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Macroprudential and monetary policies to deal with inequality

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ABSTRACT

This paper examines the impact of macro prudential policies on financial stability and inequality, focusing on the effects of debt service-to-income (DTI) ratio reductions and on its coordination with a conventional monetary policy. Using a macroeconomic simulation model, we find that reducing DTI threshold bring about a decrease in both households indebtedness and non-performing loans (NPLs), while causing economic contraction, and worsening inequality by restricting access to credit for lower-income households. Our findings suggest that while macro prudential policy (lower DTI) alone is able to grant more financial stability at the cost of greater inequality, a combination with expansionary monetary policies can reduce these disparities while ensuring financial stability.

Introduction

The 2007–2008 global financial crisis highlighted the need for macro prudential policies as crucial tools to safeguard financial stability and prevent the recurrence of systemic crises. Factors such as credit growth (Minsky, 1977; Schularick and Taylor, 2012; Di Maggio and Kermani, 2017; Mian et al., 2017), income and wealth inequality (Bellettini et al., 2019; Hauner, 2020; Paul, 2023), and developments in the financial sector (Minsky, 1977; Botta et al., 2021, 2022, 2024) have been recognised as key predictors of financial crises, often undermining economic stability. However, the literature reveals that macro prudential policies can produce a range of effects across different dimensions of the economy, leading to diverse and sometimes conflicting results.

The existing literature on macro prudential policy can be broadly categorised into three strands. The first strand focuses on the role of macroprudential policies in reducing financial risk. Studies in this area largely agree that policies such as reduction in loan-to-value (LTV) and debt service-to-income (DTI) limits can curb excessive credit growth and reduce the likelihood of financial crises (Alpanda and Zubairy, 2017; Rubio and Carrasco-Gallego, 2014; Richter et al., 2019).

The second strand of literature centres on the debate over the coordination between monetary and macro prudential policies. Some scholars advocate for a clear distinction between these policies, arguing that monetary policy should focus on price stability, while macro prudential policy should be tasked with ensuring financial stability (Galati and Moessner, 2013). Others suggest that a lack of coordination between these two policy areas can lead to inefficiencies. For instance, Boscá et al. (2024) points out that tighter macro prudential policies may lead to lower output and inflation in the absence of complementary expansionary monetary policy that can be able to mitigate the negative effects on output.

The third strand of research examines the redistributive effects of macro prudential policies, with a specific focus on income and wealth inequality. The literature here is divided, with some studies arguing that macro prudential policies can reduce inequality, while others contend that these policies may exacerbate it. For instance, Yun et al. (2024) finds that contractionary macro prudential policies, such as stricter LTV and DTI limits, can reduce speculative activity in the housing market, thereby narrowing the wealth gap by limiting risky borrowing practices. On the other hand, scholars like Park and Kim (2023) highlight that such policies may disproportionately harm lower-income households by restricting their access to credit, thereby increasing inequality.

Despite the rich literature in these three areas, a notable gap remains: few studies examine the intersection of the effects of macro prudential policy on financial stability and inequality, providing an experiment to test whether a combination of monetary and macroprudential policy could mitigate the negative welfare effects of the latter. This study aims to bridge these strands by investigating not only the impact of macro prudential measures on both financial stability and inequality but also how the coordination of macro prudential and monetary policies can mitigate the potential trade-off between financial stability and inequality. Our findings suggest that while macro

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prudential policy (lower debt service-to-income ratios) alone is able to grant more households financial stability[1] at the cost of greater inequality, a combination with expansionary monetary policies can reduce these disparities while ensuring financial stability.

This paper is organised into five section. The first section reviews the literature on macro prudential policies, focusing on financial stability, policy coordination, and inequality. The second section outlines the data and model used for the analysis, including calibration methods. The third section describe the calibration process, the fourth section presents the results, and the final section concludes.

1. Literature

The global financial crisis highlighted the critical need for robust macro prudential policies to mitigate systemic risks and reduce the likelihood of financial crises. The literature focuses on macro-prudential policies in different ways. Some studies investigate the effectiveness of macro-prudential policies in achieving the goal of limiting excessive credit growth and thus reducing the probability of credit defaults and of subsequent financial crises (Ayyagari et al., 2017; Van Bekkum et al., 2023; Riccetti et al., 2018; Ozel et al., 2019; Catapano et al., 2021), also considering the impact on other macroeconomic variables such as output (Rubio and Carrasco-Gallego, 2014; Alpanda and Zubairy, 2017; Richter et al., 2019). For example, Alpanda and Zubairy (2017) argues that macro-prudential regulation, such as mortgage interest deduction limits and loan-to-value rules, is the most effective at reducing household debt with minimal output costs compared to monetary tightening and fiscal measures. The work of Richter et al. (2019) also finds no relevant economic costs after the adoption of macro-prudential measures.

Other works examine whether macro prudential policies should be implemented by different authorities, or whether it may be necessary to coordinate them. Indeed, the review of Galati and Moessner (2013) emphasises that while some scholars advocate for a clear distinction between monetary and macro prudential policies, since the former's goal is price stability and the latter's focus is financial stability, other scholars suggest that the objectives of monetary, micro prudential and macro prudential policies are interrelated and should be coordinated. For example, Cokayne et al. (2024) argues that macro prudential policy should be delegated to an independent authority that can look beyond short-term effects. Indeed, this paper argues that macro prudential policy is able to increase household welfare, measured in terms of higher consumption, in the long run, while the negative effects of lower credit inclusion of households are only temporary. Other scholars support the integration of macro prudential and monetary policies for various reasons: first, because there is a strong interdependence between macro prudential and monetary policies; second, because of the information gains deriving from the fact that data and information from one policy area can be used as input for the other policy; and because the two policies affect each other, for example, because reducing debt decreases output and inflation, which are the main variables controlled by central banks (Malovaná et al., 2023; Rubio and Carrasco-Gallego, 2014). Crowe et al. (2012) argues that macro prudential policies should be used alongside monetary policy decisions, not apart from them, because they affect borrowing and real activity and thus influence future monetary policy actions. Furthermore, Anwar et al. (2023) suggests that combining macro prudential and monetary policies can effectively manage credit risk and improve financial stability. Their paper analyses the Indonesian context, using non-performing loans (NPLs) as a proxy for credit risk. The findings show that tight monetary policy raises lending rates, increasing the likelihood of default in the long run, while in the short run the increase in the policy rate can reduce leverage and the possibility of defaulting on loans. Conversely, tighter macro prudential policies reduce lending and NPLs in the long run, suggesting a possible combination of the two policies. Boscá et al. (2024) show that tight macro prudential policy can lead to lower debt at the cost of lower output and inflation. Their results suggest that coordinating macro prudential policy with expansionary monetary policy can neutralise the negative effects of macro prudential policy on inflation, output and taxes, thereby enhancing overall economic stability. Moreover, welfare can be improved when anti-cyclical fiscal policy is paired with macro prudential measures, or when macro prudential policy works in tandem with expansionary monetary policy, reducing the financial instability arising from accommodative monetary policy (Carvalho and Castro, 2017; Malovaná and Frait, 2017; Lorenčič and Festić, 2021; Fernandez-Gallardo, 2023).

Other strands of the literature analyse the redistributive effects of macro prudential measures. Koedijk et al. (2018) sustains the importance of taking inequality into account in macro prudential measures, as ignoring it may undermine the effectiveness of macro prudential measures in reducing financial instability. Some papers argue that macroprudential measures can benefit the stability of the financial system and reduce inequality, as demonstrated by the agent-based model in You et al. (2024). However, Frost and Van Stralen (2018) document that certain lender-based tools (e.g., interbank exposure and concentration limits) correlate with higher Gini coefficients, consistent with adverse spillovers working through tighter credit supply, weaker investment and slower wage growth for more vulnerable workers. In the same spirit, Teixeira (2023) finds that macroprudential tightening can increase unemployment and depress labour income, amplifying income inequality even when wealth effects are muted, highlighting that who is marginally constrained (small firms vs. large, low-wage vs. high-wage workers) matters for distributional outcomes.

Although our model lacks the housing market and we focus on income inequality, a large part of the literature focuses mainly on wealth inequality. We briefly summarise some of the findings. Yun et al. (2024) show that easing LTV/DTI worsens wealth inequality; instead, contractionary measures reduce inequality because higher borrowing costs reduce speculative activity in the housing market, thereby narrowing the wealth gap. Conversely, uniform tightening that affects first-time and low-income buyers more than investors can restrict entry and increase inequality (Carpantier et al., 2018; Park and Kim, 2023; Gatt, 2024; Georgescu and Martin, 2024). Thus, the effects on wealth inequality can vary depending on which households are affected the most, as pointed out in Tarne et al. (2022). As suggested by Punzi and Rabitsch (2018), selective LTVs focused on highly indebted borrowers generate welfare gains without depressing consumption among the less indebted.

To sum up, the first strand of the literature emphasises the crucial role of macro prudential policies in reducing financial risks, often examining their impact on macroeconomic variables such as growth and inflation. The second strand debates whether it is more effective to have separate authorities for monetary and macro prudential policies or to integrate them. The third strand of the literature focuses on the contentious issue of macro prudential policies and inequality, with some scholars arguing that these policies help to reduce economic disparities, while others suggest that they may exacerbate inequality. In our view, the three strands of the literature, each one stressing a relevant aspects regarding macroprudential regulation, should be considered all together, which is what we propose in our paper. In particular, we provide a calibrated model-based simulation analysis of macroprudential regulation, then combined with monetary policy, which stresses not only the financial stability side of the story but includes also inequality issues.

[1] In our work, financial stability for households is defined as their ability to repay their debts, and is measured as a percentage of non-performing loans (NPLs) compared to the total amount of household debt.

2. Data and methodology

The model proposed in this paper is calibrated using macro- and micro-level data to provide realistic model dynamics and inequality measures (e.g. Palma ratio, Gini index, income and wealth shares for the top and bottom of the gross income distribution), then implementing policy experiments on macrorpudential regulation and monetary policy to investigate the impact on inequality and financial stability.

2.1. Survey of annual social and economic supplements

The 2023 Annual Social and Economic Supplements (ASEC),[2] conducted annually by the United States Census Bureau, provides micro-level data on the labour force, including supplementary data on work experience, earnings, noncash benefits, and migration. This dataset is used to obtain a wage distribution useful for ex ante calibration, i.e. to initialise the model with a wage distribution drawn from real data. It is also used to obtain an empirical gross income distribution to test whether the baseline simulated scenario is able to reproduce real-world measures of gross income inequality, thus providing an external validity exercise.

2.2. Macroeconomic data

The Occupational Employment and Wage Statistics (OEWS)[3] is a comprehensive set of data from the U.S. Bureau of Labor Statistics that provides detailed annual employment and wage estimates for approximately 830 occupations. These estimates cover various geographical levels, including national, state, metropolitan and non-metropolitan areas. It is used in the ex-ante calibration to include a realistic number of blue-collar, white-collar and top workers demanded by the private sector. The other parameters are calibrated using macro data from FRED,[4] as shown in Table 2.

2.3. Model description

The simulation model represents five sectors of the economy: households, non-financial corporations (NFCs), commercial banks (CBs), the shadow banking system – consisting of special purpose vehicles (SPVs) –, three types of investment funds (IFs), the government, and the central bank.

The household sector is a heterogeneous sector composed of H different families. Each household unit differs from the others in terms of its main source of income, that is wages and financial incomes, such as returns on shares and dividends distributed by both the financial and non-financial firms.[5] At the beginning of each simulation, households receive a wage randomly drawn from an empirical distribution of wages taken from the 2023 ASEC, in order to start with a distribution of actual data. In the following period, wages change due to labour market dynamics: if a household was employed in the previous period, the current wage will increase, while it will decrease if the household was unemployed in the previous period (Riccetti et al., 2015; Faberman et al., 2022; Fluchtmann et al., 2024). In addition, households' wages will change according to the unemployment rate in the economy, the higher the unemployment rate the lower the wage for all households following a Phillips curve (Blanchflower and Oswald, 1995; López-Villavicencio and Saglio, 2017; Eser et al., 2020). They then calculate their disposable income, which is made up of wages and financial income, considering also the payment of interest and the repayment of loans. They then decide on the desired consumption of energy, which is the basic need, and then on the desired consumption of the homogeneous non-energy good, following a hierarchical consumption strategy (Lavoie, 2022). The consumption for the energy good is based on the wealth share of the households, because wealth also includes houses and can be used as a proxy for housing, so that the richer households spend more on energy, as they tend to live in bigger houses and have high intensive consumption habits (Huebner et al., 2015; Kelly, 2011; Santin, 2011). Households then define their desired portfolio allocation based on their wealth between deposits and IF shares. Richer households tend to invest in high-risk IFs, the middle class in intermediate-risk IFs and lower-income households in low-risk IFs. When households' disposable income does not cover their consumption and portfolio allocation purposes, they need a loan from the banking sector. If the household obtains the required loan, its desired expenditure becomes effective, otherwise it has to adjust it (see Appendix A.3).

The NFFs sector defines the number of workers needed to produce and allocates them to top managers, white, and blue collars, based on calibrated shares of top, white and blue collars elaborated from OEWS data. The NFFs sector invests on the basis of profit share, capacity utilisation and animal spirits. The higher the profit share, and the closer the NFFs sector is to the maximum use of productive capital, the higher the investment. Then, the NFFs can calculate revenues (sum of households, firms and government expenditure) and calculate their profit. Part of the profit is distributed in the form of dividends to households based on their share of wealth.

The commercial banking sector creates money endogenously by lending to the private sector. In terms of lending to households, the commercial bank decides whether or not to grant a loan based on the household's creditworthiness: a household is eligible for a loan if its specific debt service-to-income ratio ($dti_{i,t}$) is below a certain threshold defined by policy makers (DTI_t) and if the household's overall indebtedness (including the new requested loan $hhIndebt_{i,t}$) over disposable income is less than the bank's propensity to lend (Ψ_t). The latter element is based on the bank's risk assessment: if bank's capital is lower than that required by the Basel Accord, the bank reduces the amount of credit it grants, and vice versa. For the sake of simplicity, the banking sector always lends to the NFFs sector, which is then not rationed by construction.

The government hires workers, pays unemployment benefits and makes public expenditure and receives receipts in the form of taxes on wages for the household sector and on profits for financial and non-financial corporations.

The IF sector is a heterogeneous sector consisting of low, medium and high risk IFs, which attract different types of investors. In general, this kind of shadow bank entities raises funds from wealthier households and uses them to build portfolios of financial assets. This way it may finance the whole financial system through the purchase of ABS and through repo agreements. In this simulation model, the IF sector raises funds from households that buy IF shares (high- and middle-income households) and uses them to build portfolios of bonds and risky financial assets such as CDOs. In particular, high-risk IFs generate portfolios of CDOs only, medium-risk IFs use both government bonds and CDOs to construct their portfolios, while low-risk IFs invest in safe assets, i.e. only in government bonds. The choice of medium-risk IFs is based on the spread between the return on risky and non-risky assets. The IF sector issues shares and decides to adjust the amount of shares issued and the price based on the excess demand of the previous period.

[2] https://www.census.gov/data/datasets/2023/demo/cps/cps-asec-2023.html

[3] www.bls.gov/oes

[4] https://fred.stlouisfed.org/

[5] Different skill levels of households present in the economy and different proportions of top-levels, white and blue collars required by the public and private sectors are functional to allow the model to endogenously generate inequality. For example, the share of white collars and top-levels workers for both sectors is higher than the share of households present in the economy, leading to lower unemployment rates for these categories of households relative to the blue collars, who are then more exposed to unemployment and thus receive less labour income, spreading inequality.

IFs use the return on bonds and CDOs to pay the return on IF shares to households holding shares in proportion to their IF share quota.

The SPV sector allows for the securitisation process to be included in the model. Securitisation is an important feature in the real world that can generate heterogeneous income flows, which are relevant when studying inequality. In fact, securitisation can have both positive and negative effects on inequality: on the one hand, it allows for larger lending, which can reduce inequality; on the other hand, it can lead to excessive accumulation of financial income in richer households, which increases inequality. Indeed, the securitisation process allows banks to sell part of their loans to SPVs, which repackage them into structured financial products (CDOs) that are bought by IFs. According to this structure, the interest on the loans paid by the indebted households (usually middle- and low-income households) goes to the SPVs, and the SPVs use it to pay the interest on the CDOs to the IFs, and the IFs in turn use the return on the CDOs as part of the return on IFs's shares, held by richer households. This link creates a flow of resources from the poorest to the richest households and so can increase inequality (Botta et al., 2015, 2020, 2021). Thus, to study inequality, it is fundamental to investigate the interaction between the positive and negative effects of securitisation on inequality.

The main equations for each sector are given in Appendix A. The sequence of events is as follows:

- The government randomly hires the civil servants.
- The NFFs sector buys energy and determines the actual level of production using energy, labour and capital as inputs to produce a homogeneous consumption good.
- The NFFs system calculates the labour demand and determines the desired number of top managers, white collar and blue collar.
- Households receive wages that may decrease if the household was unemployed in the previous period or if the unemployment rate in the economy is higher. Households that are unemployed in the current period receive an unemployment benefit paid by the government.
- Households receive financial income in the form of dividends and returns on shares from the financial and non-financial corporations sectors, based on their share of wealth.
- Households calculate their disposable income and devote their budget to energy and non-energy consumption as well as to the portfolio allocation between precautionary deposits and IF shares. They may ask a loan from the banking sector, which decides whether or not to grant the loan.
- The NFFs sector makes investments and calculates revenues, profits and external financial needs, if any.
- Government makes public expenditure, collects taxes and issues bonds to cover the public deficit.
- The IFs sector decides to increase or decrease the supply or the prices of IFs shares based on the excess demand of the previous period. Then, each IF (low, medium and high risk) makes its precautionary deposit and portfolio allocation. The IFs use the returns on bonds and CDOs to determine the return on IF shares that will go to households based on their quota of shares.
- The central bank sets the policy rate.

3. Model calibration

We create a simulation model to study the impact of a macro-prudential policy on household financial stability and on income, wealth and consumption inequalities. The macro-prudential policy adopted is a reduction in the DTI threshold set by policy makers to reduce the level of indebtedness. We then control for the impact of this policy on inequality. We contribute to the literature by proposing a possible policy solution with a macro-prudential policy integrated with a conventional expansionary monetary policy.

Before conducting our analysis, we want our baseline simulation to report reliable measures of inequality that are representative of the empirical data, so the initial parameters have been calibrated using a combination of direct and indirect methods.

3.1. Direct calibration

The direct calibration assigns values based on empirical data and existing literature. In particular, we set the parameters as they are in a highly-financialised economy like the United States, indeed they come from the FRED economic data[6] elaboration.

Similarly, the proportions of high-, middle- and low-skilled households are calibrated based on an elaboration of private and national workers taken from the Occupational Employment and Wage Statistics of the US Bureau of Labor Statistics (BLS).[7] The assignment of skill levels for each occupational title (e.g. Chief Executive Officers, General and Operations Managers, Architects, Production Workers, and Transportation Workers) is based on the average hourly wage paid by each occupational title: if it is above the second tertile, the occupation is considered high-skilled; if it is below the first tertile, it is defined as a low-skilled occupation; and if the wage is between these two terciles, it is defined as a medium-skilled occupation. In this way, it was possible to count the number of households employed in a low, medium and high skilled occupations. We use these results to calibrate the proportions of top level, white and blue workers for both public and private sector employed workers.

In addition, we initialise the model with a wage quota for each household derived from empirical data. Thus, we use an elaboration of the real wage distribution from the Current Population Survey, 2023 Annual Social and Economic (ASEC) Supplement conducted by the Bureau of the Census for the Bureau of Labor Statistics.[8] To increase the robustness of the analysis, we drop missing values and use a trimming procedure that excludes the 5% of income values from the tails. This decision was based on the observation that extreme values (e.g. wages equal to zero) could skew the results, thereby affecting the congruence between the empirical and simulated distributions. To maintain consistency and comparability between the two distributions, we then randomly sampled wages from the trimmed empirical distribution equal to the number of households. This sampling was performed 1000 times to construct a matrix of income distributions, with each column representing a different sample. The median income distribution across these samples was then calculated to provide a single representative empirical income distribution for subsequent analysis.

3.2. Indirect calibration

For parameters where direct calibration was not possible, we used indirect calibration techniques to set parameters to bring our inequality measure closer to empirical inequality measures such as the Palma ratio. We developed an iterative optimisation algorithm. This algorithm was applied specifically to the key parameters that influence inequality. The optimisation works by finding the key parameters that minimise the discrepancy between the simulated and real inequality metrics. For parameters less directly related to inequality (non-wage parameters), but crucial for determining the dynamics of economic growth, we used Latin Hypercube Sampling (LHS), efficiently exploring the parameter space within a plausible range. Specifically, the algorithm follows the following steps: first, at each iteration, a new set of non-wage parameters is generated using LHS within defined bounds. The wage parameters, on the other hand, are optimised using a pattern search algorithm with the aim of minimising a loss function. This loss function quantifies the difference between the simulated and observed

[6] https://fred.stlouisfed.org/series/TREAST#0

[7] https://www.bls.gov/oes/current/oes_nat.htm

[8] https://www.census.gov/data/what-is-data-census-gov/latest-releases/2023.html

inequality measures (income shares for the top 10%, 20% and bottom 40% and 20% of the income distribution and the Gini index). The model is run with the current parameter set and the inequality metrics generated with the parameters chosen by the algorithm are recorded. The process is repeated for a pre-defined number of iterations, with the results of each iteration stored in an external file for post-analysis.

4. Results

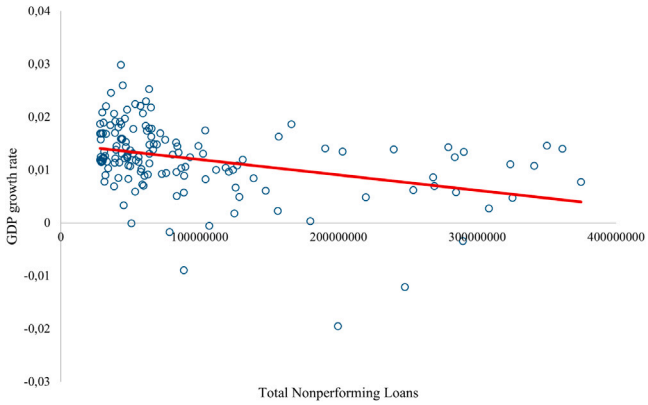
4.1. Validation results

The model effectively captures several key empirical phenomena, including the observed negative correlation between GDP and non-performing loans (NPLs), and the positive relationship between NPLs and inequality measures such as the Palma ratio. In addition, the model accurately reproduces real-world inequality indices.

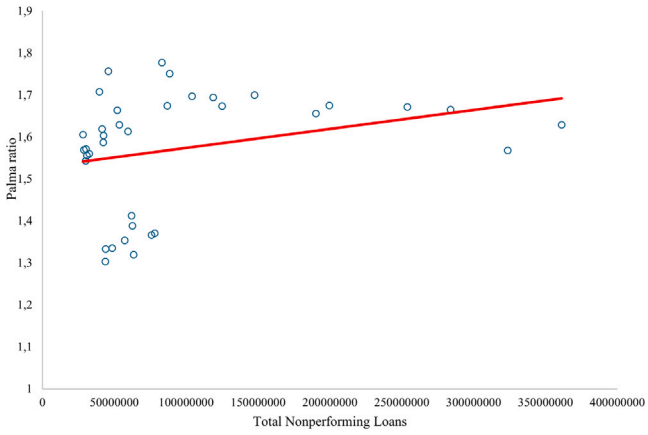
Figs. 1(a) and 1(b) illustrate the empirical correlations between GDP and NPLs and between NPLs and the Palma ratio, respectively. The data on NPL and GDP are taken from the Federal Reserve Economic Data (FRED) database, while the data on the Palma Ratio are taken from Our World in Data, with specific reference to the Luxembourg Income Study (2024).[9] Fig. 1(a) shows a negative correlation between GDP and NPLs, indicating that higher levels of NPLs are associated with slower economic growth. This relationship suggests a bi-directional causality: elevated NPLs can hinder economic expansion by restricting credit availability due to increased financial vulnerability, while economic downturns can exacerbate over-indebtedness among borrowers, leading to an increase in NPLs. Fig. 1(b) shows a positive correlation between NPLs and the Palma ratio. The positive correlation suggests two possible causal pathways. First, higher levels of inequality may lead lower-income households to accumulate debt, which could increase the incidence of NPLs. This is supported by literature suggesting that economic inequality can lead to increased borrowing by the less well-off, potentially leading to higher default rates. On the other hand, an increase in the number of non-performing loans may worsen economic conditions, thereby exacerbating inequality.

Fig. 2 shows the results of the simulation, demonstrating the model's ability to reproduce the empirical correlations between GDP and NPL, and between NPL and the Palma ratio. The simulation closely matches the observed data, demonstrating the ability of the model to replicate real economic dynamics. The simulation reports the empirical negative correlation and also reproduces the positive relationship between NPL and the Palma Ratio, suggesting that policies aimed at reducing NPLs could have the dual benefit of promoting economic growth and reducing income inequality. By matching simulation results with real data, the model provides a reliable framework for assessing the impact of macroprudential policies on financial stability and income inequality.

Table 1 shows simulated and real inequality indicators. The table shows how close simulation results are to the empirical values, validating the results of the analysis. In particular, we have calculated several key inequality measures to compare the empirical income distribution with the simulated results: The top 10% and 20% income shares were calculated by summing income for the top decile and quintile of the income distribution, respectively. These measures provide insight into the concentration of income among the highest earners. Similarly, the bottom 20% and 40% income shares were calculated by summing the income values of the bottom quintile and two quintiles respectively. The Palma ratio, a widely recognised measure of income inequality, was calculated as the ratio of the income share of the top 10% to that of the bottom 40%. This measure is particularly useful for highlighting disparities at the extremes of the income distribution. Finally, the Gini coefficient, which is a standard measure used in the literature, measures



(a) Correlation NPL and GDP growth rate



(b) Correlation NPL and Palma ratio

Fig. 1. Empirical correlations.
Note: The Panels show the empirical correlation between NPL and economic growth (left panel) and inequality (right panel).

how concentrated income is within a society.[10] The inequality metrics on empirical data are computed on a trimmed gross income distribution derived from the 2023 ASEC. We then randomly sampled from the trimmed empirical gross income distribution and repeated this process several times to obtain an income distribution matrix of sampled gross income. To ensure the robustness of the results, all inequality

[9] https://ourworldindata.org/grapher/palma-ratio-after-tax-lis?country=~USA

[10] The Gini index measures how concentrated income is within a society, but it does not tell us how that concentration is distributed across different income groups. A high Gini index may indicate high income inequality, but not whether the top 10% or the top 30% hold most of the income. This can be misleading because two countries with the same Gini index can have very different income distributions. Instead, following the work of Clementi et al. (2019), the Zanardi index would be a preferable measure of inequality because it takes into account both concentration and asymmetry of the income distribution. It gives values between −1 and 1; a value of −1 indicates that wealth is distributed in favour of the poor, while a value of 1 indicates that income is distributed favourably among the rich and unfavourably among the poor, giving a clearer sense of who is most affected by income inequality.

However, the Zanardi index may not be suitable for analysis due to its complexity, which requires detailed data on income distribution. In addition, its methodology is less familiar than the Gini index, which remains the most widely used measure in the literature because it is easy to calculate and provides a quick way to compare inequality. For these reasons we use the Gini index, but because of its limitations we also refer to inequality by studying changes in the shares of income, consumption and wealth held by those at the top and bottom of the income distribution.

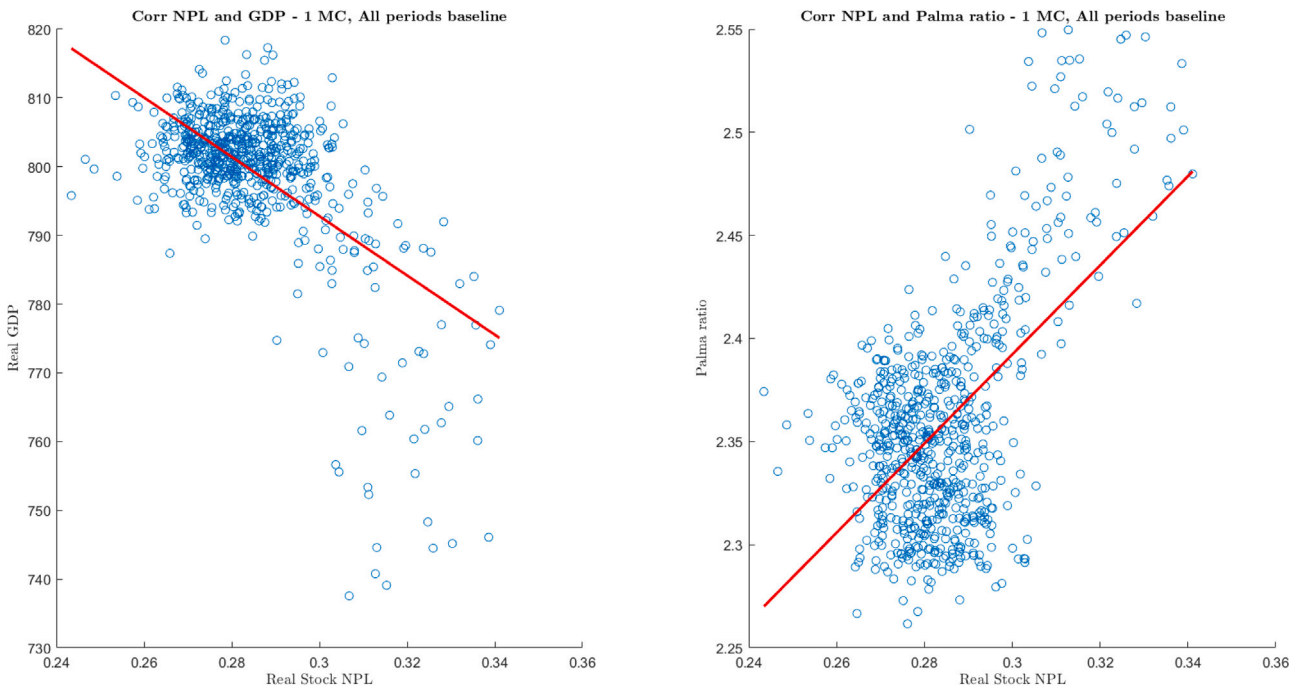


Fig. 2. Simulated correlations. **Note:** The Panels present the simulated correlation of NPL with GDP (left panel) and inequality (right panel).

Table 1
Comparison of inequality simulation results with real values.

Inequality metric	Simulation results	CIs simulation results	Real values
Share Top 10%	0.3612	0.3595 – 0.3629	0.3249
Share Top 20%	0.4929	0.4917 – 0.4943	0.4863
Share Bottom 20%	0.0652	0.0650 – 0.0656	0.0459
Share Bottom 40%	0.1580	0.1575 – 0.1585	0.1416
Palma Ratio	2.2931	2.2747 – 2.3032	2.2903
Gini Index	0.4338	0.4329 – 0.4348	0.4386

measures were computed for each sample in the income distribution matrix, and the median values of these sampled inequality measures are reported in the last column of Table 1. Instead, the simulated inequality metrics are derived as median values over multiple iterations, each generated as the median of bootstrapped Monte Carlo simulations. We focus specifically on the metrics obtained in the final period of the simulation. By isolating the last period, the potential biases that could arise from including transitional dynamics or fluctuations present in earlier periods are excluded. The close alignment of our simulation results with real-world values further validates the model's ability to replicate observed inequality dynamics, thereby enhancing the validity of our findings presented in the next subsection.

4.2. Policy experiment

We carry out two policy experiments: the first is a reduction in the DTI threshold fixed by the policy maker in order to contain the level of indebtedness in the economy; the second integrates macro prudential policy and conventional monetary policy, which in our analysis simply consists of a reduction in the policy rate. Indeed, the aim of the work is to study the impact of a macro prudential measure on financial stability and inequality, also considering a mix of policies capable of controlling both financial stability and inequality. Fig. 3 shows the general results of the two policy experiments in relation to the baseline scenario. Both policy experiments occur at time 450; before this period the first experiment is equal to the baseline scenario, so the ratio of the experiment to the baseline scenario is equal to one by construction until the shock occurs.

The first experiment activates the macro prudential measure, which is silent in the baseline scenario, setting the DTI threshold to 0.7%[11] at time 450 (red line). The police produces a reduction in output, an increase in unemployment and, consequently, a reduction in wages and inflation. It also expands the securitisation of loans, since the macro prudential policy reduces the number of loans issued and increases the proportion of households rationed. The overall effect is thus a contraction of the economy that raises the expenditure for the government.

The second experiment combines the reduction in the DTI threshold fixed by policy makers with a reduction in the policy rate by 45 bases points.[12] This scenario replicates almost the same results, but with a slightly smaller contraction of the economy. Significant differences emerge in terms of rationing and government expenditure, which exhibit lower values compared to the first experiment. There is also a slight improvement in unemployment relative to the DTI scenario, at least in the short term. The effect of the lower DTI has been offset by

[11] The DTI threshold is set to trigger the activation of macroprudential policy, but its specific value is neither calibrated to empirical data nor anchored in institutional parameters. Our analysis is therefore *qualitative*: we analyse the effects of (i) a standlone macro prudential measure and (ii) a macro prudential action combined with an expansionary monetary policy, while ensuring that some of the key outcomes – particularly inequality metrics – fall within realistic ranges. This work does not aim to provide a *quantitative* evaluation of macro prudential measures.

[12] In the baseline scenario, the policy rate was 0.8%, which was then lowered to 0.35%. These percentages were chosen to provide a realistic representation of key values of interest, such as inequality metrics.

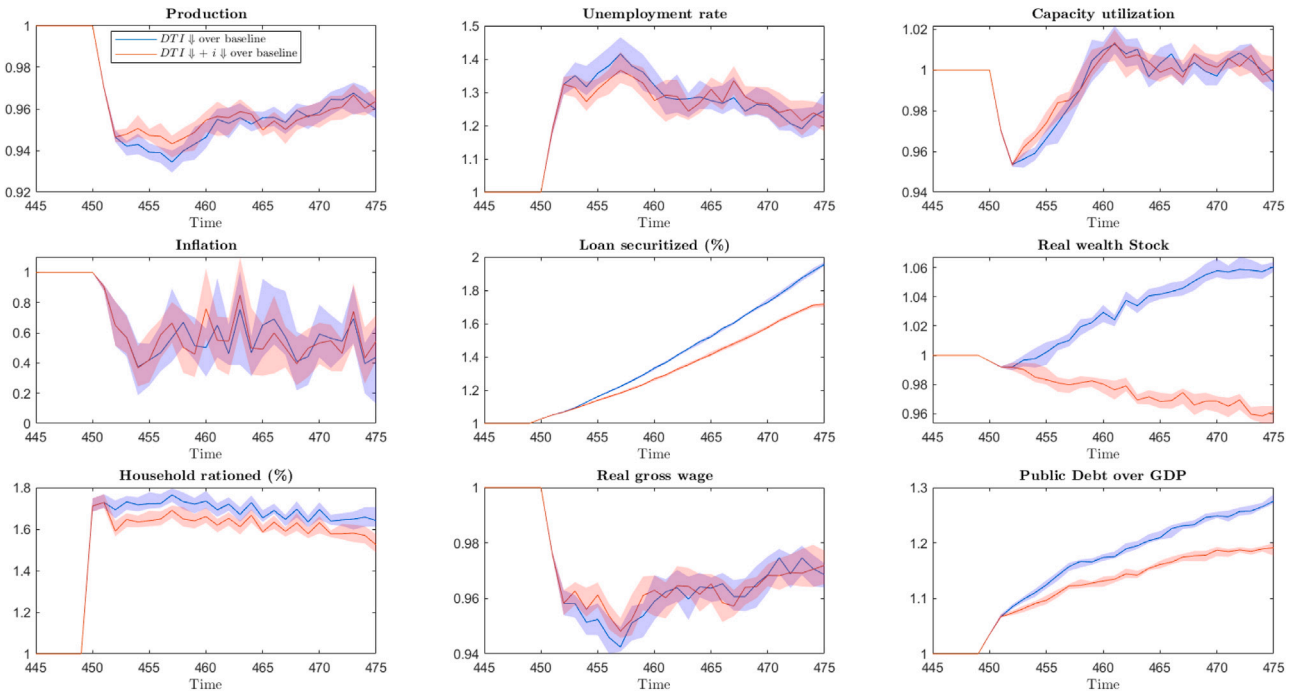


Fig. 3. Macro variables results.
Note: The Figure shows the effects of the two policy experiments relative to the baseline scenario on the main macroeconomic variables. The blue line expresses the scenario with a more restrictive debt service-to-income ratio relative to the baseline, while the red line expresses the joint effect of a macro prudential measure with an expansionary monetary policy relative to the baseline. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

the expansionary monetary policy; in fact, the macro prudential policy acts directly to reduce the indebtedness of households, especially those with an already high level of indebtedness, that is riskier households. On the other hand, the expansionary monetary policy counterbalances the credit contraction with lower interest payments for a wider range of indebted households and firms, leaving them with more income that they can use to consume and invest, taming the decline in consumption and economic growth.

Fig. 4 displays the impact of the two policy experiments on financial stability. The DTI-only experiment (blue line) successfully reduces the level of debt and then NPLs in the economy, but at the cost of a higher number of NPLs among the most vulnerable households, i.e. households with negative net worth (at least for the first 10 periods after the shock), compared to the second experiment.

Indeed, without additional stimulus to support employment and consumption, the contraction of the economy can be substantial. This is because macro prudential policies have a disproportionate impact on highly indebted households, which tend to be among the poorest and have the highest propensity to consume. As their consumption falls, aggregate demand in the economy falls, potentially triggering a broader economic downturn. This reduction in demand may also affect other households, leading to further loan defaults and an increase in non-performing loans.

In contrast, the policy mix used in this experiment not only reduces the debt levels of the most indebted and financially vulnerable households by tightening debt service-to-income ratios, but also mitigates this contractionary effect for other households and firms. As a result, households that are in a better position to repay their loans are more likely to do so than in the baseline scenario. So, it is possible observe a larger reduction in non-performing loans than in the scenario where only the DTI ratio is lowered.

With regard to income inequality, the implementation of macro prudential policies has important distributional consequences. Reductions in the DTI limit borrowing capacity, especially for low-income households that rely heavily on credit to smooth consumption. As a result, these households face reduced access to credit, leading to a sharp contraction in their consumption demand. This contraction in demand exacerbates unemployment, which particularly affects middle- and low-income households. As a result, labour income falls, especially for the poorest households, contributing to a widening gap in disposable income between lower and higher income groups. This dynamic is illustrated by the blue line in Fig. 5, which shows a decline in income shares for the lower income segments. In addition, financial incomes are directly impacted by the reduction in borrowing. As the DTI policy tightens borrowing conditions, overall loan issuance declines, leading to a reduction in interest payments on loans. This, in turn, lowers the returns on financial assets, particularly for high- and middle-income households, as their returns are linked to the interest payments through the securitisation process. In the short term, middle- and high-income households experience a dip in financial inflows due to the decrease in interest payments, resulting in a temporary decline in their income share during the first three periods. Over time, however, the wealthiest households recover as the credit squeeze disproportionately affects middle and lower income groups. Thus, the poorest households bear the brunt of the credit squeeze and rising unemployment, while middle-income households suffer from reduced access to credit and lower financial returns. As these groups face greater financial constraints and higher unemployment, income becomes increasingly concentrated in the hands of the wealthy, as shown by the recovery of the income share of the top 10% and 20% of earners after the first three periods, as in the last raw in Fig. 5, and as highlighted by the higher values of both the Gini index and the Palma ratio.

When macro prudential policy is complemented by expansionary monetary policy, the impact on income inequality becomes more balanced and less severe. Lower interest rates ease the financial burden on middle- and low-income households by reducing debt servicing costs, which helps to partially restore disposable income that had been

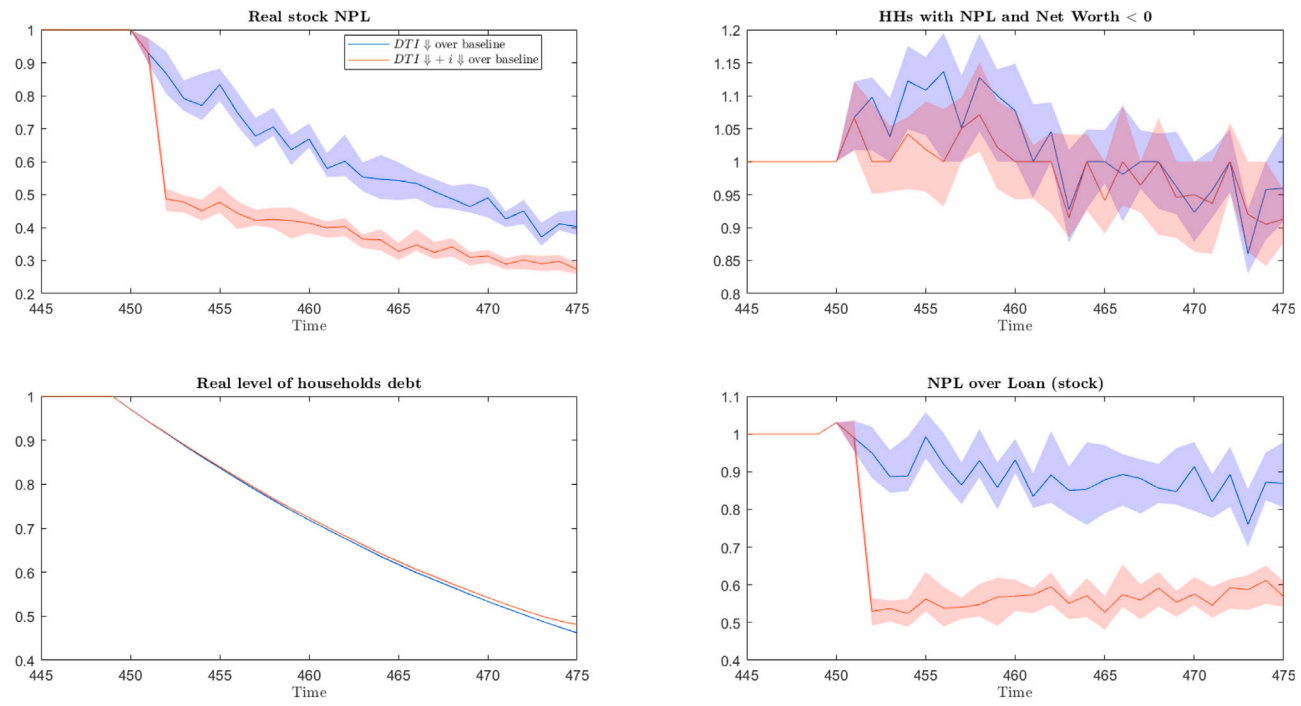


Fig. 4. Financial stability results.
Note: The Plot reports the effects of the two policy experiments relative to the baseline scenario on financial stability variables. The blue line expresses the scenario with a more restrictive debt service-to-income ratio relative to the baseline, while the red line expresses the joint effect of a macro prudential measure with an expansionary monetary policy relative to the baseline. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

reduced by unemployment and credit constraints. This recovery is thus particularly important for less well-off households, which are more sensitive to changes in borrowing costs. Moreover, the policy mix limits credit contraction and supports economic growth, reducing unemployment in the short therm and increasing labour income for middle- and low-income households. This leads to a reduction in income inequality compared to the DTI-only scenario, as middle and lower income groups benefit from lower interest payments and higher labour income. Their income shares stabilise closer to baseline levels. At the same time, wealthier households see their financial advantages diminish as lower interest rates reduce their income from structured financial products. The result is a fall in disposable income for the top 10% and 20% of earners, as shown by the red line in Fig. 5. Overall, the combination of macro prudential and expansionary monetary policies leads to a reduction in income inequality, as reflected in the lower Gini index and Palma ratio (red line).

The impact of macro prudential and monetary policy is also evident in the shaping of consumption inequality across income groups (Fig. 6). Both the DTI-only scenario and the combination of macro prudential and expansionary monetary policies lead to higher consumption inequality than in the baseline. This is because DTI restrictions reduce lending, which disproportionately affects middle- and low-income households that rely more on borrowing, thereby reducing their share of consumption and increasing inequality.

The policy mix results in a more balanced distribution of consumption across income groups. While consumption inequality still increases relative to the baseline, lower interest rates help mitigate the negative impact of the DTI policy on the poorest households. Indeed, the reduction in credit availability is less severe in this scenario, leading to lower unemployment in the short therm and higher labour income for low-income households, allowing them to maintain relatively higher consumption levels compared to the DTI-only scenario. In addition, lower interest payments increase the disposable income of middle- and low-income households, leading to higher consumption. Although lower interest rates do not fully offset the negative effects of the DTI restrictions, anyway they mitigate them so that consumption falls less for low-income households than in the DTI-only scenario.

The effect of macro-prudential policy on wealth inequality does not seem to produce statistically significant changes in wealth accumulation, [13] except for the period in which the shock occurs, in which there is a decrease in the wealth share for the bottom part of the distribution. On the other hand, the decrease in the share for the bottom generates a small increase in wealth accumulation for the top of the income distribution (see Fig. 7).

The policy mix scenario, on the other hand, bring about a smaller increase in share for the top of the income distribution. This is because the poorest households have more disposable income to accumulate wealth due to lower interest payments and lower unemployment compared to the DTI-only scenario, leading to a weaker accumulation in the hands of richer households.[14]

4.3. Sensitivity analysis

This section replicates the policy mix experiment (DTI tightening plus monetary easing) to assess how the results vary depending on the size of the reduction in the policy rate. Three variants of the policy mix

[13] This is probably due to the limitation of not including a housing market in the model.

[14] We repeat the simulation experiments with homogeneous IFs (the medium-risk ones only) and the results show no significant changes in terms of macroeconomic dynamics. The only difference was found in wealth inequality, which shows a higher wealth share for the bottom 20% of the income distribution in the homogeneous IF sector scenario. Thus, we can conclude that the heterogeneous IF sector seems to affect mainly the poorest households in terms of wealth inequality, because in this scenario, according to the real world, they tend to invest in low-risk IFs, which pay lower returns on their shares.

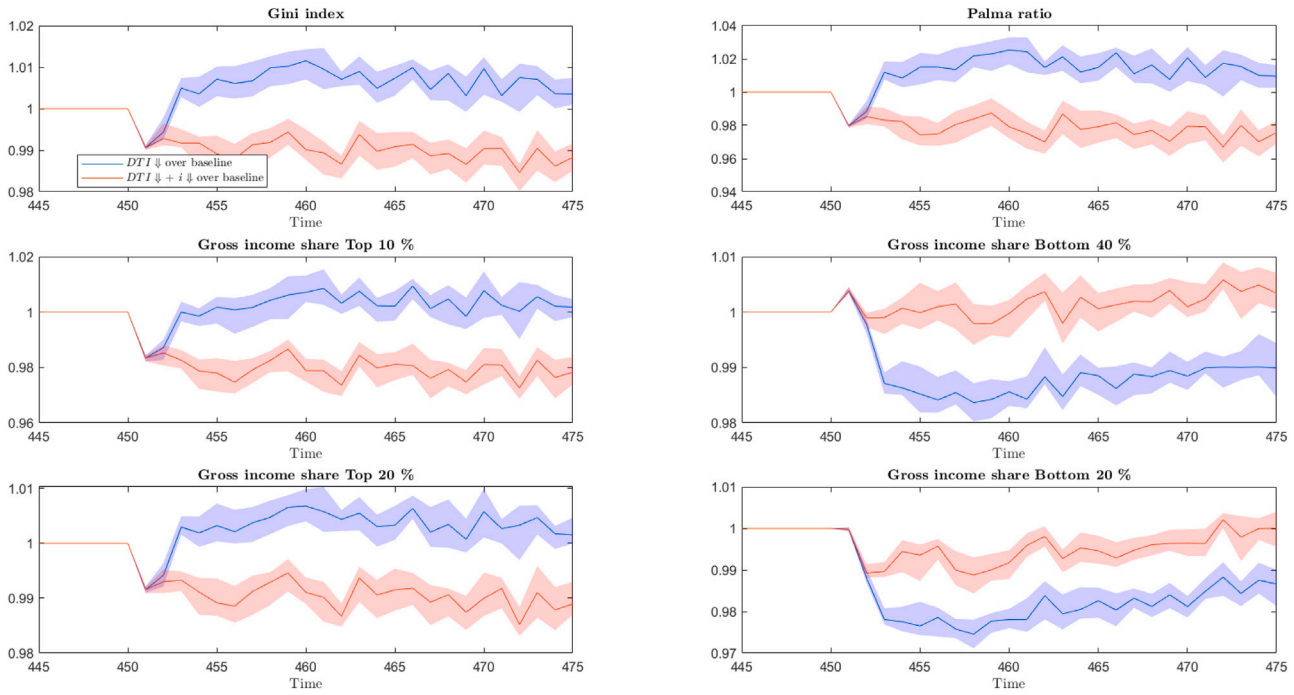


Fig. 5. Income inequality results.
Note: The Figure shows the effects of the two policy experiments relative to the baseline scenario for income inequality measures. The blue line expresses the scenario with a greater restriction on the debt service-to-income ratio relative to the baseline scenario, while the red line expresses the joint effect of a macro prudential measure with an expansionary monetary policy relative to the baseline. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

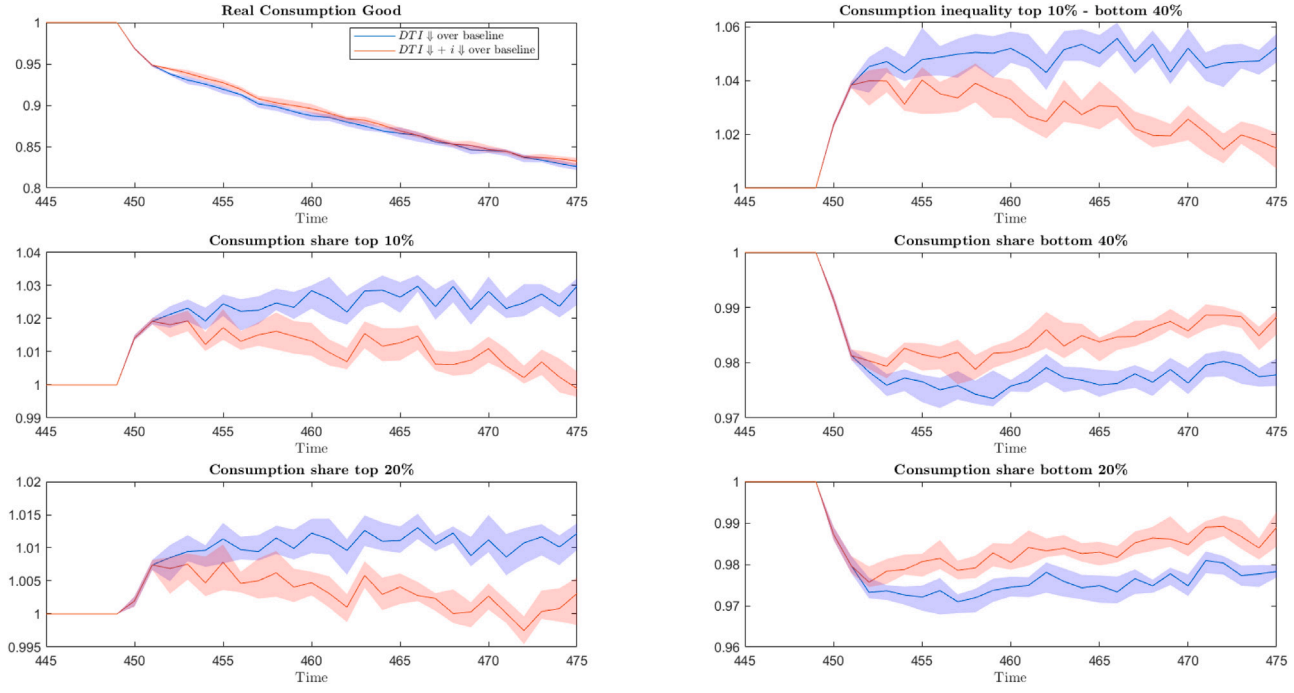


Fig. 6. Consumption inequality results.
Note: The Graph shows the effects of the two policy experiments relative to the baseline scenario on real consumption and measures of consumption inequality. The blue line expresses the scenario with a more restrictive debt service-to-income ratio relative to the baseline, while the red line expresses the joint effect of a macro prudential measure with an expansionary monetary policy relative to the baseline. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

are compared: the benchmark reduction of 45 basis points (red, as in the main results), a smaller cut of 30 basis points (green) and a larger cut of 70 basis points (purple). We plot only the policy-mix scenarios to isolate the role of the rate cut. The figures show only the policy mix experiment relative to the baseline scenario, useful for comparing the direction of the effects of different reductions in the policy rate.

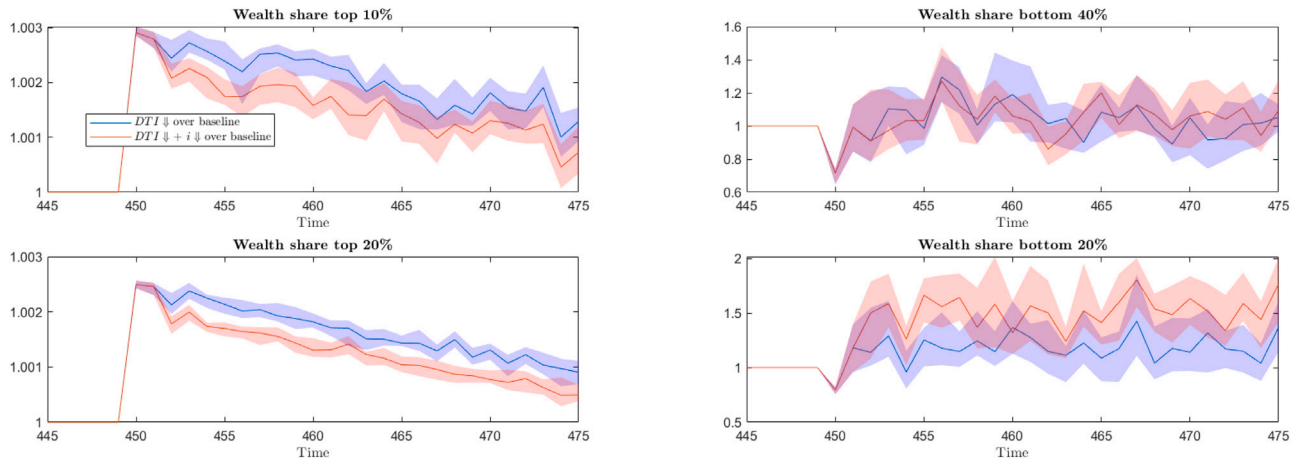


Fig. 7. Wealth inequality results.
Note: The Picture shows the effects of the two policy experiments relative to the baseline scenario for wealth inequality. The blue line expresses the scenario with a greater restriction on the debt service-to-income ratio relative to the baseline, while the red line expresses the joint effect of a macro prudential measure with an expansionary monetary policy relative to the baseline. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

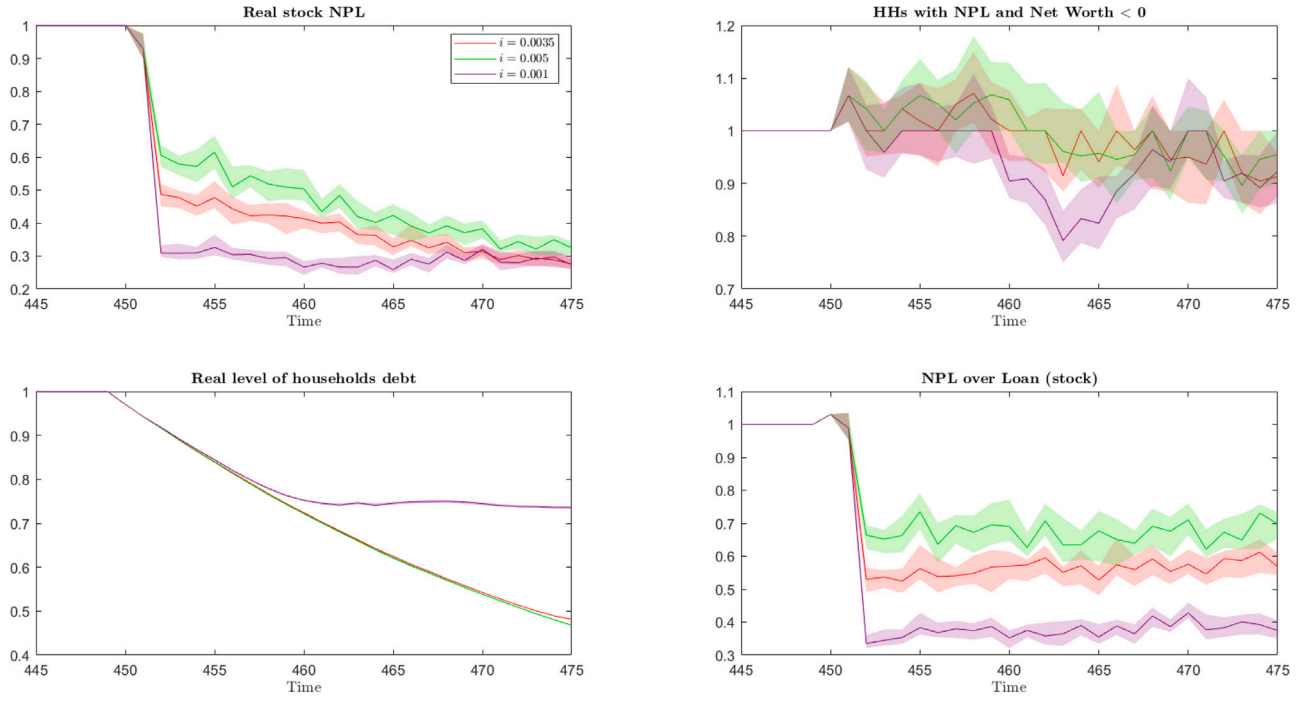


Fig. 8. Financial stability results.
Note: The figure shows the effects of three simulation scenarios for the policy mix, which use different reductions in the policy rate relative to the baseline scenario, on households financial stability. The red line shows a 45 bps reduction in the policy rate, the green line shows a 30 bps reduction, and the purple line shows a 70 bps reduction. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Across all variants, tightening the DTI ratio lowers aggregate debt and reduces NPLs. A deeper policy-rate cut does not undermine this improvement; a greater reduction in debt servicing burdens reduces household financial instability, so both the level and the NPL-to-loans ratio fall relative to the baseline in every policy mix (Fig. 8).

Fig. 9 show how a smaller reduction in the policy rate (green line) can also mitigate the negative impact on income inequality. A larger cut (purple) has an even greater effect: not only does it recover short-term income losses for the bottom 40% and 20%, it also improves their income shares via stronger employment and reduced credit rationing (Fig. 13 in Appendix C). Combined with lower interest payments, this raises disposable income, especially for low-income households (Fig. 9).

The same mechanisms apply to consumption. The larger cut (purple) delivers the strongest medium-term mitigation of consumption inequality by sustaining employment and reducing the cost of debt servicing on existing loans. This increases the consumption of the bottom 40% and 20% beyond the losses caused by tighter DTI as shown in Fig. 10.

Short-term patterns of wealth inequality are similar across the three variants (Fig. 11). Over time, the larger cut (purple) reduces the accumulation of wealth by the top group by lowering the returns on interest-linked financial assets (CDOs), while increasing the accumulation of wealth for middle- and low-income groups. However, these results should be interpreted with caution, as our model does not consider the role of the housing sector in wealth dynamics.

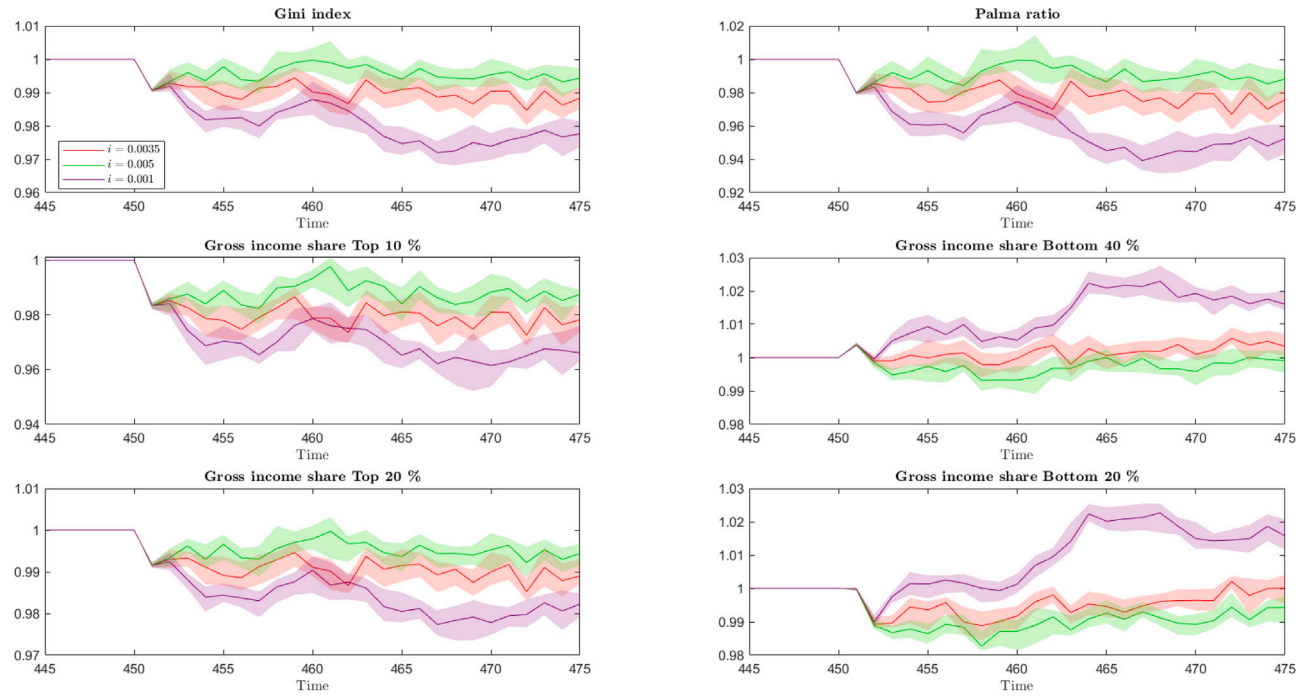


Fig. 9. Income inequality results.
Note: The figure shows the effects of three simulation scenarios for the policy mix, which use different reductions in the policy rate relative to the baseline scenario, on income inequality measures. The red line shows a 45 bps reduction in the policy rate, the green line shows a 30 bps reduction, and the purple line shows a 70 bps reduction. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

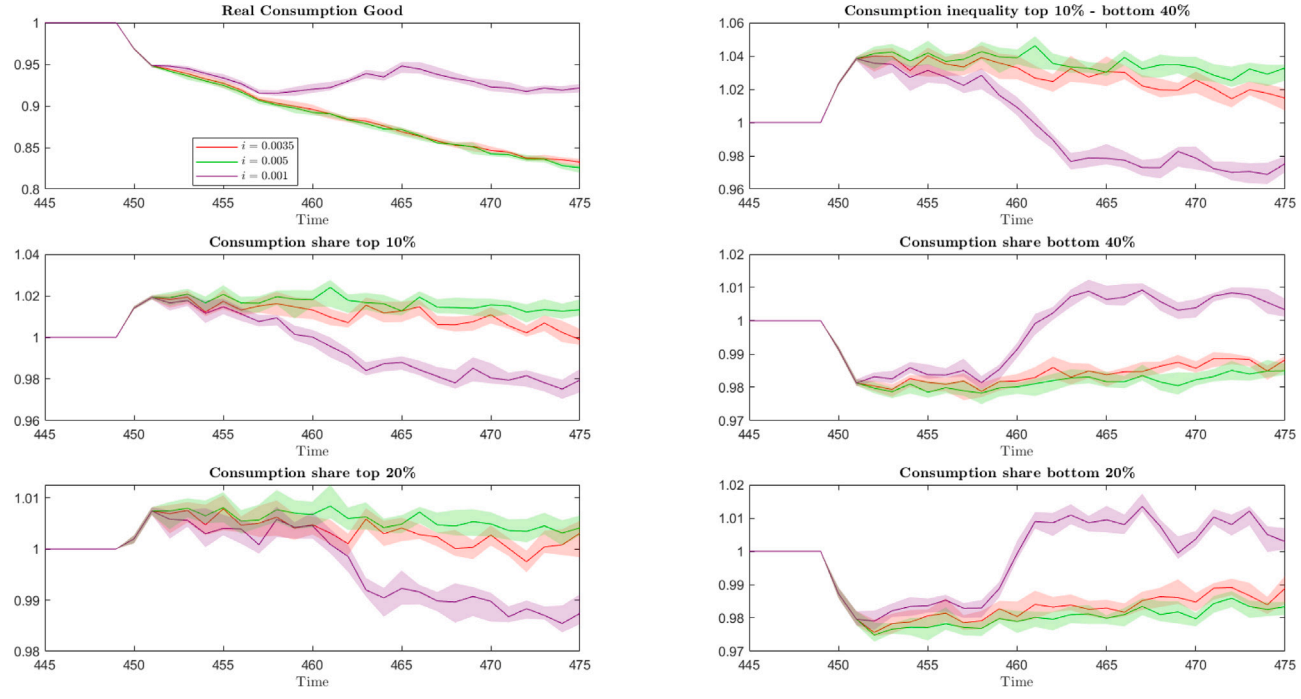


Fig. 10. Consumption inequality results.
Note: The figure shows the effects of three simulation scenarios for the policy mix, which use different reductions in the policy rate relative to the baseline scenario, on consumption inequality. The red line shows a 45 bps reduction in the policy rate, the green line shows a 30 bps reduction, and the purple line shows a 70 bps reduction. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

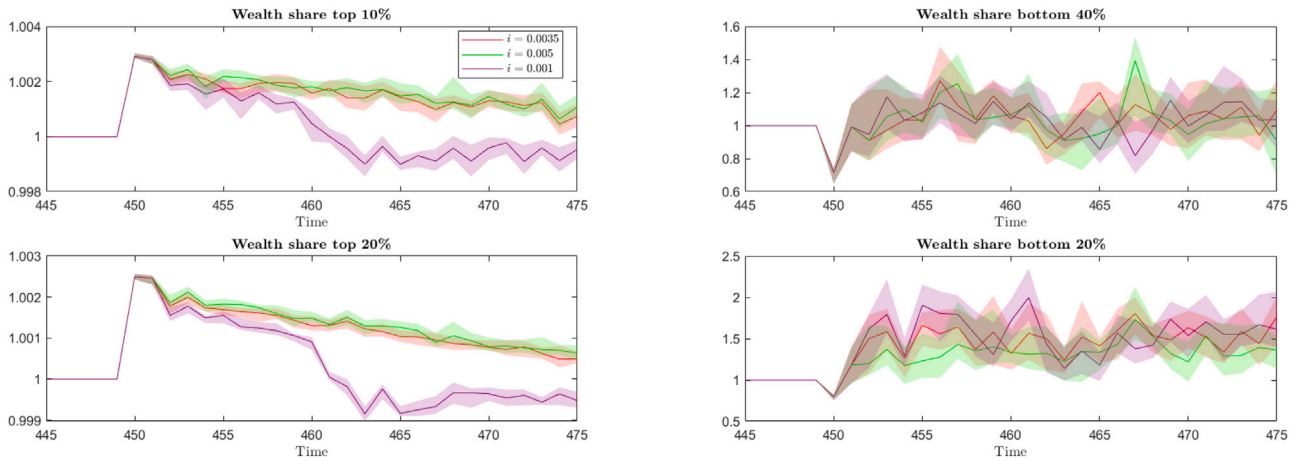


Fig. 11. Wealth inequality results.
Note: The figure shows the effects of three simulation scenarios for the policy mix, which use different reductions in the policy rate relative to the baseline scenario, on wealth inequality. The red line shows a 45 bps reduction in the policy rate, the green line shows a 30 bps reduction, and the purple line shows a 70 bps reduction. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

5. Conclusions

This paper contributes to the ongoing debate on the impact of macro-prudential policies by bridging three critical strands of the literature: the relationship between these policies and financial stability and their broader socio-economic implications, in particular on inequality, while analysing a possible policy integration between macro prudential measures and monetary policy.

Our study finds that while DTI cuts are effective in reducing household indebtedness and NPLs, they also lead to an economic contraction, characterised by lower consumption and higher unemployment, which disproportionately affects lower- and middle-income households. These groups, which rely on credit for consumption smoothing, experience a significant drop in consumption, leading to a widening of income, wealth and consumption inequalities.

However, when macro prudential measures are combined with expansionary monetary policy the negative effects are mitigated. Lower borrowing costs help to offset the contractionary impact of DTI restrictions, allowing middle- and low-income households to avoid heavy losses in disposable income and consumption, thereby reducing inequality gaps relative to a DTI-only scenario. Therefore, this policy mix not only supports financial stability by reducing NPLs, but also prevents a severe economic contraction, thereby promoting a more equitable distribution of resources.

The model's ability to replicate empirical phenomena – such as the negative correlation between GDP and NPLs, and the positive correlation between NPLs and inequality measures such as the Palma ratio – is a result of both direct and indirect calibration through the optimisation algorithm, underlining the robustness of the study's findings.

In conclusion, the results suggest that a coordinated policy approach that balances macro prudential measures with expansionary monetary policy can mitigate the trade-offs between financial stability and socio-economic outcomes. This combination improves economic welfare by supporting economic growth and reducing inequality.

Despite the strength of these findings, a key limitation of this study is the exclusion of the housing market, which prevents an analysis of loan-to-value (LTV) policies and their broader effects. Future research should also include the housing market to provide a more comprehensive analysis, particularly with regard to housing purchases and price dynamics, which are important factors in controlling wealth inequality.

CRediT authorship contribution statement

Samantha Coccia: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mauro Gallegati:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Alberto Russo:** Writing – review & editing, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Model equations

A.1. The firm sector

This section contains the main equations for the enterprise sector, which describe the behaviour of enterprises in terms of production, hiring, and sources of finance. The firm sector produces a homogeneous good with a Leontief production function. Thus, output y_t is the minimum of expected firm output y_t^e and potential output y_t^p. Expected output is adjusted on the basis of the excess demand index from the previous period $EDindex_{t-1}$ as in Eq. (1).

$$y_t^e = y_{t-1}^e \times (\text{parEDindex} + EDindex_{t-1}) \tag{1}$$

The firm's potential output y_t^p is the minimum of capital, labour and energy-based capacities. Then, following the Leontief production function, the firm's output is determined as the minimum of expected and potential output:

$$y_t = \min(y_t^e, y_t^p) \tag{2}$$

The firm's desired number of workers $N_t^{workers*}$ is based on the level of production and labour productivity:

$$N_t^{workers*} = \frac{y_t}{ProdLav_t} \tag{3}$$

The actual number of workers $N_t^{workers}$ is constrained by the available labour force. Then the firm's demand for labour is divided between blue-collar, white-collar and top-level workers and is constrained by the number of blue-collar, white-collar and top-level workers already in the economy.

The firms sector makes investment according to Eqs. (4)–(7)

$$K_t^r = \gamma_1 \times \Pi_{t-1}^{sh} + \gamma_2 \times (CapacityUtilization_{t-1} - 0.8) + \gamma_3 \tag{4}$$

$$I_t = K_{t-1} \times K_t^r \tag{5}$$

$$I_t^{net} = I_t - \delta \times K_{t-1} \tag{6}$$

$$K_t = K_{t-1} + I_t^{net} \tag{7}$$

In Eq. (4), K_t^r is the capital growth rate of the firm, Π^{sh} is the profit share of the firm, and the parameters γ_1 and γ_2 are positive parameters, in particular γ_3 is the parameter for investments driven by animal spirits.

The total revenue and firm profit are computed as in the equation:

$$FirmRevenues_t = C_t + Pl_t \times I_t + PublicPurchases_t \tag{8}$$

where $C_t = \sum_{i=1}^{N} c_{i,t}$ is the sum of the consumption of all households, I_t are the investment realised by the NFFs sector. The value added of the enterprise is the difference between revenue and energy costs, while the gross profit of the enterprise is calculated by subtracting the labour costs from the value added as in Eq. (9)

$$\Pi_t^o = FirmValueAdded_t - Wage_t \tag{9}$$

Then the net profit Π_t is the gross profit minus taxes and interest payments on loans; if the firm makes a positive net profit, it distributes dividends and the remaining profit is used as internal funds for investment and precautionary deposits. If additional funds are needed, the firm borrows from the commercial banking sector and obtains loans. For the sake of simplicity, the NFF system is not rationed.

$$div_t^{NFF} = \rho^{NNF} \times FirmNetProfit_t \tag{10}$$

A.2. The investment funds (IFs)

The investment fund (IF) sector consists of three heterogeneous types of funds: low-risk (LR), medium-risk (MR) and high-risk (HR). These funds decide with random probability to adjust their supply of shares or prices based on excess demand from households. For example, if there was excess demand in the previous period, the funds may decide to increase the supply of shares or their prices in the current period as in Eqs. (11) and (12).

$$ShareStock_t^{LR^s} = ShareStock_{t-1}^{LR^s} + \left(ShareStock_{t-1}^{LR^d} - ShareStock_{t-1}^{LR^s} \right) \tag{11}$$

$$P_t^{LR} = \begin{cases} P_{t-1}^{LR} \times (1 + adj^{IF} \times U(0,1)), & \text{if } ED_{t-1}^{LR} > 0 \\ P_{t-1}^{LR} \times (1 - adj^{IF} \times U(0,1)), & \text{if } ED_{t-1}^{LR} < 0 \\ P_{t-1}^{LR} & \text{otherwise} \end{cases} \tag{12}$$

The adjustment of share issue, pricing and matching for medium and high risk funds follows the same pattern as for low risk funds.

Investment funds are important financial intermediaries that allocate the funds they raise by issuing shares into portfolios of financial assets. Each IF collects shares, a part of which is allocated to deposits, while the remaining funds are used to construct portfolios of financial assets. Each IF then follows a specific investment strategy. Low-risk IFs invest primarily in safe financial assets, such as government bonds. The amount invested in bonds is determined by the difference between the shares issued and the deposits held.

$$BondStock_t^{LR} = ShareStock_t^{LR} - DepositStock_t^{LR} \tag{13}$$

Medium-risk IFs allocate their investments between bonds and CDOs. Their decision is influenced by the spread between the return on CDOs and the interest on bonds, as in Eq. (14), and their requested quota of bonds is in Eq. (15).

$$Spread_t^{CDOvsB} = Return_t^{CDO} - i_t^B \tag{14}$$

$$qBond_t^{MR} = \min(1, qBond_{t-1}^{MR} \times (1 - \beta \times \Delta Spread_t^{CDOvsB})) \tag{15}$$

The demand for bonds by the medium-risk IF is:

$$BondStock_t^{MR} = qBond_t^{MR} \times \left(ShareStock_t^{MR} - DepositStock_t^{MR} \right) \tag{16}$$

High-risk IFs invest exclusively in high-risk assets such as CDOs. The demand for CDOs by high-risk IFs is calculated as the difference between the shares they issue and the deposits they want:

$$CDOStock_t^{HR} = ShareStock_t^{HR} - DepositStock_t^{HR} \tag{17}$$

A.3. The households sector

The household sector is highly heterogeneous, with households differing in terms of wages, accumulated wealth (deposits and shares in investment funds), indebtedness and financial vulnerability. Households receive wages based on an empirical distribution and their gross wages evolve over time based on their unemployment status and the unemployment rate. The different income distribution among households allows each household to be allocated to one of three categories: richer households are allocated to the top workers category, middle-wage households to the white-collar workers category, and low-wage households to the blue-collar workers category. Households remain in their allocated category throughout the simulation.

Part of the labour force is employed directly by the government in the public sector. The government employs shares of top managers, white-collar workers and blue-collar workers. Then, for simplicity, these households are randomly selected from the pool of top managers, white-collar workers and blue-collar workers.

The remaining households are employed in the private sector. Firms in the economy determine their hiring needs based on their production levels and the productivity of their workers. Firms then seek to hire the number of workers they need and to distribute them across different skill levels: blue-collar, white-collar and top-level. The proportions are always calibrated from the OEWS data.

Households' gross wages evolve according to their employment status from the previous period and the overall unemployment rate. If a household was unemployed in the previous period, it tends to settle for lower wages, whereas if it was employed, it tends to seek and expect higher wages, reflecting a tendency to negotiate for better pay (Riccetti et al., 2015; Krueger and Mueller, 2016; Banfi et al., 2019; Faberman et al., 2022; Fluchtmann et al., 2024), as in Eq. (18). In addition, the equation expresses the negative relationship between unemployment and wages, reflecting how households living in areas of high unemployment tend to earn less (Sachs and Gordon, 1983; Blanchflower and Oswald, 1995; Seputiene, 2011; López-Villavicencio and Saglio, 2017; Eser et al., 2020). For an unemployed household in period $t-1$, $wage_{i,t-1}$ is the wage it would have received if it had not been unemployed in the previous period.

$$wage_{i,t} = \begin{cases} wage_{i,t-1} \times \left(1 + \text{adjH} + \frac{adj2}{UnempRate_{t-1}}\right) & \text{if } employed_{t-1} \\ wage_{i,t-1} \times \left(1 - \text{adjH} + \frac{adj2}{UnempRate_{t-1}}\right) & \text{if } unemployed_{t-1} \end{cases} \tag{18}$$

Household wages are subject to progressive taxation, with different rates depending on whether the gross wage is above or below the median wage.

They then receive financial income, based on their share of wealth, from dividends paid by companies and investment funds and from returns on shares in IFs.

Households have to repay both interest and capital on their loans. The proportion of loans repaid is calculated on the basis of the outstanding stock of loans and a fixed repayment rate ϵ.

$$interestLoan_{i,t} = i^{h}_{i,t-1} \times loanStock_{i,t-1} \tag{19}$$

$$principalRepay_{i,t} = loanStock_{i,t-1} \times \epsilon \tag{20}$$

If a household's income (labour and financial resources) is insufficient to cover at least half of its current consumption, loan repayments and interest payments, it is defined as financially vulnerable and accumulates non-performing loans (NPLs) if it cannot meet its obligations. In this case, they have to pay principal and interest for the next period.[15]

$$\begin{aligned} loanQuotaToBePaid_{i,t} = interestLoan_{i,t} + principalRepay_{i,t} + \frac{c_{i,t-1}}{2} - \\ -wage_{i,t} - financialIncome_{i,t} - dole_{i,t} - depositStock_{i,t-1} \end{aligned} \tag{21}$$

Households' disposable income is determined by their net wage, financial income, and other inflows, minus loan repayments.

$$yd_{i,t} = wage_{i,t} + dole_{i,t} + financialIncome_{i,t} - (interestLoan_{i,t} + principalRepay_{i,t}) \tag{22}$$

Household consumption is divided into two main components: energy consumption and goods consumption. These are modelled on the basis of household wealth, disposable income and imitation behaviour. Eq. (23) expresses the aggregate energy demand of households. Household specific quota of real energy demand is proportional to their wealth quota, as reported in Eq. (24), so that, in line with the literature, richer households tend to consume more energy relative to the poorest households because they tend to have a warmer environment and their consumption tends to be highly energy intensive (Huebner et al., 2015; Kelly, 2011; Santin, 2011).

$$C^{energy}_{t} = \alpha \times WealthStock_{t-1} \tag{23}$$

$$quotaCons^{energy}_{i,t} = \frac{wealthStock_{i,t}}{WealthStock_{t-1}} + \overline{quotaCons^{energy}_{i,t}} \tag{24}$$

$\overline{quotaCons^{energy}_{i,t}} = median\left(\frac{wealthStock_{i,t}}{WealthStock_{t-1}}\right) \times \frac{1}{10}$ is the minimum energy consumption for each household.

Real energy consumption for each household is then calculated by multiplying the energy quota by the aggregate household's energy demand:

$$c^{e^r}_{i,t} = quotaCons^{energy}_{i,t} \times C^{energy}_{t} \tag{25}$$

Consumption of non-energy goods is influenced by households' disposable income and a tendency to imitate the consumption patterns of higher income households (Duesenberry, 1948; Galbraith, 1998; Frank et al., 2014), as indicated by Eq. (26). For instance, lower-skilled households try to emulate the consumption habits of wealthier individuals within the same group (among blue-collar workers), and so on for white and top workers. The model simplifies this process by adjusting each household's consumption based on the average consumption within its category, with a stronger effect on the spending patterns of poorer households compared to wealthier ones within the same category. Furthermore, in order to have a different average propensity to consume, households tend to consume their non-financial disposable income, so that the poorest households (with no financial income) consume more relative to their disposable income than the richer ones. The third part of the consumption function $c^{s} \times \frac{c^{e^r}}{Pl_t}$ is because households follow a hierarchical decision-making process (Lavoie, 2022). This idea suggests that households prioritise their consumption based on a pyramid of needs, with basic needs taking precedence (energy good), followed by goods that satisfy the higher needs (non-energy good).

$$c^{g^r}_{i,t} = c_y \times \frac{yd_{i,t} - financialIncome_{i,t}}{Pl_t} + c^{Imitate} \times \frac{imitate}{Pl_t} - c^{s} \times \frac{c^{e^r}}{Pl_t} \tag{26}$$

$imitate = mean(c^{h}_{i,t-1})$ h stands for blue, white collars or top manager and its the part devolved to the imitation consumption process. Total desired nominal consumption for households is the sum of energy and non-energy goods consumption:

$$c^{*}_{i,t} = c^{e^r}_{i,t} \times P^{e}_{t} + c^{g^r}_{i,t} \times Pl_t \tag{27}$$

After defining households consumption choice they allocate their portfolios among desired deposits, and shares of the investment funds sector.

$$depositStock^{*}_{i,t} = depositStock_{i,t-1} \times (1 + \eta \times wealth^{growth}_{i,t}) \tag{28}$$

$$shareStock^{*,h}_{i,t} = shareStock^{*,h}_{i,t-1} \times \left(1 + adj^{P^{IF}} \times \frac{P^{IF,j}_{t} - P^{IF,j}_{t-1}}{P^{IF,j}_{t-1}}\right) \tag{29}$$

in which $h = blue, white, top$ workers and j represent the typology of investment funds, i.e. low, medium and high risk funds. Since in this model the lower-income workers are low-risk, they tend to invest in low-risk IFs, medium-risk households (middle income class) invest in medium-risk assets, while richer households are high-risk families that tend to hold high-risk IF shares.

When households' disposable income is insufficient to cover their consumption, desired deposits and demand of shares, they have a positive desired loan and apply to the commercial banking sector to obtain the external funds necessary to cover their needs. The desired flows of external funds for a household are defined by Eq. (30).

$$loan^{*}_{i,t} = deposit^{*}_{i,t} + share^{*}_{i,t} - saving^{*}_{i,t} \tag{30}$$

If the loan request is accepted, the household can finance its desired level of consumption and savings (deposits and IF shares). Households may face credit rationing if their debt service-to-income ratio or debt service (if they get the loan) is too high. After rationing, the possible scenarios are as follows:

- If households have positive savings, this means that they can fully finance their desired consumption and have some money in excess to finance some level of portfolio allocation, but below their desired level. Thus:
  1. The households' desired consumption becomes effective and they calculate their possible savings.
  2. They try to cumulate their desired deposit with their available savings. If the savings are not sufficient to cumulate their desired deposit, they are below the desired level and they do not cumulate any IF shares.
  3. Only if their savings can grant them the desired deposits, they use the extra savings to try to cumulate IFs' shares.
- When households face negative savings, they sell financial assets to meet their consumption needs.
  1. First, households sell their IF shares and use the proceeds of the IF shares sold and their disposable income to satisfy their desired consumption.

[15] For the sake of simplicity, households do not fully repay interest and principal in order to satisfy their consumption.

2. If the sold IF shares and their disposable income are not sufficient to satisfy their desired consumption, they use all their deposit holdings to satisfy their desired consumption.
3. If the deposit stocks are also insufficient, they have to reduce their desired consumption.

If the desired loan is negative, households do not need to borrow and first use the surplus money to repay their loan stock. If a household has already repaid all its loans, it allocates the excess money in the form of extra deposits and IF shares.

A.4. The government sector

The government plays a crucial role in the economy by hiring workers, making public purchases, paying unemployment benefits, collecting taxes and issuing public bonds. The government hires shares of the workforce and divides them into different skill groups: top managers, white-collar workers and blue-collar workers.

Public purchases contribute to government expenditure and are proportional to total household consumption. This is modelled as in Eq. (31):

$$G_t = \xi \times C_t \tag{31}$$

The primary public deficit is the result of wages Gw_T, unemployment benefits (dole), and public purchases G_t, minus the taxes collected from firm profits, household, and commercial banks respectively $\tau_t^f, \tau_t^h, \tau_t^B$.

$$PrimaryPublicDeficit_t = Gw_t + Dole_t + G_t - \tau_t^f - \tau_t^h - \tau_t^B \tag{32}$$

Public debt is accumulated from the public deficit and, to finance the public deficit, the government issues bonds which are bought by investment funds and banks.

A.5. The special purpose vehicles sector

Special purpose vehicles (SPVs) play a crucial role in the securitisation process by buying loans from the commercial banking sector and repackaging them into structured financial products, such as collateralised debt obligations (CDOs). These CDOs are then sold to investment funds, which use them, together with government bonds, to issue investment fund (IF) shares, which are mainly bought by the wealthiest households. These have two important implications for inequality. On the one hand, SPVs allow commercial banks to sell loans, which improves their capital position (in particular their Tier 1 capital ratios) and allows them to lend more. This increased lending could stimulate consumption, especially among poorer households, potentially reducing inequality. On the other hand, the interest paid by borrowers flows through the financial system and becomes returns on CDOs held by investment funds. As the richest households own most of the IFs' shares, they ultimately receive these returns, which could increase inequality.

The issuance of CDOs by SPVs $CDOsupply_t^{SPV}$ is demand-driven, so the loans securitised by SPVs are equal to the total demand for CDOs, which is the sum of the demand from medium-risk (MR) and high-risk (HR) investment funds.

The share of securitised loans z_t is calculated as follows:

$$z_t = \min\left(1, \frac{CDOsupply_t^{SPV}}{LoanStock_t^h + LoanStock_t^{NFF}}\right) \tag{33}$$

Thus, loans represent the asset side of the SPV balance sheet and the are the raw materials for the construction of structured financial products which are the liability side of the sector.

A.6. The commercial bank system

The banking sector plays a key role in the economy by providing credit to both households and firms.

The decision to lend to the household sector is influenced by several factors, including household indebtedness and the bank's propensity to lend. The bank's propensity to lend Ψ (Eq. (34)) depends on the bank's Tier 1 capital ratio and non-performing loans (NPLs). $DiffTierBasel_t$ means that the Tier 1 capital ratio is compared to a Basel 1 capital requirement.

$$\Psi_t = \Psi^o + \omega_1 \times DiffTierBasel_t \tag{34}$$

The Tier 1 capital ratio is a key indicator of the Bank's financial health and affects its ability to lend. It is calculated as the ratio of the Bank's Tier 1 capital (Eq. (35)) to risk-weighted assets, as defined in the (36).

$$Tier1Bank_{t,mc} = Tier1Bank_{t-1,mc} + RetainedProfitB_{t,mc} - NPL_{t,mc}. \tag{35}$$

$$Tier1Ratio_t = \frac{Tier1Bank_t}{(\rho \times (1-z_t) \times (LoanStock_t^h + LoanStock_t^{NFF}) + (1-\rho) \times BondStock_t^B)} \tag{36}$$

The Bank's decision to lend to the household sector is also based on two factors: the household-specific debt service-to-income ($dti_{i,t}$) ratio, as defined in Eq. (37), and the household's indebtedness relative to its income inflows if it was to receive the loan for which it is applying ($hhIndebt_{i,t}$ in Eq. (38)). These factors ensure that households do not become over-indebted. A household is eligible for a loan if its household-specific dti ratio ($dti_{i,t}$) is below certain thresholds set by the policy maker (DTI_t) and if the household's indebtedness (including the requested loan) expressed by Eq. (38) is less than the bank's propensity to lend Ψ_t as reported in Fig. 12.

$$dti_{i,t} = \frac{i_{i,t}^h \times loanStock_{i,t-1} + \epsilon \times loanStock_{i,t-1}}{netWage_{i,t} + dole_{i,t} + financialIncome_{i,t}} \tag{37}$$

$$hhIndebt_{i,t} = \frac{i_{i,t}^{*h} \times (loanStock_{i,t-1} + loan_{i,t-1}^*) + \epsilon \times (loanStock_{i,t-1} + loan_{i,t-1}^*)}{netWage_{i,t} + dole_{i,t} + financialIncome_{i,t}} \tag{38}$$

In case the households receive the loans, the interest rate charged by the commercial bank sector is:

$$i_{i,t}^h = i_t^{BC} + i^h \times \frac{(i_t^{BC} \times loanStock_{i,t})}{(netWage_{i,t} + financialIncome_{i,t} + dole_{i,t})}; \tag{39}$$

Unlike households, the non-financial corporate sector does not experience credit rationing. For the sake of simplicity, firms receive the loans they request on the basis of their external financing needs. The interest rate charged to the NFF system is:

$$i_t^{NFF} = i^{BC} \times \kappa_1 + i^{NFF} \times \left(\frac{i^{BC} \times LoanStock_t^{NFF}}{FirmRevenues_t}\right) \tag{40}$$

If the NFFs sector does not need financing (negative external funds), the company uses its money to reduce its loans.

The bank's profit comes from retained interest on loans and interest on bonds. Taxes on these profits are paid to the government, and some is distributed as dividends according to the share of wealth held by households. The remaining profit is added to the bank's Tier 1 capital, adjusted for non-performing loans (NPLs).

Appendix B. Calibration parameters

See Table 2.

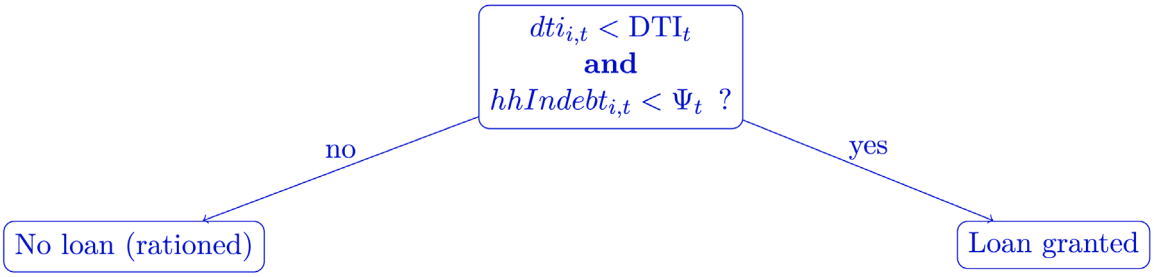

Fig. 12. Rule for loan requests under DTI_t set by policy maker and bank propensity to lend Ψ_t.

Table 2
List of parameters.

Symbol	Description	Baseline
T	Number of period	800
N	Number of households	1000
MC	Number of Monte Carlo simulations	300
τ_1	Lower tax rate on income	0.13
τ_2	Higher tax rate on income	0.37
τ_3	Tax rate on firms' profits	0.25
τ_4	Tax rate on commercial banks' profits	0.25
SF^{blue}	Share of blue-collar workers in the firm sector	0.55
SF^{white}	Share of white-collar workers in the firm sector	0.20
SF^{top}	Share of top workers in the firm sector	0.25
SG^{blue}	Share of blue-collar workers in the public sector	0.40
SG^{white}	Share of white-collar workers in the public sector	0.32
SG^{top}	Share of top workers in the public sector	0.28
$adjH$	Adjustment for households wage	0.000587312340736389
$adj2$	Sensitivity to the unemployment rate	0.0029765587747097
$parEDindex$	Adjustment to previous period's expected firm production	0.0397938883822597
$ProdLav$	Labour productivity	1.2
γ_1	Profit share weight (investment function)	0.687896629385932
γ_2	Capacity utilisation weight (investment function)	0.794643735867379
γ_3	Animal spirits weight (investment function)	0.0535866206015475
ω	Sensitivity to distance from Basel capital ratio	0.025
c_y	Propensity to consume out of disposable income	0.77341769074018
$c^{Imitate}$	"Socially determined" consumption	0.326102549315889
c^s	Weight of the consumption for primary good	0.1
δ	Capital monthly depreciation rate	0.01
ξ	Public purchases' determination out of aggregate consumption	0.10462543108258
α	Propensity to consume energy for the household sector	0.2
ψ^o	Basic risk attitude of banks	0.0164363565797337
ι^h	Sensitivity of banks to the debt position of households	0.01
κ_1	Multiplier of the policy rate on the interest rate on business loans	2.15
ι^{NFF}	Sensitivity of banks to the debt position of firms	0.5
ρ	Weight of risky assets on commercial banks' balance sheet (Tier1 function)	0.95
p	Part of the minimum gross wage to determine dole	0.66484375
s_1	IFs' portfolio share for government bonds	0.5
ρ^{NFF}	Quota of profit distributed from NFFs	0.67
ρ^B	Quota of profit distributed from banks	0.67
adj^{IF}	Adjustment for IF share price	0.02
β	Sensitivity to purchase public bonds by Medium-risk IF	10
η	Propensity to increase the accumulation of deposits	0.01
$adj^{P^{IF}}$	Sensitiveness to IF price increase	0.01
ω_1	Banks' sensitivity to difference between Tier 1 ratio and Basel Accord	0.025
ϵ	Monthly principal repayment	0.0042
Ψ^0	Bank's propensity to lend	0.0164363565797337

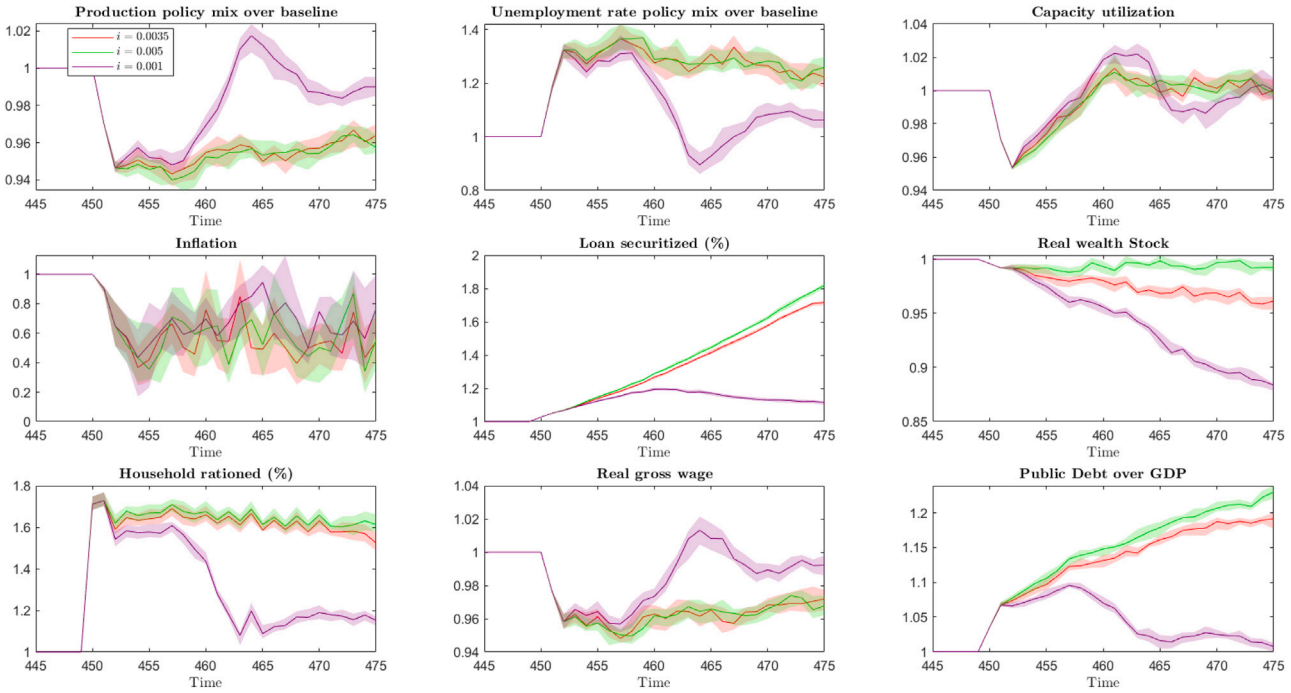

Fig. 13. Macro variables results.

Appendix C. Figures

See Fig. 13.

Data availability

Data will be made available on request.

References

Alpanda, S., Zubairy, S., 2017. Addressing household indebtedness: Monetary, fiscal or macroprudential policy? Eur. Econ. Rev. 92, 47–73. http://dx.doi.org/10.1016/j.euroecorev.2016.11.004.

Anwar, C.J., Suhendra, I., Purwanda, E., Salim, A., Rakhmawati, N.A., Jie, F., 2023. Investigating the relationship between monetary policy, macro-prudential policy and credit risk in Indonesia banking industry. Heliyon 9 (7), e18229. http://dx.doi.org/10.1016/j.heliyon.2023.e18229.

Ayyagari, M., Beck, T., Martinez Peria, M.S., 2017. Credit growth and macroprudential policies: Preliminary evidence on the firm level. BIS Paper (91a).

Banfi, S., Choi, S., Villena-Roldán, B., 2019. Deconstructing job search behavior. Available at SSRN 3323545.

Bellettini, G., Delbono, F., Karlström, P., Pastorello, S., 2019. Income inequality and banking crises: Testing the level hypothesis directly. J. Macroecon. 62, 103054. http://dx.doi.org/10.1016/j.jmacro.2018.08.007.

Blanchflower, D.G., Oswald, A.J., 1995. An introduction to the wage curve. J. Econ. Perspect. 9 (3), 153–167.

Boscá, J.E., Ferri, J., Rubio, M., 2024. Fiscal and macroprudential policies in a monetary union. Rev. Quant. Financ. Account. 1–35.

Botta, A., Caverzasi, E., Russo, A., 2022. When complexity meets finance: A contribution to the study of the macroeconomic effects of complex financial systems. Res. Policy 51 (8), 103990. http://dx.doi.org/10.1016/j.respol.2020.103990.

Botta, A., Caverzasi, E., Russo, A., 2024. Same old song: On the macroeconomic and distributional effects of leaving a Low Interest Rate Environment. Struct. Change Econ. Dyn. 69 (C), 552–570. http://dx.doi.org/10.1016/j.strueco.2024.03.

Botta, A., Caverzasi, E., Russo, A., Gallegati, M., Stiglitz, J.E., 2021. Inequality and finance in a rent economy. J. Econ. Behav. Organ. 183, 998–1029. http://dx.doi.org/10.1016/j.jebo.2019.02.013.

Botta, A., Caverzasi, E., Tori, D., 2015. Financial–real-side interactions in an extended monetary circuit with shadow banking: Loving or dangerous hugs? Int. J. Political Econ. 44 (3), 196–227.

Botta, A., Caverzasi, E., Tori, D., 2020. The macroeconomics of shadow banking. Macroecon. Dyn. 24 (1), 161–190.

Carpantier, J.-F., Olivera, J., Van Kerm, P., 2018. Macroprudential policy and household wealth inequality. J. Int. Money Financ. 85, 262–277. http://dx.doi.org/10.1016/j.jimonfin.2017.11.009.

Carvalho, F.A., Castro, M.R., 2017. Macroprudential policy transmission and interaction with fiscal and monetary policy in an emerging economy: a DSGE model for Brazil. Macroecon. Financ. Emerg. Mark. Econ. 10 (3), 215–259. http://dx.doi.org/10.1080/17520843.2016.1270982.

Catapano, G., Franceschi, F., Loberto, M., Michelangeli, V., 2021. Macroprudential policy analysis via an agent based model of the real estate sector. SSRN Electron. J. http://dx.doi.org/10.2139/ssrn.3891583.

Clementi, F., Gallegati, M., Gianmoena, L., Landini, S., Stiglitz, J.E., 2019. Mismeasurement of inequality: a critical reflection and new insights. J. Econ. Interact. Coord. 14, 891–921.

Cokayne, G., Gerba, E., Kuchler, A., Pank Roulund, R., 2024. "Thank me later": Why is (macro)prudence desirable? J. Financ. Stab. 71, 101227. http://dx.doi.org/10.1016/j.jfs.2024.101227.

Crowe, C., Dell'Ariccia, G., Igan, D., Rabanal, P., 2012. Policies for macrofinancial stability: Managing real estate booms and busts. pp. 1–25, International Monetary Fund.

Di Maggio, M., Kermani, A., 2017. Credit-induced boom and bust. Rev. Financ. Stud. 30 (11), 3711–3758. http://dx.doi.org/10.1093/rfs/hhx056.

Duesenberry, J.S., 1948. The Consumption Function: A Study of Relations Between Income and Consumer Expenditures. University of Michigan.

Eser, F., Karadi, P., Lane, P.R., Moretti, L., Osbat, C., 2020. The phillips curve at the ECB. Manch. Sch. 88, 50–85.

Faberman, R.J., Mueller, A.I., Şahin, A., Topa, G., 2022. Job search behavior among the employed and non-employed. Econometrica 90 (4), 1743–1779.

Fernandez-Gallardo, A., 2023. Preventing financial disasters: Macroprudential policy and financial crises. Eur. Econ. Rev. 151, 104350. http://dx.doi.org/10.1016/j.euroecorev.2022.104350.

Fluchtmann, J., Glenny, A.M., Harmon, N., Maibom, J., 2024. Unemployed Job Search Across People and Over Time: Evidence from Applied-For Jobs. Technical Report, IZA Discussion Papers.

Frank, R., Levine, A., Dijk, O., 2014. Expenditure cascades. Available at SSRN 1690612.

Frost, J., Van Stralen, R., 2018. Macroprudential policy and income inequality. J. Int. Money Financ. 85, 278–290. http://dx.doi.org/10.1016/j.jimonfin.2017.11.010.

Galati, G., Moessner, R., 2013. Macroprudential policy – A literature review. J. Econ. Surv. 27 (5), 846–878. http://dx.doi.org/10.1111/j.1467-6419.2012.00729.x.

Galbraith, J.K., 1998. The Affluent Society. Houghton Mifflin Harcourt.

Gatt, W., 2024. Wealth inequality and the distributional effects of maximum loan-to-value ratio policy. J. Econom. Dynam. Control 164, 104873. http://dx.doi.org/10.1016/j.jedc.2024.104873.

Georgescu, O.-M., Martin, D.V., 2024. Do macroprudential measures increase inequality? Evidence from the euro area household survey. Econ. Notes 53 (3), e12243. http://dx.doi.org/10.1111/ecno.12243.

Hauner, T., 2020. Aggregate wealth and its distribution as determinants of financial crises. J. Econ. Inequal. 18 (3), 319–338. http://dx.doi.org/10.1007/s10888-020-09444-9.

Huebner, G.M., Hamilton, I., Chalabi, Z., Shipworth, D., Oreszczyn, T., 2015. Explaining domestic energy consumption–the comparative contribution of building factors, socio-demographics, behaviours and attitudes. Appl. Energy 159, 589–600.

Kelly, S., 2011. Do homes that are more energy efficient consume less energy?: a structural equation model of the English residential sector. Energy 36 (9), 5610–5620.

Koedijk, K.G., Loungani, P., Monnin, P., 2018. Monetary policy, macroprudential regulation and inequality: An introduction to the special section. J. Int. Money Financ. 85, 163–167. http://dx.doi.org/10.1016/j.jimonfin.2017.11.003.

Krueger, A.B., Mueller, A.I., 2016. A contribution to the empirics of reservation wages. Am. Econ. J.: Econ. Policy 8 (1), 142–179. http://dx.doi.org/10.1257/pol.20140211.

Lavoie, M., 2022. Post-Keynesian Economics: New Foundations. Edward Elgar Publishing.

López-Villavicencio, A., Saglio, S., 2017. The wage inflation-unemployment curve at the macroeconomic level. Oxf. Bull. Econ. Stat. 79 (1), 55–78.

Lorenčič, E., Festić, M., 2021. Macroprudential policy versus other economic policies. Croat. Econ. Surv. 23 (2), 33–66.

Malovaná, S., Frait, J., 2017. Monetary policy and macroprudential policy: Rivals or teammates? J. Financ. Stab. 32, 1–16. http://dx.doi.org/10.1016/j.jfs.2017.08.004.

Malovaná, S., Hodula, M., Gric, Z., Bajzík, J., 2023. Macroprudential policy in central banks: Integrated or separate? Survey among academics and central bankers. J. Financ. Stab. 65, 101107. http://dx.doi.org/10.1016/j.jfs.2023.101107.

Mian, A., Sufi, A., Verner, E., 2017. Household debt and business cycles worldwide*. Q. J. Econ. 132 (4), 1755–1817. http://dx.doi.org/10.1093/qje/qjx017.

Minsky, H.P., 1977. The financial instability hypothesis: An interpretation of Keynes and an alternative to “standard” theory. Challenge 20 (1), 20–27.

Ozel, B., Nathanael, R.C., Raberto, M., Teglio, A., Cincotti, S., 2019. Macroeconomic implications of mortgage loan requirements: an agent-based approach. J. Econ. Interact. Coord. 14 (1), 7–46. http://dx.doi.org/10.1007/s11403-019-00238-5.

Park, S., Kim, Y.-H., 2023. The impact of macroprudential policy on inequality and implications for inclusive financial stability. J. Bank. Financ. 146, 106716. http://dx.doi.org/10.1016/j.jbankfin.2022.106716.

Paul, P., 2023. Historical patterns of inequality and productivity around financial crises. J. Money, Credit. Bank. 55 (7), 1641–1665. http://dx.doi.org/10.1111/jmcb.13020.

Punzi, M.T., Rabitsch, K., 2018. Effectiveness of macroprudential policies under borrower heterogeneity. J. Int. Money Financ. 85, 251–261. http://dx.doi.org/10.1016/j.jimonfin.2017.11.008.

Riccetti, L., Russo, A., Gallegati, M., 2015. An agent based decentralized matching macroeconomic model. J. Econ. Interact. Coord. 10, 305–332.

Riccetti, L., Russo, A., Gallegati, M., 2018. Financial regulation and endogenous macroeconomic crises. Macroecon. Dyn. 22 (4), 896–930. http://dx.doi.org/10.1017/S1365100516000444.

Richter, B., Schularick, M., Shim, I., 2019. The costs of macroprudential policy. J. Int. Econ.

Rubio, M., Carrasco-Gallego, J.A., 2014. Macroprudential and monetary policies: Implications for financial stability and welfare. J. Bank. Financ. 49, 326–336, Publisher: Elsevier BV.

Sachs, J.D., Gordon, R.J., 1983. Real wages and unemployment in the OECD countries. Brookings Pap. Econ. Act. 1983 (1), 255–304.

Santin, O.G., 2011. Behavioural patterns and user profiles related to energy consumption for heating. Energy Build. 43 (10), 2662–2672.

Schularick, M., Taylor, A.M., 2012. Credit booms gone bust: monetary policy, leverage cycles, and financial crises, 1870–2008. Am. Econ. Rev. 102 (2), 1029–1061.

Seputiene, J., 2011. The estimation of the relationship between wages and unemployment in the European Union. Int. J. Soc. Sci. Humanit. Stud. 3 (2), 277–285.

Tarne, R., Bezemer, D., Theobald, T., 2022. The effect of borrower-specific loan-to-value policies on household debt, wealth inequality and consumption volatility: An agent-based analysis. J. Econom. Dynam. Control 144, 104526.

Teixeira, A., 2023. Does macroprudential policy affect wealth inequality? Evidence from synthetic controls. J. Financ. Stab. 67, 101135. http://dx.doi.org/10.1016/j.jfs.2023.101135.

Van Bekkum, S., Gabarro, M., Irani, R.M., Peydró, J.-L., 2023. Take it to the limit? The effects of household leverage caps. The Effects of Household Leverage Caps (May 16, 2023).

You, Y., Hu, X., Huang, Z., 2024. Macroprudential policies, capital controls, and income inequality. Rev. Int. Econ. 32 (4), 1824–1867. http://dx.doi.org/10.1111/roie.12756.

Yun, T.-S., Bae, H.-S., Moon, I.-C., Jeong, D., 2024. The relationship between housing finance and inequality. J. Econ. Interact. Coord. 19 (1), 151–191. http://dx.doi.org/10.1007/s11403-024-00405-3.