + d_{h,t-1}) & \text{if } c^d_{h,t} + \Delta d^d_{h,t} > yd_{h,t} + d_{h,t-1} \\ 0 & \text{otherwise.} \end{cases} \tag{6}$$

The bank assesses the creditworthiness of households on individual bases (see section 4.3), so that the affordable consumption for non-rationed households corresponds to desired consumption, while for rationed ones the maximum affordable consumption is constrained by available resources, namely $yd_{h,t} + d_{h,t-1}$.

By summing up individual consumption we obtain aggregate consumption C_t. Aggregate consumption plus public purchases G_t gives rise to the aggregate demand in nominal terms. If the aggregate demand in real terms, D^*_t, is larger than production Y_t (i.e. excess demand), both individual consumption and public purchases are scaled down in order for the effective demand to be equal to production. Accordingly, households' effective consumption $c_{h,t}$ can be lower than the affordable level. Households' saving is equal to disposable income minus effective consumption.

Indebted households have to pay a fraction ι of the loan principal, that is the installment $\iota l_{h,t-1}$; in case of insufficient resources, the household is not able to pay back the installment, fully or partially, and the bank suffers a non-performing loan $npl_{h,t}$ (thus negatively impacting bank's capital; see section 4.3). Accordingly, the household's deposit stock at the end of the period is:

$$d_{h,t} = \begin{cases} d_{h,t-1} + yd_{h,t} + \Delta l_{h,t} - c_{h,t} - \iota l_{h,t-1} & \text{if } npl_{h,t} = 0 \\ 0 & \text{if } npl_{h,t} > 0. \end{cases} \tag{7}$$

Finally, the households' net worth is:

$$nw_{h,t} = d_{h,t} - l_{h,t}. \tag{8}$$

4.2 Firm

The non-financial sector produces homogeneous goods using only labour and according to a linear production technology:

$$Y_t = \omega N_t \tag{9}$$

where $\omega > 0$ represents the (fixed) labour productivity, and $N_t = min(H - PW, N^d_t)$ is the actual (private) employment level, which in turn is the minimum between the number of available workers, after that the government hired PW public workers, and firm's labour demand N^d_t. The number of workers hired by the government is $PW = \lfloor pw \cdot H \rceil$, with $pw \in (0, 1)$. The firm's labor demand is given by:

$$N^d_t = \lceil D^e_t / \omega \rceil \tag{10}$$

[8]The intuition is that households' consumption norms are also determined by habit formation, in this sense a household tries to accumulate enough liquid resources so that she can at least afford the realized consumption of the previous period.

where D_t^e is the firm's expected demand. The firm follows an adaptive scheme for expectations setting:

$$D_t^e = D_{t-1}^e + \lambda(D_{t-1}^* - D_{t-1}^e) \tag{11}$$

where $\lambda > 0$ and D_{t-1}^* stays for potential aggregate demand (in real terms), namely the amount of goods corresponding to the total households' and public expenditures evaluated at the previous period price, independently of the (possibly binding) quantity constraint.

The price at which homogeneous goods are sold is:

$$P_t = (1 + \mu)\frac{W_t + FC_t}{Y_t} \tag{12}$$

where W_t is the wage bill, FC_t the interest on bank loan (if any), and μ is the markup, which is used in the model to implement the "inequality shock"(see section 5).

Finally, firm's gross profit is given by:

$$\pi_t = P_t \cdot D_t - W_t - FC_t \tag{13}$$

where D_t is actual demand (that can be equal or smaller than production Y_t). The firm then pays a proportional tax on (positive) profit (no tax is paid in case of negative profit) and distributes the net profit to households.

4.3 Bank

The banking sector provides credit to both the firm and households. In the case of households, the bank firstly assesses the creditworthiness of potential clients by checking, for any household h demanding credit $\Delta l_{h,t}^d$, the condition:

$$\iota l_{h,t}^d \leq \theta y d_{h,t} \tag{14}$$

Where ι represents the percentage repayment of the principal, $l_{h,t}^d = l_{h,t-1} + \Delta l_{h,t}^d$ is h's loan stock if her demand $\Delta l_{h,t}^d$ is met, and θ is the maximum principal repayment-to-income ratio allowed by the bank, which is used in the model to implement the "financial deregulation shock"(see section 5). If condition (14) is not met, household h is denied credit, otherwise h's credit demand is accommodated in full. Indebted households pay an interest rate on loan, which is given by a homogenous premium σ over the policy rate $i_{CB,t-1}$, plus a household specific risk-premium defined by her loan stock-to-income ratio:

$$i_{h,t} = i_{CB,t} + \sigma + (i_{CB,t-1} + \sigma)\frac{l_{h,t}}{yd_{h,t}} \tag{15}$$

The interest rate on the bank loan to the firm (there is no rationing in this case) is computed according to a similar formula:

$$i_t^F = i_{CB} + \sigma + (i_{CB,t-1} + \sigma)\frac{L_t^F}{P_t D_t} \tag{16}$$

where $P_t D_t$ represents firm's revenues.

The bank's profit is given by the interest on both loans and bonds (there is no interest paid on deposits). The bank pays a proportional profit tax. The fraction of net profit distributed to households evolves according to the following equation:

$$\delta_t = \delta_{t-1} + \left(\frac{BC_{t-1} - NPL_t}{L_t + L_t^F} - car \right) \tag{17}$$

where BC_{t-1} is previous period bank's capital, NPL_t is the total amount of non-performing loan in period t, L_t and L_t^F are the loan stock of households and the firm, respectively, and car is the capital requirement.

4.4 Government

The government hires a fraction pw of total workers H.[9] They are paid a total bill equal to W_t^B, which is then distributed to each single worker according to the same mechanism applied to the private sector. Moreover, the government pays unemployment benefits for a total of UB_t. It also pays interest on bonds equal to $i_{t-1}^G B_{t-1}$. Public purchases are proportional to past aggregate demand: $G_t = \chi(P_{t-1}D_{t-1})$, where $\chi > 0$. The government collects taxes, Tax_t, on both wages and profits. Therefore, the public deficit is:

$$\Delta B_t = W_t^B + UB_t + i_{t-1}^G B_{t-1} + G_t - Tax_t \tag{18}$$

The public debt is given by cumulative public deficits. Public bonds are bought by the banking sector and the central bank. In particular, we assume that a fraction ψ of government bonds is bought by the central bank.[10]

4.5 Central bank

The central bank sets the policy rate following a standard single mandate Taylor rule with inflation targeting:

$$i_{CB,t} = \tilde{i}_{CB}^{(1-\phi_r)} i_{CB,t-1}^{\phi_r} \left[\left(\frac{\pi_t}{\tilde{\pi}_{CB}} \right)^{\phi_\pi} \right]^{(1-\phi_r)} \tag{19}$$

where $\tilde{i}_{CB}$ is an exogenous anchor for the policy rate, $\tilde{\pi}_{CB}$ is the central bank inflation target, ϕ_r and ϕ_π are positive parameters, and π_t is the current inflation rate.

In our policy experiments, we augment the Taylor rule described in equation (19) in order to include aggregate households' debt:

$$i_{CB,t} = \tilde{i}_{CB}^{(1-\phi_r)} i_{CB,t-1}^{\phi_r} \left[\left(\frac{\pi_t}{\tilde{\pi}_{CB}} \right)^{\phi_\pi} \right]^{(1-\phi_r)} + \beta \phi_D \left(\frac{L_t}{Y_t} \right)^2 \tag{20}$$

where L_t is the total loan stock held by households, Y_t is total households' disposable income, ϕ_D is a positive parameter. β is a dummy taking values (-1, 0, 1) and acting as the policy regime switching parameter: with $\beta = 0$, we have the *single mandate* Taylor rule; with $\beta = 1$, we have the *leaning against the wind* regime, and with $\beta = -1$ an *accommodative* regime.

[9] Public servants do not produce tangible goods but rather manage the public sector which is supposed to be essential for the economy to work.

[10] Consequently, only a fraction of the total flow of interest generated by the public debt, namely $(1 - \psi) i_{t-1}^G B_{t-1}$ is really paid by the government (to private banks), being the remaining part paid to the central bank that immediately returns it to the government.

5 Results

The full list of calibrated parameters used in the simulation can be found in Table 1 and 2 of the Appendix A. In order to analyze the model response to ensuing inequality and financial liberalization, we impose a series of continuous shocks starting at t=500. We model an inequality shock as an exogenous shock to the markup μ and a financial liberalization shock as an exogenous shock on the households' maximum principal payment-to-income ratio allowed by the bank, i.e. the parameter θ. Like in Cairó and Sim (2020), rising μ depresses real wages and increases profit margins. Since dividends are redistributed to households according to their relative wealth, rich households benefit from an increase in the profit share. Indeed, we will show that larger markups are associated with larger top-income shares. Rising θ allows the bank to extend more credit to an applicant for a given income level, therefore allowing for higher leverage in the system. The shocks are implemented as period-by-period increases in the aforementioned parameters, up to a predetermined maximum level. The evolution of μ and θ can therefore be expressed as:

$$\mu_t = \begin{cases} \mu_0 & \text{if} \quad t < 500 \\ min\left\{\bar{\mu}, \quad (1+\gamma^{\mu})\,\mu_{t-1}\right\} & \text{if} \quad t \geq 500 \end{cases} \tag{21}$$

$$\theta_t = \begin{cases} \theta_0 & \text{if} \quad t < 500 \\ min\left\{\bar{\theta}, \quad \left(1+\gamma^{\theta}\right)\theta_{t-1}\right\} & \text{if} \quad t \geq 500 \end{cases} \tag{22}$$

Where γ^{μ} and γ^{θ} are the proportional increments occurring at any t, for μ and θ respectively. $\bar{\mu}$ and $\bar{\theta}$ are the maximum attainable values for μ and θ respectively.

5.1 The effect of inequality on macroeconomic dynamics

In the baseline scenario, we assume a single mandate Taylor rule aimed at inflation stabilization, i.e. $\beta = 0$ in eq. 20.

The transmission mechanism of our model goes as follows (fig. 3): increasing the markup directly exacerbates income inequality (fig. 3g). Indeed, since capital income is mostly concentrated among wealthy individuals, increasing the profit margins lowers the wage share and widens the income differential between the top and bottom deciles. The inequality shock, combined with imitative consumption (eq. 5), widens the distance between desired and affordable consumption for low and middle-income households, who, in order to finance the gap, demand more credit. Financial liberalization allows the increased credit demand to be met: credit rationing drops (fig. 3i) as a direct result of larger θ, meaning that more credit applications are granted, resulting in a larger realized aggregate households' debt-to-income ratio (fig. 3d). As we will see in section 5.2, financial liberalization is a necessary condition for the credit boom to take place, as increasing credit demand is not enough.

Redistribution from poor to rich households depresses aggregate demand since rich households have lower propensities to consume. The keeping up mechanism only partially counteracts the lack of aggregate demand, moreover, the accumulated stock of private debt reduces disposable income for a large share of households, which contributes to depressing aggregate demand in the long run. The lack of aggregate demand translates into high unemployment (fig. 3a) and therefore low inflation[11] (fig. 3c), which carries important implications for the monetary policy. Indeed, as inflation slows down, the central bank reduces the policy rate (fig. 3h) in an attempt to stimulate the economy. Therefore, the deflationary effect is one channel through which inequality can constrain monetary policy.

[11] Recall from equation 2 that wage inflation is negatively linked to the unemployment rate and that prices are set applying a fixed mark-up over production and financial costs (see eq. 12).

The reaction of the interest rate (fig. 3f) is non-trivial as two opposite forces occur: as households' debt-to-income ratio increases, the bank seeks higher risk premia (see eq. 15), therefore charging larger interests on loans[12]. On the other hand, the policy rate drop drives the interest on loans down. In the first part of the simulation, households' debt grows faster than the central bank is able to adjust the policy rate, however, in the long-run household debt stabilizes quicker than the policy rate does. Such dynamics are reflected in the interest rate on loans, which at first increases when the leverage effect dominates and then decreases when the policy rate effect dominates.

Finally, we wish to draw attention to two important stylized facts that the model is able to match and which we believe to be an innovation to the literature. The first of those stylized facts is the falling aggregate saving rate (fig. 3b), which qualitatively matches the observed dynamics in the US during the period 1980-2008 (fig. 2b). Redistribution from low to high-income households increases the aggregate saving rate, as the latter tend to save more than the former. However, imitative social pressures nudge low-income households to increase their consumption level relative to disposable income, effectively reducing their saving rate. In principle, the net effect of those two opposing forces is ambiguous, as there is no theoretical reason to assume that one would always dominate the other. However, our parametrization allows for the latter effect to more than compensate for the former effect and therefore allows us to match an empirically relevant fact. Note also that we achieve the falling aggregate saving rate by keeping constant, by design, the saving rate of the top 10%, which is also consistent with empirical observations.

The second stylized fact that we are able to match is a reduction of non-performing loans (fig. 3e) accompanying the credit boom, which is also observable for the US economy (fig. 2c). This result is apparently contradictory as rising debt would suggest a deterioration of financial stability, whereas low levels of NPLs would suggest the opposite. Two reasons explain the result: (i) financial liberalization allows debt to be rolled over even when households' financial position deteriorates, in such a way the bank is able to keep afloat debt that is actually highly risky and would probably default under a more conservative bank's behavior; (ii) the low-interest rate environment fostered by the central bank lowers debt servicing costs for given debt stock, therefore allowing households to sustain higher debt-to-income ratios without incurring in bankruptcies.

[12]Note that our financial liberalization shock only affects the parameter θ, which proxies the bank's willingness to extend credit to households for a given level of riskiness. On the other hand, the parameter σ, which proxies how the bank price risk, remains untouched.

Figure 3: Baseline Simulation

The figure shows the baseline scenario. Each time series is smoothed using a moving average and a Gaussian kernel. Each time series is normalized at t=500, i.e. when the shock series begins.

5.2 Disentangling the role of inequality and financial liberalization: sensitivity exercise on $\bar{\theta}$ and $\bar{\mu}$

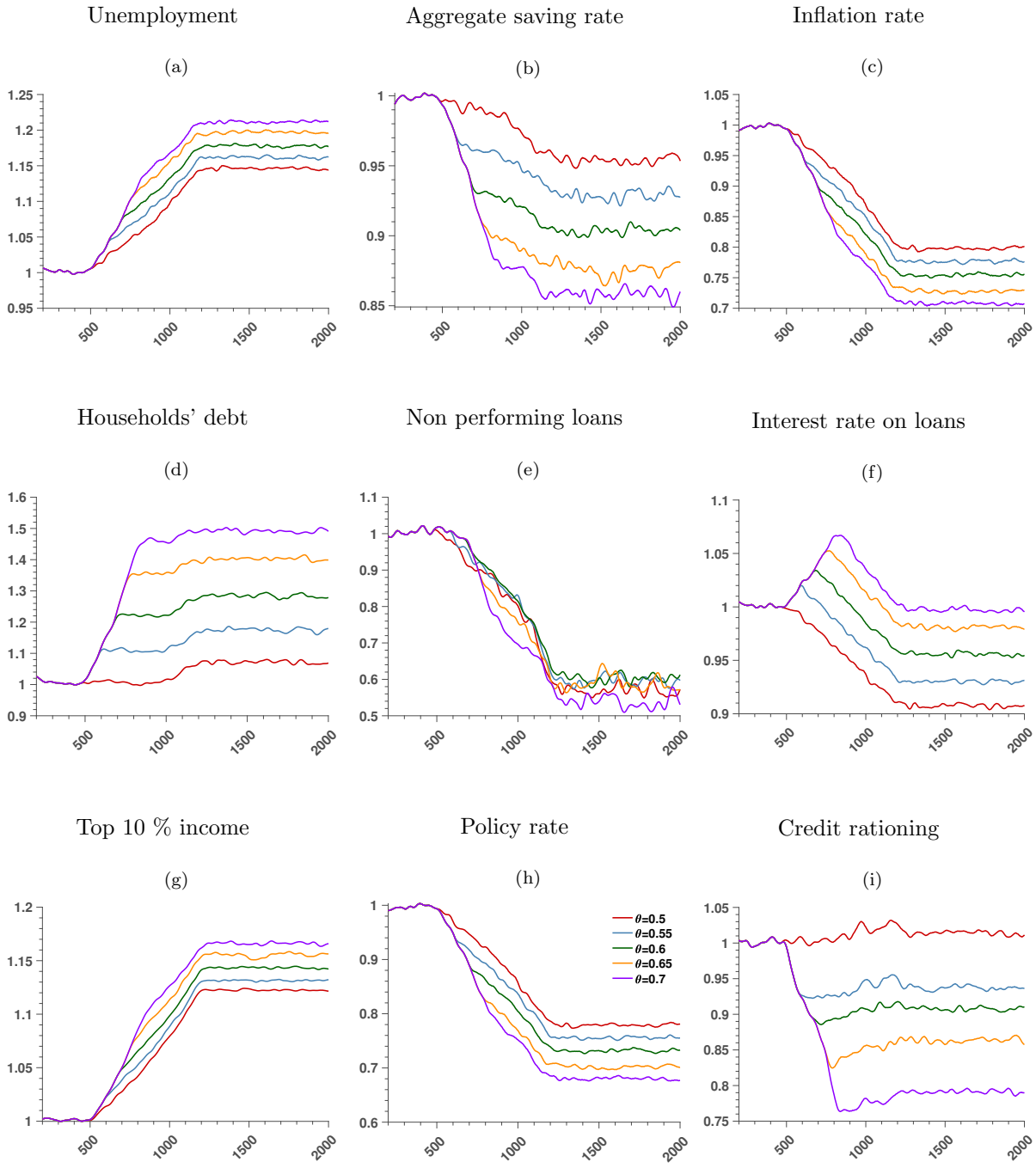
In the first sensitivity exercise, we keep fixed $\beta = 0$, i.e. we assume a single mandate Taylor rule, however, we assume different levels for $\bar{\theta}$, that is different levels of financial liberalization. Results are summarized in fig. 4.

The first effect we notice is that credit rationing is negatively related to financial liberalization, i.e. the larger is $\bar{\theta}$, or in other words the stronger is financial liberalization, the less rationing occurs (fig. 4i). Consequently, when financial liberalization is stronger households' debt grows more in the aftermath of an inequality shock, insofar as more credit demand is accommodated by the bank (fig. 4d). Also, the drop in the aggregate saving rate is more pronounced when financial liberalization is stronger, this is because as low and middle-income households are allowed to take up more debt, their saving rate is effectively curtailed, therefore reinforcing the aggregate saving rate fall discussed in section 5.1.

Interestingly, financial liberalization feedbacks in the inequality dynamics, as we observe that larger values of $\bar{\theta}$ are associated with larger levels of inequality (fig. 4g), despite the inequality shock being the same across the sensitivity exercise. This is because as low and middle-income households accumulate more debt, a larger part of their earnings are used for interest payments, which implies a redistribution from households to the financial system. The bank is disproportionately owned by richer households, who are also entitled to most of its distributed dividends. The final effect is a redistribution toward richer households and an increase in inequality.

The interest rate on loans tends to be larger when the financial liberalization is stronger (fig. 4f), as the bank charges larger risk premia due to larger households leverage. Those larger interest rates result in higher unemployment (fig. 4a) and therefore lower inflation. Thus, the central bank reacts by lowering the policy rate more when the financial liberalization is stronger (fig. 4h). However, a central bank employing a single mandate Taylor rule is not able to fully counteract the risk premia effect and therefore has only a limited ability to bring the interest rate down when financial liberalization is strong. Finally, we see no sizable effect on the NPLs (fig. 4e).

Figure 4: Financial liberalization sensitivity $\bar{\theta}$



Each time series is smoothed using a moving average and a Gaussian kernel. Each time series is normalized at t=500, i.e. when the shock series begins. Each time series within a sub-figure refers to a different $\bar{\theta}$.

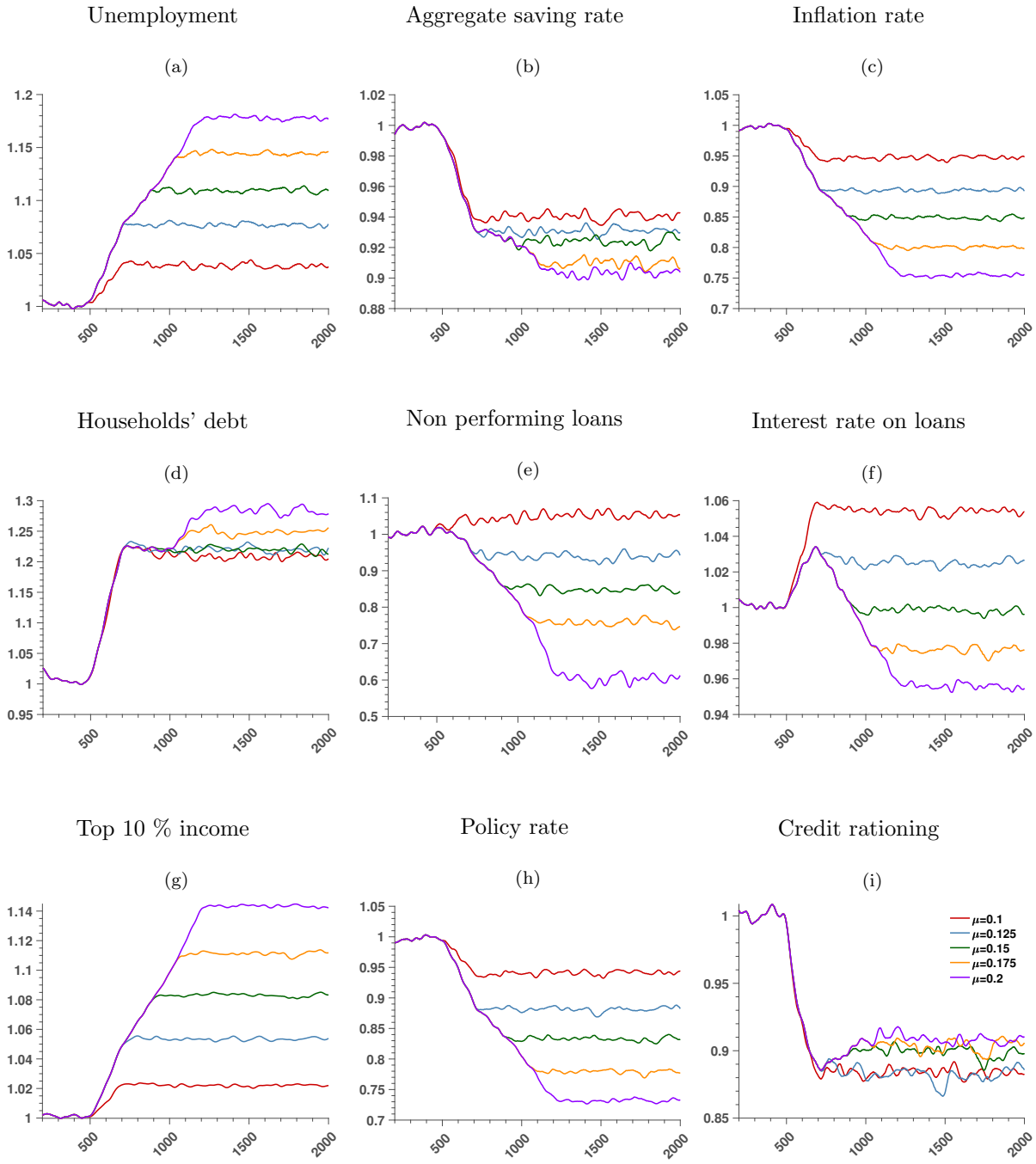
The second sensitivity exercise follows the same logic as the previous one, the only difference being the parameter of interest, which in this case is $\bar{\mu}$, i.e. the size of the inequality shock. Results are summarized in fig. 5.

As expected, the larger the mark-up shock is, the more inequality we get (fig. 5g). To larger levels of inequality are associated lower aggregate saving rates (fig. 5b), which is a straightforward implication of consumption imitative behavior: as the income difference between low and high-income households

widens, the former consume more of their available resources in order to catch up with the latter. However, although the aggregate saving rate decreases it does not necessarily spur more household debt (fig. 5d). The reason is that if the growing credit demand triggered by inequality is not accompanied by financial liberalization, such demand will simply not be served. Indeed, we observe more credit rationing for larger mark-up shocks.

These sensitivity results confirm that inequality is detrimental to real economic activity, indeed to large mark-up shocks are associated larger level of unemployment (fig. 5a) and stronger deflationary pressures (fig. 5c). It follows that the stronger the inequality shock, the more the policy rate is reduced by the central bank.

Figure 5: Inequality sensitivity: $\bar{\mu}$



Each time series is smoothed using a moving average and a Gaussian kernel. Each time series is normalized at t=500, i.e. when the shock series begins. Each time series within a sub-figure refers to a different $\bar{\mu}$.

6 Monetary policy: leaning against the wind vs accommodative regime

Our policy experiment is aimed at studying how a central bank targeting private debt modifies the macroeconomic adjustment to inequality and financial liberalization shocks. There are two possible regimes that the central bank can choose, a leaning against the wind or an accommodative regime (see

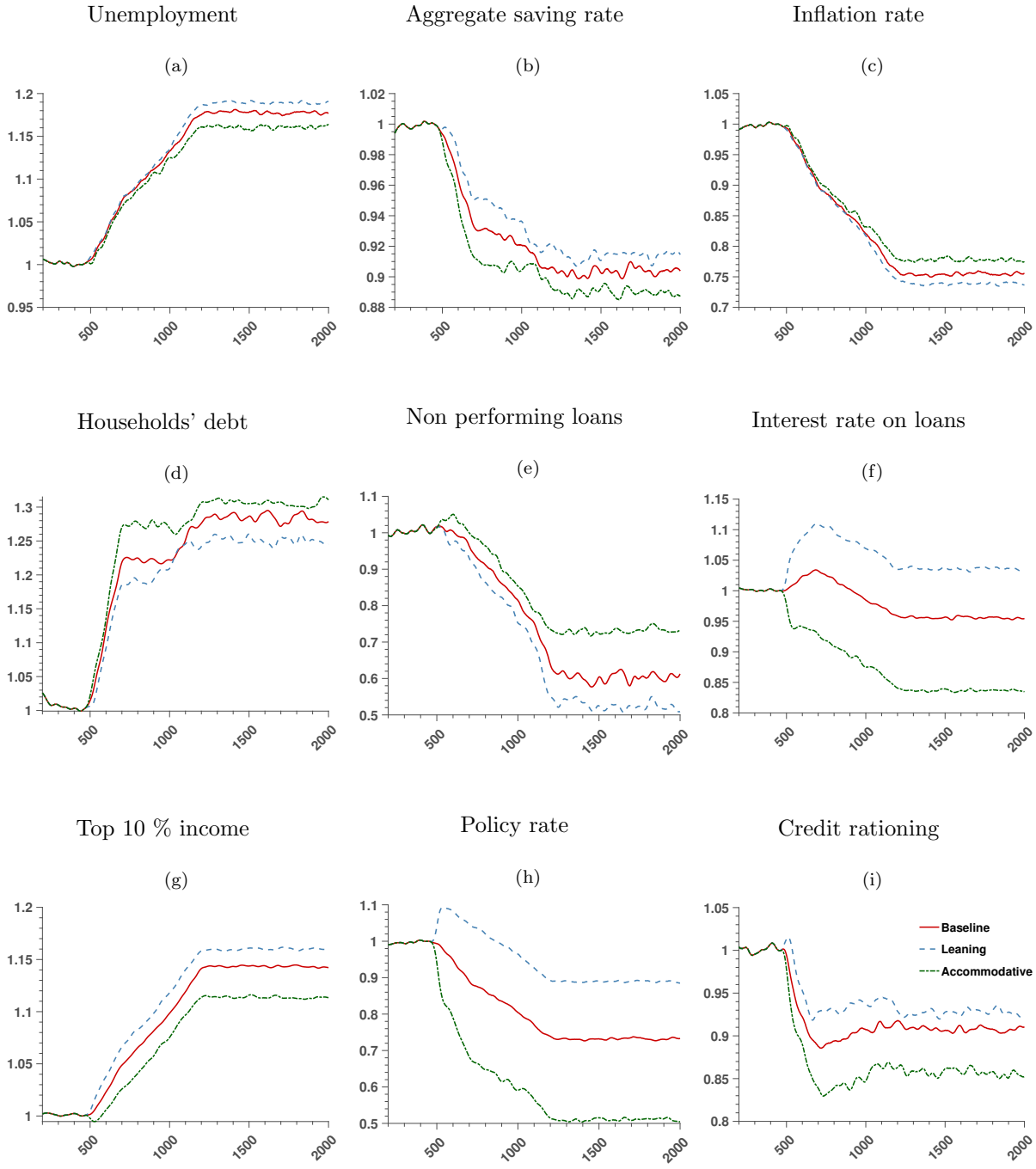
eq. 20). We assume that up to period t=500 no shock is applied and the central bank uses the usual single mandate Taylor rule. After period t=500, the series of shocks on μ and θ start and the central bank changes its policy regime either to accommodative or leaning against the wind. Results are presented in fig. 6.

The policy rate is higher in the leaning regime relative to the single mandate, whereas in the accommodative regime it is lower (fig. 6h) and the same pattern applies to the interest rate on loans (fig. 6f). The accommodative strategy is successful in limiting the negative real effects brought about by the inequality shock, we indeed observe lower unemployment (fig. 6a) and a weaker deflationary tendency (fig. 6c). However, this comes at the cost of stronger debt growth (fig. 6d), which is due to the bank serving a larger share of credit demand (fig. 6i) and it is reflected in a stronger fall of the aggregate saving rate (fig. 6b). Moreover, financial stability is impaired as more NPLs occur (fig. 6e). On the contrary, the leaning regime is able to achieve better financial stability, at the cost of weaker real economic activity.

The key message is that rising inequality puts the central bank in a very difficult corner. Indeed, the central bank must face a trade-off between two unpleasant scenarios, one in which it is somehow able to address the lack of aggregate demand issue, but at the cost of undermining financial stability and therefore accepting the risk of future disruptive crises. In the other possible scenario, the central bank can to some extent preserve financial stability, but it has to let aggregate demand plumb. The point being that the central bank arguably does not have the ability to address the structural issue causing the macroeconomic and financial turmoil, namely inequality. This closely resembles the period leading to the 2007-8 financial crisis and the following global recession, when the FED probably employed an accommodative strategy at least until the early 2000s.

Finally, we observe that inequality is lower under the accommodative regime, which is in line with the literature surveyed in section 2, as the accommodative regime implies a more expansionary monetary policy. The main channel at work is the ability of the financial sector to extract interest payments from households and generate profits. As the interest rate reduces, indebted households need to pay less interests for any given level of accumulated debt and therefore the bank generates less profits to be redistributed to rich households. In short, lowering the interest rate can contain the redistribution from the bottom to the top of the income distribution occurring through debt and the financial sector.

Figure 6: Policy simulation results. Baseline, leaning against the wind, and accommodative monetary policy



The figure shows the baseline (red solid line), the leaning against the wind (dashed blue line), and the accommodative monetary policy (dotted green line) scenarios. Each simulation is smoothed using a moving average and a Gaussian kernel.

7 Conclusions

The paper shows how central banks can react to rising income inequality even when the latter is not an explicit target of the monetary policy rule. We shed light on two salient channels through which income inequality feedbacks within the policy rate. The first channel is an aggregate demand channel: redistri-

bution from low to high-income households depresses aggregate consumption, as the two groups feature different saving rates, the consequent lack of aggregate demand translates into a deflationary pressure, which the central bank is compelled to counteract by lowering the policy rate. The second channel is a financial fragility channel, which kicks in only if the central bank directly reacts to private debt. In such circumstances, the central bank can choose between two opposite stances: an accommodative or a leaning against the wind monetary policy regimes. The former imposes reductions of the policy rate when the households sector leverage increases, allowing it to accompany debt growth and sustain aggregate demand, at least in the short run. On the other hand, the leaning against the wind regime can tame private debt growth and preserve financial stability vis-a-vis the accommodative regime, however, at the cost of weaker aggregate demand and higher unemployment. We would argue that the accommodative regime is the one that more closely resembles, though in a stylized way, the FED's behavior during the Great Moderation and in particular in the years before the Great Recession.

Broadly speaking, our paper contributes to the literature on income inequality from a macroeconomic perspective, more specifically, we focus on the debt-inequality nexus and the link between inequality and monetary policy. We make four main contributions: the first contribution is to revert the typical causal order of analysis, which focuses on the impact of monetary policy on inequality. Indeed, we study how ensuing income inequality constrains the central bank in conducting monetary policy, which is a far less researched, although equally relevant, issue. Within this context, we explicitly model a central bank together with its reaction function, which is, perhaps surprisingly, rare in this specific literature and we regard it as our second main contribution. The third contribution we make is the policy insight we propose, particularly the two channels we identified and summarized above. Lastly, although qualitatively, the proposed theoretical framework can replicate several crucial dynamics and stylized facts, some of which are new in the literature. Again, let us mention the fall in the aggregate saving rate in the aftermath of an inequality shock, the stable saving rate among households belonging to the top of the income distribution, and the fall in non-performing loans going hand in hand with the increasing leverage in the household sector.

Our goal was to devise an extremely simple framework in order to isolate and analyze the aforementioned economic mechanisms as clearly as possible. As such, we have decided to leave out of the analysis some relevant elements, in particular, we refer to real and/or financial assets, for example, equities and housing. We deem that important both from a narrative point of view, all in all, the housing market played undoubtedly a central role in the 2007 financial meltdown, but also from a more practical point of view, as enriching our model with asset price dynamics, would implicitly add a balance sheet channel, which is relevant both as a leveraging factor and as a destabilizing factor in a boom and bust type of trajectory. We planned to extend our simple framework in order to include those elements, however, we leave this task for future research.

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A Parameters

Table 1: Calibrated parameters

Parameter	Description	Value
λ	Adaptive expectation	0.8
ω	Labour productivity	10
c_{nw}	Propensity to consume out of wealth	0.1
c^h_{yd}	Propensity to consume out of income	see Table (2)
ξ	Imitation intensity	0.5
ν	Unemployment benefit	0.5
ι	Loan repayment rate	0.2
car	Capital adequacy ratio	0.08
τ^H	Tax rate on households	0.35
τ^F	Tax rate on firms and banks	0.45
pw	% of public servants	0.25
α_0	Phillips curve intercept	0.08
α_1	Phillips curve slope	0.8
$\widetilde{i_{CB}}$	Policy rate anchor	0.02
$\widetilde{\pi_{CB}}$	Inflation target	0.02
ϕ_R	Taylor rule stickiness	0.8
ϕ_π	Response to inflation	1.1
ϕ_D	Response to credit	0.009
ψ	Share of public debt held by the central bank	0.3
μ_0	Initial markup	0.1
$\bar{\mu}$	Maximum value the markup can achieve during the policy shock	0.2
γ^μ	Growth rate of the markup after the shock	0.001
θ_0	Initial maximum principal repayment-to-income-ratio	0.4
$\bar{\theta}$	Maximum value θ can achieve during the policy shock	0.6
γ^θ	Growth rate of θ after the shock	0.001
κ	Standard deviation of lognormally distributed individual wage quotas	0.4
χ	Government expenditure	1/3.5
σ	Markup on interest rates on loans	0.03

Table 2: Calibrated propensity to consume out of income

Parameter	Description	Value
c_{yd}^{10}	10^{th} decile	0.50
c_{yd}^{9}	9^{th} decile	0.60
c_{yd}^{8}	8^{th} decile	0.70
c_{yd}^{7}	7^{th} decile	0.75
c_{yd}^{6}	6^{th} decile	0.80
c_{yd}^{5}	5^{th} decile	0.85
c_{yd}^{4}	4^{th} decile	0.90
c_{yd}^{3}	3^{rd} decile	0.95
c_{yd}^{2}	2^{nd} decile	1.00
c_{yd}^{1}	1^{st} decile	1.00